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Phase III Environmental Site Assessment, Human Health and Ecological Risk Assessment and Remedial Action Plan for the Former U.S. Military Site at Northwest Point, Labrador, NL

Prepared for

Newfoundland and Labrador Department of Environment and Conservation

Final Report

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EXECUTIVE SUMMARY

At the request of the Newfoundland and Labrador Department of Environment and Conservation (NLDEC), a Phase III Environmental Site Assessment (ESA), a Human Health Risk Assessment and an Ecological Risk Assessment (HHRA/ERA) have been carried out and a Remedial Action Plan (RAP) has been prepared for the Former U.S. Military Site in Northwest Point, herein referred to as "the Site." The environmental site investigation and risk assessments were carried out to address data gaps and actions listed in the Implementation Plan prepared for the Site in March 2008 (Jacques Whitford Project No. 1036365) to enable the development of an overall RAP.

The Site, which covers an area of 450 hectares, is located in central Labrador, west of Lake Melville and north of Happy Valley-Goose Bay. It is located 6 km west of the Innu Community of Sheshatshiu and is accessed via a gravel road from Sheshatshiu. The Site is a former United States Military Facility, constructed in the early 1950s. It was reportedly decommissioned in 1965. The Site was used for long and short range communications. Historical activities included diesel power generation, large-scale storage and distribution of petroleum hydrocarbons, transformer oil and glycol, solid waste disposal, liquid waste discharge and disposal, boiler operation and equipment maintenance. Several small cabins are currently present on the Site.

Three (3) previous ESAs, including a limited Phase I/II program, a Phase II ESA and a limited remediation and assessment program, have been completed on the Site. The primary issues identified were petroleum hydrocarbon, polycyclic aromatic hydrocarbon (PAH) and metals impacts (i.e., above applicable guidelines at the times of the investigations) in soil and groundwater, petroleum hydrocarbon and metals impacts in surface water, waste disposal sites, surface debris (i.e., scrap metal, asbestos-containing materials, foundations and building debris, etc.) and free phase petroleum product. A limited remediation program including free product recovery at two (2) areas of the Site (i.e., the North and South Bulk Fuel Storage sites), removal of surface debris from several areas of the Site and removal or covering of foundations at several areas of the Site was carried out in 2001. A preliminary risk assessment was conducted at the South Bulk Fuel Storage Site as part of the site remediation and assessment program in 2001. The risk assessment indicated the potential for unacceptable risks to human receptors and terrestrial ecological receptors at the Site.

In 2008, the NLDEC commissioned an Implementation Plan that identified various data gaps and outstanding actions that needed to be addressed prior to the development of an overall remedial action plan/risk management plan for the Former U.S. Military Site in Northwest Point. The information contained in the Implementation Plan was used extensively to develop the scope of work for the current investigation. Based on previous environmental reports and field work completed as part of the current investigation, the Site was divided into 18 smaller study sites. These sites are summarised in Table A.

Table A Study Sites

Area	Site Name	Area	Site Name
Former U.S. Military Site	North Bulk Fuel Storage Site	Former U.S. Military Site	Oil Shed Site
	South Bulk Fuel Storage Site		Lake Melville Dump Site
	East Bulk Fuel Storage Site		Underground Pipeline System
	East Generator Site		Sewer System
	West Generator Site		Dock Road Drum Storage Site
	Transmitter Building		VOR Site
	Camp Road Dump Site		Helicopter Pad
	Camp Road Drum Storage Site		Surface Water and Drainage Ditches
	Service Site (including desalination plant, boiler site and garbage freezer)	Background	Innu Healing Ground
			Clean Background Area

Where possible, data gaps identified in the Implementation Plan were addressed during the current investigation. The field component of this project consisted of the identification of debris and physical hazards, the excavation of test pits, borehole drilling complete with monitor well installation and associated soil and groundwater sampling and analysis as well as the collection of surface soil, sediment, surface water, benthic invertebrate, vegetation, berry, small mammal, rabbit and fish samples for laboratory analysis of various parameters. Field work was performed between August and November, 2009. During the current investigation, sheens were observed on groundwater encountered in test pits and extracted from monitor wells at various sites. Measurable free product was detected on water at the following locations:

- 09-MW4 (Service Site): No measurable product was detected on groundwater on August 27, 2009 and 4 mm of product was measured on groundwater on October 18, 2009.
- 09-MW20 (East Generator Site): 100 mm of product was measured on groundwater on August 27, 2009. Free product/groundwater was extracted from the well using a bailer on August 27, 2009 and was disposed of at a licensed treatment facility. 1 mm of product was measured on groundwater on October 18, 2009.
- Second manhole (Sewer System Site) - 150 mm of product was measured on sewer water in the manhole. A sample of this product was collected (09-Product1) and the laboratory results identified one product in the fuel oil range resembling weathered diesel.

Results of the soil, groundwater, surface water and sediment sampling conducted as part of the current Phase III ESA and previous investigations are summarized in Table B, which highlights chemicals of concern (COCs) with concentrations exceeding the applicable criteria, where such criteria exist. The maximum concentrations of COCs in soil, sediment, surface water and groundwater and the criteria applied for each site are provided in Table B.

Table B Summary of Impacts Identified in the Phase III ESA

Site	Impacted Media	Impacted Test Locations	COCs Exceeding Criteria	Maximum Concentration	Applicable Guideline	Applicable Criteria	Estimated Area of Impacts
North Bulk Fuel Storage Site	Soil	NF-TP1 (1999) NF-TP5 (1999) P-TP22 (1999) 09-TP1-BS3 09-TP2-BS2 09-TP3-BS2 09-TP4-BS2 09-TP5-BS2 09-MW2-SS2	TPH Lead	12,102 mg/kg 170 mg/kg	140 mg/kg 140 mg/kg	Tier I RBSL, 2003 CCME SQGs, 2008	TPH : 1,711 m^2 Metals : 42 m^2
	Groundwater	NF-TP6 (1999) S-TP2 (1999) 09-MW1 09-MW2S 09-MW3	TPH Mercury pH	4,501 mg/L 1 µg/L 6.07	20 mg/L 0.29 µg/L 6.5 – 9.0	Tier I RBSL, 2003 MOE, 2009 CCME FWAL, 2007	TPH : 523 m^2 Metals: 87 m^2 Gen. Chem. : 114 m^2
	Surface Water	09-SW8	Aluminum* Iron* Mercury pH	117 µg/L 484 µg/L 0.075 µg/L 6.42	5 µg/L 300 µg/L 0.026 µg/L 6.5 – 9.0	CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007	Metals : 52 m^2 Gen. Chem. : 53 m^2
South Bulk Fuel Storage Site	Soil	SF-TP1 (1999) SF-TP8 (1999) SF-TP10 (1999) SF-TP14 (1999) SF-TP31 (1999) SF-TP16 (2001) SF-MW1 (2001) 09-TP21-BS2 09-TP21-BS1 09-TP22-BS2 09-TP23-BS2 09-TP25-BS2 09-MW14-SS4 09-MW34D-SS1	TPH Benzene Xylenes	21,580 mg/kg 5.0 mg/kg 82 mg/kg	140 mg/kg 0.16 mg/kg 17 mg/kg	Tier I RBSL, 2003 Tier I RBSL, 2003 Tier I RBSL, 2003	TPH : 1,222 m^2 BTEX: 546 m^2
	Groundwater	SF-TP7 (1999) SF-TP11 (1999) SF-MW1S (2001) SF-MW1D (2001) 09-MW13S 09-MW14 09-MW34S	TPH Ethylbenzene Toluene Mercury pH	970,000 mg/L 560 mg/L 2,500 mg/L 0.8 µg/L 6.00	20 mg/L 20 mg/L 20 mg/L 0.29 µg/L 6.5 – 9.0	Tier I RBSL, 2003 Tier I RBSL, 2003 Tier I RBSL, 2003 MOE, 2009 CCME FWAL, 2007	TPH : 483 m^2 BTEX: 93 m^2 Metals: 174 m^2 Gen. Chem. : 57 m^2

Site	Impacted Media	Impacted Test Locations	COCs Exceeding Criteria	Maximum Concentration	Applicable Guideline	Applicable Criteria	Estimated Area of Impacts
South Bulk Fuel Storage Site	Surface Water	09-SW1	Aluminum Cadmium Chromium Copper Iron Lead Mercury pH	725 µg/L 0.041 µg/L 10.0 µg/L 9.5 µg/L 4,610 µg/L 1.02 µg/L 0.065 µg/L 5.99	5 µg/L 0.010 µg/L 8.9 µg/L 2 µg/L 300 µg/L 1 µg/L 0.026 µg/L 6.5 – 9.0	CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007	Metals : 39 m^2 Gen. Chem. : 39 m^2
East Bulk Fuel Storage Site	Soil	EF-TP1 (1999) EF-TP8 (1999) EF-TP9 (1999) EF-TP35 (1999) EF-TP37 (1999) 09-TP27-BS2 09-TP28-BS2 09-TP29-BS2 09-TP30-BS2 09-MW16-SS3 09-MW17-SS3 09-SS18 09-SS19	TPH	23,387 mg/kg	140 mg/kg	Tier I RBSL, 2003	TPH : 2,609 m^2
	Groundwater	EF-TP3 (1999) 09-MW15 09-MW16 09-MW17	TPH pH	12,380 mg/L 5.95	140 mg/L 6.5 – 9.0	Tier I RBSL, 2003 CCME FWAL, 2007	TPH : 353 m^2 Gen. Chem. : 665 m^2
East Generator Site	Soil	EG-TP1 (1999) EG-TP3 (1999) EG-TP4 (1999) EG-TP7 (1999) 09-TP32-BS2 09-TP33-BS2 09-MW19-SS3 09-MW20-SS2	TPH	14,820 mg/kg	140 mg/kg	Tier I RBSL, 2003	TPH : 1,158 m^2

Site	Impacted Media	Impacted Test Locations	COCs Exceeding Criteria	Maximum Concentration	Applicable Guideline	Applicable Criteria	Estimated Area of Impacts
	Groundwater	EG-TP2 (1999) P-TP34 (1999) 09-MW18 09-MW19 09-MW20	TPH Mercury Acenaphthylene Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(ghi)perylene Benzo(k)fluoranthene Chrysene Fluorene Ideno(1,2,3-cd)pyrene pH	760 mg/L 1.2 µg/L 42 µg/L 18 µg/L 5.9 µg/L 2.7 µg/L 2.5 µg/L 1.3 µg/L 2.5 µg/L 5.4 µg/L 410 µg/L 1.5 µg/L 5.73	20 mg/L 0.29 µg/L 1.8 µg/L 2.4 µg/L 4.7 µg/L 0.81 µg/L 0.75 µg/L 0.2 µg/L 0.4 µg/L 1 µg/L 400 µg/L 0.2 µg/L 6.5 – 9.0	Tier I RBSL, 2003 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 CCME FWAL, 2007	TPH : 507 m^2 Metals: 127 m^2 PAHs : 96 m^2 Gen. Chem. : 576 m^2
West Generator Site	Soil	WG-TP3 (1999) WG-TP6 (1999) WG-TP11 (1999) WG-TP12 (1999) 09-TP11-BS1 09-TP13-BS2 09-TP14-BS2 09-MW7-SS3 09-MW8-SS3 09-MW9-SS4 09-SS51	TPH Benzene Anthracene Benzo(a)pyrene TPE	32,340 mg/kg 4.2 mg/kg 6.3 mg/kg 12.0 mg/kg	140 mg/kg 0.16 mg/kg 2.5 mg/kg 5.3 mg/kg	Tier I RBSL, 2003 Tier I RBSL, 2003 CCME SQG, 2008 CCME SQG, 2008	TPH : 1, 317 m^2 BTEX: 86 m^2 PAHs : 120 m^2
	Groundwater	09-MW7 09-MW8	TPH Mercury Acenaphthylene Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo (b)fluoranthene Benzo(ghi)perylene Benzo(k)fluoranthene Chrysene Dibenz(ah) anthracene Fluoranthene Ideno(1,2,3-cd)pyrene Pyrene	33 mg/L 0.9 µg/L 2.1 µg/L 39 µg/L 51 µg/L 42 µg/L 35 µg/L 25 µg/L 35 µg/L 53 µg/L 6.5 µg/L 160 µg/L 30 µg/L 130 µg/L	20 mg/L 0.29 µg/L 1.8 µg/L 2.4 µg/L 4.7 µg/L 0.81 µg/L 0.75 µg/L 0.2 µg/L 0.4 µg/L 1 µg/L 0.52 µg/L 130 µg/L 0.2 µg/L 68 µg/L	Tier I RBSL, 2003 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009	TPH : 161 m^2 PAHs : 96 m^2

Site	Impacted Media	Impacted Test Locations	COCs Exceeding Criteria	Maximum Concentration	Applicable Guideline	Applicable Criteria	Estimated Area of Impacts
	Surface Water	09-SW10	Aluminum* Cadmium Copper* Iron* Zinc	151 µg/L 0.027 µg/L 2.2 µg/L 1,000 µg/L 117 µg/L	100 µg/L 0.017 µg/L 2 µg/L 300 µg/L 30 µg/L	CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007	Metals : 40 m^2
	Sediment	09-SED10	TPH Cadmium Zinc	3,200 mg/kg 0.9 mg/kg 910 mg/kg	1,500 mg/kg 0.6 mg/kg 123 mg/kg / 315 mg/kg	CCME ISQG, 2002 CCME ISQG, 2002 CCME ISQG, 2002 CCME PEL, 2002	TPH : 38 m^2 Metals: 40 m^2
Transmitter Building	Soil	WG-TP10 (1999) 09-TP19-BS2 09-SS47 09-SS50	TPH Anthracene Benzo(a)pyrene TPE	5,800 mg/kg 7.6 mg/kg 15.5 mg/kg	140 mg/kg 2.5 mg/kg 5.3 mg/kg	Tier I RBSL, 2003 CCME SQG, 2008 CCME SQG, 2008	TPH : 203 m^2 PAHs : 405 m^2
	Groundwater	WG-TP10 (1999)	TPH Mercury Nitrite pH	77 mg/L 0.9 µg/L 0.18 mg/L 6.47	20 mg/L 0.29 µg/L 0.06 mg/L 6.5 – 9.0	Tier I RBSL, 2003 MOE, 2009 CCME FWAL, 2007 CCME FWAL, 2007	TPH : 37 m^2 Metals: 31 m^2 Gen. Chem. : 190 m^2
Camp Road Dump Site	Soil	09-TP39-BS2 09-SS10 09-SS14	TPH Chromium Copper Lead Molybdenum Zinc	760 mg/kg 5,600 mg/kg 690 mg/kg 33,000 mg/kg 58 mg/kg 390 mg/kg	140 mg/kg 64 mg/kg 63 mg/kg 140 mg/kg 10 mg/kg 200 mg/kg	Tier I RBSL, 2003 CCME SQG, 2007 CCME SQG, 2007 CCME SQG, 2007 CCME SQG, 2007 CCME SQG, 2007	TPH : 195 m^2 Metals : 528 m^2
	Groundwater	09-MW23D	Mercury Benzo(a)pyrene Benzo(b)fluoranthene Benzo(ghi)perylene Benzo(k)fluoranthene Chrysene Ideno(1,2,3-cd)pyrene Pyrene	0.8 mg/kg 3.0 µg/L 2.4 µg/L 1.7 µg/L 2.4 µg/L 3.5 µg/L 1.9 µg/L 6.6 µg/L	0.29 mg/kg 0.81 µg/L 0.75 µg/L 0.2 µg/L 0.4 µg/L 1 µg/L 0.2 µg/L 68 µg/L	MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009 MOE, 2009	Metals : 242 m^2 PAHs : 173 m^2
Camp Road Drum Storage Site	Soil	CDS-TP1 (1999)	TPH	21,902 mg/kg	140 mg/kg	Tier I RBSL, 2003	TPH: 86 m^2

Site	Impacted Media	Impacted Test Locations	COCs Exceeding Criteria	Maximum Concentration	Applicable Guideline	Applicable Criteria	Estimated Area of Impacts
Service Site	Soil	SS-TP1 (1999) WG-TP6 (1999) 09-TP7-BS2 09-TP10-BS2 09-SS55	TPH Lead	16,739 mg/kg 210 mg/kg	140 mg/kg 140 mg/kg	Tier I RBSL, 2003 CCME SQG, 2007	TPH : 528 m^2 Metals : 87 m^2
	Groundwater	09-MW4 09-MW6	TPH Nitrate pH	540 mg/L 3.1 mg/L 6.41	20 mg/L 2.9 mg/L 6.5 – 9.0	Tier I RBSLs CCME FWAL, 2007 CCME FWAL, 2007	TPH : 86 m^2 Gen. Chem. : 190 m^2
Oil Shed Site	Soil	O-TP1 (1999)	TPH	3,800 mg/kg	690 mg/kg	Tier I RBSL, 2003	TPH: 86 m^2
	Groundwater	09-MW25	Silver	52.3 µg/L	1.5 µg/L	MOE, 2009	Metals : 87 m^2
Lake Melville Dump Site	Soil	LD-TP1 (1999) 09-MW27D-SS1 09-MW27D-SS3 09-SS32 09-SS33	TPH Anthracene Fluoranthene Benzo(a)pyrene Benzo(a)pyrene TPE PCBs	29,500 mg/kg 57 mg/kg 230 mg/kg 81 mg/kg 120.9 mg/kg 3.1 mg/kg	140 mg/kg 2.5 mg/kg 50 mg/kg 20 mg/kg 5.3 mg/kg 1.3 mg/kg	Tier I RBSL, 2003 CCME SQG, 2007 CCME SQG, 2007 CCME SQG, 2007 CCME SQG, 2007 CCME SQG, 2007	TPH : 105 m^2 PAHs : 70 m^2 PCBs : 64 m^2
	Groundwater	09-MW28	Mercury	1.1 µg/L	0.29 µg/L	MOE, 2009	Metals : 146 m^2
	Surface water	09-SW6	Aluminum* Cadmium Chromium Copper* Iron Lead	398 µg/L 0.071 µg/L 10.2 µg/L 4.8 µg/L 3,090 µg/L 2.97 µg/L	100 µg/L 0.017 µg/L 8.9 µg/L 2 µg/L 300 µg/L 1 µg/L	CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007	Metals: 45 m^2
	Sediment	09-SED6	Lead	430 mg/kg	35 mg/kg 91.3 mg/kg	CCME ISQG, 2002 CCME PEL, 2002	Metals: 45 m^2
Underground Pipeline System	Soil	P-TP16 Cable Wrap (1999) 09-SS22	TPH	6,804 mg/L	140 mg/L	Tier I RBSL, 2003	TPH : 110 m^2
Sewer System	Soil	S-TP3 (1999) S-TP7 (1999) S-TP10 (1999) S-TP12 (1999)	TPH	22,029 mg/kg	140 mg/kg	Tier I RBSL, 2003	TPH : 340 m^2
	Groundwater	S-TP2 (1999) S-TP6 (1999) S-TP12 (1999) 09-MW31	TPH	525 mg/L	20 mg/L	Tier I RBSL, 2003	TPH: 232 m^2
	Sewer Water	SEWER 2 (1999)	TPH	16,480 mg/L	15 mg/L above background con'c.	NL Reg. 65/03, 2003	TPH: Insufficient data

Site	Impacted Media	Impacted Test Locations	COCs Exceeding Criteria	Maximum Concentration	Applicable Guideline	Applicable Criteria	Estimated Area of Impacts
Dock Road Drum Storage Site	Soil	DDS-TP2 (1999)	TPH	209 mg/kg	140 mg/kg	Tier I RBSL, 2003	TPH : 86 m^2
	Surface Water	09-SW5	Toluene Aluminum Cadmium Copper Iron Lead Zinc pH	0.005 mg/L 612 µg/L 0.086 µg/L 6.3 µg/L 1,020 µg/L 66.3 µg/L 32.7 µg/L 5.69 µg/L	0.002 mg/L 5 µg/L 0.009 µg/L 2 µg/L 300 µg/L 1 µg/L 30 µg/L 6.5 – 9.0	CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007	BTEX: 86 m^2 Metals: 87 m^2 Gen. Chem. : 77 m^2
	Sediment	09-SED5	TPH Lead	1,600 mg/kg 300 mg/kg	1,500 mg/kg 35 mg/kg / 91.3 mg/kg	MOE CCME ISQG/ CCME PEL	TPH : 86m^2 Metals: 87 m^2
Helicopter Pad Site	No exceedances						
Streams	Surface Water	SW1 (1999) SW1 (2001 SW3 (2001) SW6 (2001) 09-SW7	Aluminum* Copper* Iron* Colour pH	529 µg/L 5 µg/L 3,040 µg/L 100 TCU 6.03	100/100 µg/L 2 to 4 µg/L 300/300 µg/L 15 TCU 6.5 – 9.0/ 6.5 – 8.5	CCME FWAL,2007/ CDWQG, 2008 CCME FWAL, 2007 CCME FWAL,2007/ CDWQG, 2008 CDWQG, 2008 CCME FWAL,2007/ CDWQG, 2008	Metals : Insufficient data Gen. Chem. : Insufficient data
Innu Healing Ground	No exceedances						
Clean Background Area	Surface Water	SW-C1 (2001) SW-C2 (2001) SW-C3 (2001) 09-SWM1 09-SWM6	Aluminum Copper Cadmium Chromium Iron pH	442 µg/L 5 µg/L 0.017 µg/L 23.6 µg/L 1,150 µg/L 4.55	5 µg/L 2 to 4 µg/L 0.002 µg/L 8.9 µg/L 300 µg/L 6.5 to 9.0	CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007 CCME FWAL, 2007	N/A

Notes:
MW = Monitor well
TP = Test pit
SS = Surface soil sample
SED = Sediment sample
SW = Surface water sample
Benzo(a)pyrene TPE = Benzo(a)pyrene Total Potency Equivalents
* = Concentration is within the range detected in background surface water samples
N/A/ = Not applicable

Referenced Guidelines:

Tier I RBSLs : Partnership in Risk-Based Corrective Action (RBCA) Tier I Risk Based Screening Levels (RBSLs) for a residential site with non-potable groundwater, coarse grained soil and fuel oil impacts (March, 2007)

CCME SQGs : Canadian Council of Ministers of the Environment (CCME) Soil Quality Guidelines for a Residential/Parkland Site (2007)

MOE Groundwater Standards: Ontario Ministry of the Environment (MOE) Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act. July 27, 2009. Table 3: full depth generic site condition standards in a non-potable groundwater condition, coarse-grained soil

CCME FWAL : CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life (2007)

CDWQG : Health Canada Drinking Water Quality Guidelines (2008)

CCME ISQG : CCME Interim Sediment Quality Guidelines for freshwater sediment (2002)

CCME PEL : CCME Probable Effects Levels for freshwater sediment (2002)

NL Reg. 65/03 : Environmental Control Water and Sewage Regulations for sewage discharging into a body of water. Newfoundland and Labrador Regulation 65/03 - Schedule A (2003)

Surface debris and physical hazards were found throughout the Site, and generally consisted of empty 200 L drums, steel pipes and vavles, steel cable, concrete and domestic debris. Surface debris and physical hazards were found at or in the vicinity of the following sites:

- North Bulk Fuel Storage Site
- West Generator Site
- Transmitter Building Site
- Service Site
- Camp Road Dump Site
- Camp Road Drum Storage Site
- Service Site
- Lake Melville Dump Site
- Underground Pipeline Site (i.e., Lake Melville shoreline)
- Sewer System Site
- Dock Road Drum Storage Site
- Helicopter Pad Site

The end goals of the risk assessment were to quantify risk associated with the identified chemicals of concern at the Former U.S. Military Site in Northwest Point for the various receptor pathways that humans, animals and other biota may be exposed to. These receptor pathways have been determined for the overall site and associated risk evaluated for each of these pathways and, site-specific target levels (SSTLs) were calculated for the overall site. This output will assist NLDEC in focusing on those areas that require remedial efforts and provide more realistic clean up goals than those provide in Table B, that are site specific and protective of both human health and ecological components, hence providing a cost effective approach to risk manage the Site. Public consultation will be an essential component for remedial efforts at this Site. The SSTLs calculated for the overall site are present in Table 9.1 below.

Table C Summary of SSTLs to be applied to the Former U.S. Military Site

Chemical	SSTL (mg/kg)	Source	Areas Requiring Remediation
		Soil	
PAHs (Benzo(a)pyrene TPE)	23	HHRA	Lake Melville Dump Site (Drawing No. 121410105-EE-25C, Appendix 25)
TPH	2,100	ERA	East Bulk Fuel Storage Site (Drawing No. 121410105-EE-25A, Appendix 25)[1]
PCBs	1.5	ERA	Lake Melville Dump Site (Drawing No. 121410105-EE-25C, Appendix 25)[1]
		Sediment	
TPH	500[2]	ERA	Lake Melville Dump Site (Drawing No. 121410105-EE-25C, Appendix 25)

1 = Additional sampling required prior to remediation, as described in the following section

2 = Benchmark value used in the ecological risk assessment

The exposure point concentration (EPC) is an estimate of a reasonable upper limit value for the average chemical concentration in a medium, determined for each exposure unit through statistical analysis (USEPA, 1989). The areas of soil requiring remediation were selected in order to obtain area-wide EPCs that are less than the SSTLs for PAHs (i.e., Benzo(a)pyrene TPE), TPH and polychlorinated biphenyls (PCBs).

Remedial Action Plan

The following actions, remedial activities, and risk management strategies are recommended for the control of hazards related to petroleum hydrocarbon, PCBs, PAHs and metals impacts at the Site. Some of these recommendations are intended to be flexible, and will be modified as appropriate, depending upon the results of consultation with regulators and local residents.

Actions

1. An area of TPH impacted soil exceeding the SSTL generated for protection of ecological health was identified at the East Bulk Fuel Storage Site (Drawing No. 121410105-EE-25A, Appendix 25). However, because there were too few surface soil (i.e., <30 cm) samples analysed for TPH to calculate an EPC, the maximum concentration was used in the ecological risk assessment. In order to get an estimate of the area wide EPC, it is recommended that additional surface soil samples (< 30 cm) be collected and analysed for TPH. An area wide EPC can then be calculated and compared to the SSTL generated for protection of ecological receptors to determine if remediation is necessary.
2. An area of PCB impacted soil exceeding the SSTL generated for the protection of ecological health was identified at the Lake Melville Dump Site (Drawing No. 121410105-EE-25C, Appendix 25). Because there were too few soil samples analysed for PCBs to calculate an EPC, the maximum concentration of PCBs was used in the ecological risk assessment. Therefore, additional soil samples should be collected from this area to calculate an area wide EPC and to further delineate the PCB impacts prior to conducting any site remediation.
3. One surface water and one sediment sample was collected from the stream running through the Former U.S. Military Site during the 2009 field program. Concentrations of aluminum and iron and the pH value in the surface water sample exceeded the generic Canadian Council of Ministers of the Environment (CCME) and Health Canada guidelines. Because only one surface water sample was collected, it is uncertain if additional portions of the stream are impacted. A stream survey to determine the location of the streams on the Site as well as the collection of surface water samples and sediment samples from various portions of the stream are required in order to conduct an aquatic ecological risk assessment. Analysis should include TPH/BTEX and metals as well as PCBs and PAHs which had not been previously tested in sediment or surface water.
4. According to AMEC (2001), Innu from the area use surface water from the stream for drinking water. A pipe had been placed in the area of surface water sample SW1 for obtaining drinking water. Interviews with local residents (e.g., cabin owners) should be conducted to establish the use of surface water at the Site to ensure that all areas being used for drinking water are properly sampled.
5. Soil samples were selected for analysis of petroleum hydrocarbons based on the measured

soil vapor concentrations, field observations and site usage and history. No surface soil samples from the Service Site were analysed for petroleum hydrocarbons. Petroleum hydrocarbons were present in the subsurface soil at the site but it is unknown if the impacts are present in the surface soil. Because the knowledge of the presence of petroleum hydrocarbons in the surface soil is essential for the ecological risk assessment, surface soil samples should be collected and analysed for petroleum hydrocarbons at this site.

6. It is recommended that further sampling be conducted at the Helicopter Pad Site to verify the presence/absence of pesticides in surface soil.
7. Due to the dense vegetation present at the VOR site at the time of the site visit, a thorough site inspection could not be completed. It is recommended that the site be inspected in the late fall during a later site visit to assess for possible environmental issues related to the abandoned 900 L UST.
8. If site conditions or land uses change (e.g., residential usage, use of potable groundwater or further development on the Site), the results of the on-site risk assessment may need to be revisited to ensure that there are no additional or increased risks to potential receptors, on-site or off-site.
9. It is recommended that if vegetable gardens are grown in the future, they are kept away from contaminated areas of the Site. Clean imported topsoil should be brought in for this purpose.
10. It is our understanding that there is no current groundwater use for potable drinking water. The assumption is made that prior to any future use of groundwater for potable drinking water or other human use (i.e., showering, washing), the groundwater will be tested to demonstrate that groundwater quality is within the Guidelines for Canadian Drinking Water Quality.

Remedial Activities

1. Remove soil, metal and other debris from the area of soil sample 09-SS14, which is located at the Camp Road Dump Site (121410105-EE-25a, Appendix 25). The Camp Road Dump Site was used for the disposal of non-recyclable, non-hazardous waste recovered during the 2001 remediation program conducted by AMEC. Waste was placed into 10 m^2 by 4 m deep pits along the north side of the site. This may explain the elevated metals concentrations in soil sample 09-SS14. The items would be transported by truck to a lay-down area where metals leachability swab sampling would be conducted. Surface soil in the area of sample 09-SS14 should be resampled for metals leachability. Based on the results of leachability testing, soil (approximately 129 m^3), metal and other debris the area of 09-SS14 would be transported by truck to the local landfill or handled as hazardous waste and transported to an appropriate approved disposal facility.
2. The pH in surface water sample (09-SWM6) which was collected in the vicinity of the sewage discharge structure was low (4.55). Because aluminum can be a potential concern for aquatic receptors at pH values lower than six, the sewage discharge should be removed from this area of Lake Melville. The abandoned sewage discharge structure would be emptied of sludge by qualified personnel, following standard procedures. The removed sludge would be disposed of at local approved facilities. The discharge structure would be

cleaned and removed from the Site. The discharge structure would be disposed of at the local landfill. Sewer piping would be left in place and capped.

3. An area of PAHs impacted soil exceeding the SSTL (i.e., 23 mg/kg for Benzo(a)pyrene TPE) generated for protection of human health was identified at the Lake Melville Dump Site (Drawing No. 121410105-EE-25C, Appendix 25). Soil in this area should be remediated to a depth of 1.5 mbgs to be protective of human health. Based on the remedial options evaluation, the preferred option for remediation of PAHs-impacted soil is: Excavate soil and transport to a soil treatment facility or an out-of province hazardous waste landfill (dependant on the results of leachability testing).

4. The sediment sample collected from a small area of standing water at the Lake Melville Dump Site had a TPH concentration that exceeded the benchmark value of 500 mg/kg used in the ecological risk assessment. Concentrations of TPH are expected to be similar throughout the approximately 45 m^2 area of standing water. This area provides habitat for ecological receptors as evidenced by the presence of several tadpoles in the water during the 2009 field program. It is recommended that the sediment be removed from the area of standing water in the late fall season. Based on the remedial options evaluation, the preferred option for remediation of TPH-impacted sediment is to excavate sediment and transport to local landfill.

5. Free phase petroleum product was observed at the following sites: South Bulk Fuel Storage Site (09-TP21), Service Site (09-MW4), East Generator Site (09-MW20), Sewer System Site (second manhole). Because the Atlantic PIRI RBCA model is only applicable to sites where free product is not present, it is recommended that the free product be removed from these areas. Prior to the selection of a remedial option for free phase petroleum products on groundwater, it is recommended that further delineation be conducted at the South Bulk Fuel Storage Site, the Service Site and the East Generator Site. Free product should be purged from the sewer line and the sewer line should be decommissioned through capping.

Soil removal operations would be inspected on a continuous basis by an environmental consultant. Confirmatory soil sampling would be carried out in remediated areas to demonstrate that remedial objectives are obtained. Approval is needed from the local landfill, soil treatment facility and/or out-of-province hazardous waste landfill before soil can be sent there for disposal. It is assumed that approval would be received from the local landfill to accept the TPH-impacted soil described in the previous sections, based on the site characterization information which describes the acceptable levels of contaminants in soil disposed of at the landfill.

Once all soils and sediment requiring remediation have been removed from the Site and the EPCs for the Site are below the SSTLs and the identified human health and ecological risks at the Site have been mitigated, a summary report would be prepared and submitted to NLDEC to obtain site closure for the property.

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LIST OF ACRONYMS

ACOE	Army Corps of Engineers
ADD	Average Daily Dose
AENV	Alberta Environment
AF	Absorption Factor
AST	Aboveground Storage Tank
ASTM	American Society for Testing Materials
BA	Biotransfer Factors
BAF	Bioaccumulation Factor
BCF	Bioconcentration factor
BS	Bulk Sample
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
BW	Body Weight
CCME	Canadian Council of Ministers of the Environment
CDI	Chronic Daily Intake
CDWQG	Canadian Drinking Water Quality Guideline
COC	Chemical or Contaminant of Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EC50	Effective Concentration, 50%
Eco-SSLs	Ecological Soil Screening Levels
ED50	Effective Dose, 50%
EDI	Estimated Daily Intake
EHQ	Ecological Hazard Quotient
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESA	Environmental Site Assessment
FOC	Fraction Organic Carbon
FWAL	Freshwater Aquatic Life
GPS	Global Positioning System
GSI	Groundwater Services Inc.
GW	Ground Water
HD5	Hazardous Dose, 5%
HI	Hazard Index
HHERA	Human Health and Ecological Risk Assessment
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
HMW	High Molecular Weight
ICE	Interspecies Correlation Estimation
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
ISQG	Interim Sediment Quality Guidelines.
Kd	Partition coefficient of chemicals in bottom sediment
LADD	Lifetime Average Daily Dose
LC50	Lethal Concentration, 50%
LD50	Lethal Dose, 50%
LOAEL	Lowest Observed Adverse Effect Level

LOAEC	Lowest Observed Adverse Effect Concentration
LMW	Low Molecular Weight
mbgs	Meters Below Ground Surface
MH	Manhole
MOE	Ontario Ministry of the Environment
MW	Monitor Well
NLDEC	Newfoundland and Labrador Department of Environment and Conservation
NOAEC	No Observed Adverse Effects Concentration
NOAEL	No Observed Adverse Effect Level
ORNL	Oakridge National Laboratory
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PEL	Probable Effects Level
PID	Photoionization Detector
PIRI	Partnership in RBCA (Risk-Based Corrective Action) Implementation
POE	Point of Exposure
PQRA	Preliminary Quantitative Risk Assessment
PSSL	Pathway Specific Screening Level
QA/QC	Quality Assurance/Quality Control
RBCA	Risk-Based Corrective Action
RBSL	Risk-Based Screening Level
RDL	Reportable Detection Limit
RfC, RfD	Reference Concentration, Reference Dose
SAF	Soil Allocation Factor
SARA	Species at Risk Act
SD	Surface Debris
SF	Slope Factor
SM	Small Mammal
SS	Surface Sample
SSM	Sediment Sample - Marine
SSTL	Site Specific Target Level
SQG	Soil Quality Guideline
SW	Surface Water
SWM	Surface Water - Marine
TDI	Tolerable Daily Intake
TP	Test Pit
TPE	Total Potency Equivalent
TPH	Total Petroleum Hydrocarbons
TR	Target Risk
TRV	Toxicity Reference Value
UCL	Upper Confidence Limit
UP	Uptake Factor
UST	Underground Storage Tank
US EPA	United States Environmental Protection Agency
VECs	Valued Ecosystem Components
VOC	Volatile Organic Compound
VOR	Variable Omni-directional Range

1.0 INTRODUCTION

At the request of the Newfoundland and Labrador Department of Environment and Conservation (NLDEC), a Phase III Environmental Site Assessment (ESA) and a Human Health and Ecological Risk Assessment (HHRA/ERA) have been carried out and a Remedial Action Plan (RAP) has been prepared for the Former U.S. Military Site in Northwest Point, Labrador (see Drawing No. 121410105-EE-01A in Appendix 1), herein referred to as "the Site". The environmental site investigation and risk assessments were carried out to address data gaps and actions listed in the Implementation Plan prepared for the Site in March 2008 (Jacques Whitford Project No. 1036365) to enable the development of an overall RAP.

Based on previous environmental reports and field work completed as part of the current investigation, the Site was divided into 18 smaller study sites for the purpose of the Phase III ESA investigation. These sites are summarised in Table 1.1 and their locations with respect to the overall site are shown on Drawing No. 121410105-EE-01B in Appendix 1. Supporting documentation for the individual study sites, including site plans, are provided in Appendices 2 to 19, as described in Table 1.1.

Table 1.1 Study Sites

Area	Site Name	Supporting Documentation
Former U.S. Military Site	North Bulk Fuel Storage Site	Appendix 2
	South Bulk Fuel Storage Site	Appendix 3
	East Bulk Fuel Storage Site	Appendix 4
	East Generator Site	Appendix 5
	West Generator Site	Appendix 6
	Transmitter Building	Appendix 7
	Camp Road Dump Site	Appendix 8
	Camp Road Drum Storage Site	Appendix 9
	Service Site (including desalination plant, boiler site and garbage freezer)	Appendix 10
	Oil Shed Site	Appendix 11
	Lake Melville Dump Site	Appendix 12
	Underground Pipeline System	Appendix 13
	Sewer System	Appendix 14
	Dock Road Drum Storage Site	Appendix 15
	VOR Site	-
	Helicopter Pad	Appendix 16
	Surface Water and Drainage Ditches	Appendix 17
Background	Innu Healing Ground	Appendix 18
	Clean Background Area	Appendix 19

This report is organized into eight (8) sections. Section 1 provides background information about the property, explains the regulatory guidelines and their applicability, and describes the scope of work for the current investigation. Section 2 summarizes the methodology used for the field investigation and for laboratory analyses. Results of the Phase III investigation are presented in Section 3 by site and include the results of field investigations and laboratory analyses, as well as a discussion of results and conclusions. Section 3 also presents the results of the surface debris and physical hazards survey conducted at the Site. Sections 4 to 8 present the human health risk assessment and ecological risk assessment. Section 9 provides recommendations for future work on the property and details on various remedial options for the Site. Section 10 discusses the limitations of the assessment and its findings and Section 11 presents referenced materials. Supporting information is given in appendices.

This report was prepared specifically and solely for the above project. The report presents all of the factual findings and laboratory results of the Phase III ESA investigation, and presents our comments on the environmental status of the property.

1.1 Property Description

The Site, which covers an area of 450 hectares, is located in central Labrador, west of Lake Melville, and north of Happy Valley-Goose Bay (refer to Drawing No. 121410105-EE-01A, Appendix 1a). The Site is located 6 km west of the Innu Community of Sheshatshiu and is accessed via a gravel road from Sheshatshiu. The Site is fairly level, with gently sloping land. The land is covered by thick woods, mainly aspen and poplar with alder and willow in grown-in disturbed areas. Overburden materials on the Site consist of a mixture of sand and silty clay. Pockets of shallow perched groundwater are present in some areas of the Site. Boggy areas are present in portions of the Site and several small streams and drainage ditches are present in the site area. The Site is bounded to the north and east, and partly to the west, by Lake Melville and to the south and partly to the west by undeveloped crown land. Surface drainage and groundwater flow in the area of the Site are expected to follow local topography and flow to the north, east and west towards Lake Melville.

The Site is a former United States Military Facility, constructed in the early 1950s. It was reportedly decommissioned in 1965. The Site was used for long and short range communications. Historical activities included diesel power generation, large-scale storage and distribution of petroleum hydrocarbons, transformer oil and glycol, solid waste disposal, liquid waste discharge and disposal, boiler operation and equipment maintenance. Several small cabins are currently present on the Site.

1.2 Previous Investigations

Three (3) previous Environmental Site Assessments have been completed for the Site, including a Limited Phase I/II Reconnaissance Testing Program in 1998 (AGRA Earth and Environmental report dated November 23, 1998), a Phase II Environmental Site Assessment in 1999 (AGRA Earth and Environmental report dated May 19, 2000), and a Site Remediation and Assessment program in 2001 (AMEC Earth and Environmental report dated May 2002). In addition, an Implementation Plan was prepared in early 2008 (Jacques Whitford report dated March 31, 2008), which mapped out a way forward to carry out the Phase III Environmental Site Assessment, Human Health and Ecological Risk Assessment, and develop and implement a Remedial Action/Risk Management Plan for the Site.

During these previous investigations at the Site, the following areas of environmental concern were identified (refer to Drawing No. 121410105-EE-01B, Appendix 1a for site locations):

- North Bulk Fuel Storage Site
- South Bulk Fuel Storage Site
- East Bulk Fuel Storage Site
- East Generator Site
- West Generator Site
- Transmitter Building
- Camp Road Dump Site
- Camp Road Drum Storage Site
- Service Site (including desalination plant, boiler site and garbage freezer)
- Oil Shed Site
- Lake Melville Dump Site
- Underground Pipeline System
- Sewer System
- Dock Road Drum Storage Site
- Helicopter Pad
- VOR Site
- Tower Rubble, Foundation Ruins and Surface Debris (several areas)
- Surface Water and Drainage Ditches

The Limited Phase I/II program included the excavation of several test pits and collection of soil, groundwater and surface water samples for selected analysis of petroleum hydrocarbons, volatile organic carbons (VOCs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and/or metals. The investigation did not include an assessment of the entire site. Free phase petroleum product was encountered at several locations on the Site. Petroleum hydrocarbons, PAHs and metals were identified in site soils at levels above the applicable guidelines in place at the time of the investigation. BTEX parameters (benzene, toluene, ethylbenzene and xylenes) in the settling tank for the sewer system also exceeded the CCME guidelines for freshwater aquatic life in place at the time of the investigation. Building foundations and demolition debris were observed on the Site, primarily in the main compound area.

The Phase II ESA was conducted to delineate the extent of impacts at selected areas of the Site, to assess potential remedial alternatives and provide cost estimates for further investigation or remedial action. The assessment was limited to a survey to determine underground pipeline locations, delineation of impacts at the North and South Bulk Fuel Storage sites and the East and West Generator sites, and assessment of the Pipelines and Sewer System. The assessment included the excavation of several test pits and the collection of soil, groundwater and surface water samples for selected analysis of petroleum hydrocarbons, VOCs, PAHs and/or metals. Free phase petroleum product was encountered at several locations on the Site. Petroleum hydrocarbons, PAHs and metals were identified in site soils at levels above the applicable guidelines in place at the time of the investigation. Metals, including mercury, and PAHs were identified in groundwater samples from the Site at concentrations that exceeded the CCME guidelines for freshwater aquatic life in place at the time of the investigation.

In 2001, a limited remediation and assessment program was carried out at the Site. The remediation program included free product recovery at two (2) areas of the Site (i.e., the North and South Bulk Fuel Storage sites), removal of surface debris from several areas of the Site and removal or covering of foundations at several areas of the Site. The assessment program included the installation of three (3) monitor wells and the excavation of additional test pits at the South Bulk Fuel Storage Site. The assessment program included the collection of soil, groundwater and surface water samples for selected analysis of petroleum hydrocarbons, VOCs, PAHs, PCBs and/or metals. A preliminary risk assessment was conducted at the South Bulk Fuel Storage Site as part of the Site remediation and assessment program in 2001. The risk assessment indicated the potential for unacceptable risks to human receptors and terrestrial ecological receptors at the Site.

In summary, the primary issues identified at the former military facility were petroleum hydrocarbons, PAHs and metals impacts (i.e., above applicable guidelines at the times of the investigations) in soil and groundwater, petroleum hydrocarbons and metals impacts in surface water, waste disposal sites, surface debris (i.e., scrap metal, asbestos-containing materials, foundations and building debris, etc.) and free phase petroleum product.

In 2008, the NLDEC commissioned an Implementation Plan for the former military facility. The Implementation Plan was developed following a desktop review of the three available environmental assessment reports that were previously completed for the Site. The Implementation Plan served as a framework for development and implementation of remedial action plans/risk management plans for the former Northwest Point military facility. During the review of existing reports, various data gaps and outstanding actions were identified. The Implementation Plan suggested the completion of various studies and investigations at the former military facility prior to the development of overall remedial action plans for the area. The information contained in the Implementation Plan was used extensively to develop the scope of work for the current investigation.

1.3 Project Objectives

In general, the objectives of the Phase III ESA, HHERA and RAP as presented in the Terms of Reference prepared by the NLDEC were as follows:

1. Review the scope of previous physical hazards removal, evaluate the current extent of on-site physical hazards, and make recommendations for further physical hazards mitigation, if required.
2. Delineate the extent of sub-surface contamination on the Site identified during previous investigations.
3. Identify areas of potential concern that were not fully investigated previously, conduct reconnaissance testing in these areas and make recommendations for Phase III delineation, if required.

4. Review the results of the previous human health and ecological risk assessments, and conduct additional and/or more detailed human health and ecological risk assessments.
5. Prepare a comprehensive remedial action plan outlining alternative approaches and preferred methods to address mitigation of physical hazards and remediation of environmental contaminants.

1.4 Summary of Concerns and Proposed Field Program

This section includes a summary of the issues identified in the areas of concern and identifies data gaps. It should be noted that some issues are site-wide. For the site-wide recommendations, refer to Section 1.4.18.

The proposed field program was developed based on a review of the existing environmental reports for the Site, and particularly based on data gaps and sampling requirements outlined in the Implementation Plan.

1.4.1 North Bulk Fuel Storage Site

Data gaps and outstanding actions identified for the north bulk fuel storage area on the former U.S. military facility based on review of existing environmental assessment reports included:

1. Free phase petroleum product was previously noted to be present on site, but no measurements of product thickness were provided and no recovery/bail down tests had been carried out to assist in calculation of free product volume. The 2001 remediation report indicates that all free product was removed from the site, but no follow-up testing had been completed as verification.
2. Soil impacts were previously noted for TPH, but the extent of the impacts was not fully delineated.
3. It did not appear that surface soil samples had been collected from the site. Samples were collected from 0.5 m below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.
4. No groundwater monitor wells were previously installed on the site. Limited groundwater analysis had been carried out on groundwater samples collected from open test pits. The results of the groundwater analyses indicated that concentrations of some metals and mercury exceeded the CCME freshwater aquatic life guidelines and concentrations of TPH exceeded Tier I RBSLs. However, since the groundwater samples were not collected from a properly installed and purged monitor well, the groundwater results were not likely representative of the actual groundwater chemistry on the site. The extent of groundwater exceedances was not delineated.
5. Site-specific human health and ecological risk assessments had not been completed for the chemicals of concern (petroleum hydrocarbons, metals, mercury) at the site.
6. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had been collected and analysed for the chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small

mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.

7. A cache of tower sections was previously found south of the former north bulk fuel tank. The towers, which were painted with lead-based paints, were removed from the site in 2001, but no metals analysis had been completed on surface soils in the previous storage area. Dependent on metals results, metals leachability analysis and biota collection and analysis may also be required.
8. A single pump block and a section of exposed piping were not removed from the site during the 2001 remediation program. Two (2) concrete tower bases, located east of the former storage tank, and three (3) concrete tower bases, located northeast of the former storage tank, were not removed or covered during the 2001 remediation program.
9. The 2001 remediation program was terminated because of the early onset of snow at the site. It was noted that some surface debris may still be present on the site. Some grubbings and cut trees from the 2001 remediation program were said to possibly still be present on the site.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill three (3) boreholes, completed as groundwater monitor wells, with associated soil and groundwater sampling, to delineate the extent of petroleum hydrocarbon and metals impacts, and the extent of free product, if present.
- Excavation of two (2) test pits, with associated soil sampling to delineate the extent of petroleum hydrocarbon and metals (including mercury) impacts in the soil, to identify the absence or presence and possible extent of PAHs impacts in soil, and to aid in delineation of free product.
- Collection of three (3) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA, and to delineate the extent of petroleum hydrocarbon and metals impacts in surface soil.
- Conduct a groundwater depth survey, as well as a free product survey to verify that free phase product has been removed from the site.
- If free product is present, determine the thickness and estimate the total volume of free product at the site.
- If free product is present, conduct a bail down test to determine product recovery rates to assist in planning for remediation.
- Conduct falling head tests on one of the monitor wells to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.
- Submit select soil samples from bulk soil sampling, test pits and boreholes for analysis of petroleum hydrocarbons, PAHs and available metals (including mercury).
- Submit groundwater samples from the monitor wells for analysis of petroleum hydrocarbons and metals (including mercury).

1.4.2 South Bulk Fuel Storage Site

Data gaps and outstanding actions identified for the south bulk fuel storage area on the former U.S. military facility based on review of existing environmental assessment reports included:

1. Free phase petroleum product was previously noted to be present on site, but no measurements of product thickness were provided and no recovery/bail down tests had been carried out to assist in calculation of free product volume. The 2001 remediation report indicates that all free product was removed from the site, but no follow-up testing had been completed as verification.
2. Soil impacts were noted for TPH, but the extent of the impacts had not been fully delineated. Additional test pits and three (3) monitor wells were installed in 2001, but no drawing was included in the reviewed report to show the locations of these test pits and monitor wells.
3. It did not appear that surface soil samples had been previously collected from the site. Samples had been collected from 0.5 m below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.
4. Three (3) groundwater monitor wells were installed on the site in 2001. Limited groundwater analysis was also carried out on groundwater samples collected from open test pits at that time. The results of the groundwater analyses indicated that concentrations of toluene, some metals and mercury exceeded the CCME freshwater aquatic life guidelines and concentrations of TPH exceeded Tier I RBSLs. However, since all of the groundwater samples were not collected from a properly installed and purged monitor well, some of the groundwater results are not likely representative of the actual groundwater chemistry on the site. The extent of groundwater exceedances had not been delineated. The previous monitor well results confirmed that there is perched groundwater in the site area. The 2001 assessment recommended that additional monitor wells be installed at the site to check for possible migration of petroleum hydrocarbons in groundwater towards the adjacent bog.
5. A site-specific human health risk assessment (RBCA) was completed for the site in 2001. The risk assessment addressed petroleum hydrocarbons, VOCs and metals with the RBCA model. The results of the risk assessment indicated that concentrations of TPH in surface soils exceeded the SSTL derived for the site. The RBCA risk model had been updated since 2001. Under the existing risk assessment protocols followed by NLDEC, VOCs and metals would not be assessed using the RBCA risk model. It was stated that human health risks should be re-evaluated for the site, using the appropriate risk models.
6. An ecological screening indicated that there are potential ecological receptors in the site area. A site-specific ecological risk assessment had not been completed for the chemicals of concern (petroleum hydrocarbons, metals, mercury) at the site.
7. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had been collected and analysed for the chemicals of concern (other than TPH fractionation samples) to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.

8. The 2001 remediation program was terminated because of the early onset of snow at the site. It was noted that some surface debris may still be present on the site. Some grubbings and cut trees from the 2001 remediation program were said to possibly be present on the site.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill two (2) boreholes, completed as groundwater monitor wells, with associated soil and groundwater sampling, to delineate the extent of petroleum hydrocarbon and metals impacts in shallow groundwater, and the extent of free product, if present.
- Excavation of two (2) test pits, with associated soil sampling to delineate the extent of petroleum hydrocarbon and metals (including mercury) impacts in the soil, to identify the absence or presence and possible extent of PAHs impacts in soil, and to aid in delineation of free product.
- Collection of two (2) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA and to delineate the extent of petroleum hydrocarbon and metals impacts in surface soil.
- Conduct a groundwater depth survey, as well as a free product survey to verify that free phase product has been removed from the site.
- If free product is present, determine the thickness and estimate the total volume of free product at the site.
- If free product is present, conduct a bail down test to determine product recovery rates to assist in planning for remediation.
- Conduct falling head tests on one of the monitor wells to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PAHs and available metals (including mercury).
- Submit groundwater samples from the monitor wells for analysis of petroleum hydrocarbons and metals (including mercury).

1.4.3 East Bulk Fuel Storage Site

Data gaps and outstanding actions identified for the east bulk fuel storage area on the former U.S. military facility based on review of existing environmental assessment reports included:

1. Free phase petroleum product was previously noted to be present on site, but no measurements of product thickness had been provided and no recovery/bail down tests had been carried out to assist in calculation of free product volume.

2. Soil impacts were previously noted for TPH, but the extent of the impacts had not been fully delineated.

3. No testing had previously been carried out for metals and mercury in soil at the site. Dependent on metals results, metals leachability analysis and biota sampling may also be required.

4. It did not appear that surface soil samples had been collected from the site. Samples had been collected from 0.5 m below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.

5. No groundwater monitor wells had been installed on the site. Limited groundwater analysis for TPH/BTEX had been carried out on a groundwater sample collected from an open test pit which indicated TPH impacts. However, since the groundwater samples were not collected from a properly installed and purged monitor well, the groundwater results are not likely representative of the actual groundwater chemistry on the site. The extent of TPH impacted groundwater was not delineated and groundwater samples had not been analysed for metals and mercury.

6. Site-specific human health and ecological risk assessments had not been completed for the chemicals of concern (petroleum hydrocarbons and possibly metals and mercury) at the site. The results of further soil and groundwater investigations would be used to determine the chemicals of concern for inclusion in the risk assessments.

7. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had been collected and analysed for the chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.

8. The 2001 remediation program was terminated because of the early onset of snow at the site. It was noted that some surface debris may still be present on the site. Some grubbings and cut trees from the 2001 remediation program may still be present on the site.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill three (3) boreholes, completed as groundwater monitor wells, with associated soil and groundwater sampling, to delineate the extent of petroleum hydrocarbon impacts, and the extent of free product, if present, as well as the presence or absence and possible extent of metals (including mercury) impacts.
- Excavation of five (5) test pits, with the associated soil sampling to delineate the extent of petroleum hydrocarbon impacts in the soil, to identify the absence or presence and possible extent of metals (including mercury) and PAHs impacts in soil, and to aid in delineation of free product.
- Collection of five (5) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA, and to identify the absence or presence and possible extent of petroleum hydrocarbons, metals (including mercury) and PAHs impacts in surface soil.
- Conduct a groundwater depth survey. If free product is present, determine the thickness of product. Based on the data collected during the groundwater depth and free product survey, the total volume of free product at the site will be estimated.
- If free product is present, conduct a bail down test to determine product recovery rates to assist in planning for remediation.
- Conduct falling head tests on one of the monitor wells to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.

- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PAHs and available metals (including mercury).
- Submit groundwater samples from the monitor wells for analysis of petroleum hydrocarbons and metals (including mercury).

1.4.4 East Generator Site

Data gaps and outstanding actions identified for the east generator site area on the former U.S. military facility based on review of the existing environmental assessment reports included:

1. Free phase petroleum product was previously noted to be present on site, but no measurements of product thickness were provided and no recovery/bail down tests had been carried out to assist in calculation of free product volume.
2. Soil impacts were previously noted for TPH, but the extent of the impacts had not been fully delineated.
3. No testing had been previously carried out for PCBs in soil, even though electrical equipment was historically present on the site.
4. It did not appear that surface soil samples had previously been collected from the site. Samples were collected from 0.5 m below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.
5. No groundwater monitor wells had previously been installed on the site. Limited groundwater analysis had been carried out on groundwater samples collected from open test pits. No samples were tested for TPH. The results of the groundwater analyses indicated that concentrations of some metals, mercury and PAHs exceeded the CCME freshwater aquatic life guidelines. However, since the groundwater samples were not collected from a properly installed and purged monitor well, the groundwater results are not likely representative of the actual groundwater chemistry on the site. The extent of groundwater exceedances had not been delineated.
6. Site-specific human health and ecological risk assessments had not been completed for the chemicals of concern (petroleum hydrocarbons, metals, mercury, PAHs and possibly PCBs) at the site. The results of further soil and groundwater investigations would be used to determine the chemicals of concern for inclusion in the risk assessments.
7. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had been collected and analysed for the chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.
8. Foundation ruins from generator slab pads, as well as four concrete AST cribs, and a small underground concrete chamber (located approximately 30 m northeast of the foundation ruins) were noted as remaining on the site.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill three (3) boreholes, completed as groundwater monitor wells, with the associated soil and groundwater sampling, to delineate the extent of petroleum hydrocarbon and metals (including mercury) impacts, and the extent of free product, if present.
- Excavation of four (4) test pits, with associated soil sampling to delineate the extent of petroleum hydrocarbon and metals (including mercury) impacts in the soil, to identify the absence or presence and possible extent of PAHs impacts in soil, and to aid in delineation of free product.
- Collection of two (2) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA, and to identify the absence or presence and possible extent of petroleum hydrocarbons, metals (including mercury) and PAHs impacts in surface soil.
- Conduct a groundwater depth survey. If free product is present, determine the thickness of product. Based on the data collected during the groundwater depth and free product survey, the total volume of free product at the site will be estimated.
- If free product is present, conduct a bail down test to determine product recovery rates to assist in planning for remediation.
- Conduct falling head tests on one of the monitor wells to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PAHs, PCBs, and available metals (including mercury).
- Submit select groundwater samples from the monitor wells for analysis of petroleum hydrocarbons, PAHs and metals (including mercury).

1.4.5 West Generator Site

Data gaps and outstanding actions identified for the west generator site area on the former U.S. military facility based on review of existing environmental assessment reports included:

1. Free phase petroleum product was previously noted to be present on site, but no measurements of product thickness were provided and no recovery/bail down tests had been carried out to assist in calculation of free product volume.
2. Soil impacts were noted for TPH, but the extent of the impacts had not been fully delineated.
3. No testing had previously been carried out for PCBs in soil, even though electrical equipment was historically present on the site.
4. It did not appear that surface soil samples had previously been collected from the site. Samples were collected from 0.5 m below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.
5. No groundwater monitor wells had previously been installed on the site. Limited groundwater analysis had been carried out on groundwater samples collected from open test pits. Only one (1) sample was tested for TPH at that time. The results of the groundwater analyses indicated that concentrations of some metals, mercury and PAHs exceeded the CCME freshwater aquatic life guidelines. However, since the groundwater samples were not collected from a properly installed and purged monitor well, the

groundwater results are not likely representative of the actual groundwater chemistry on the site. The extent of groundwater exceedances had not been delineated.

6. Site-specific human health and ecological risk assessments had not been completed for the chemicals of concern (petroleum hydrocarbons, metals, mercury, PAHs and possibly PCBs) at the site. The results of further soil and groundwater investigations would be used to determine the chemicals of concern for inclusion in the risk assessments.
7. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had been collected and analysed for the chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.
8. One foundation ruin, with several open pits, was said to remain on the site.
9. Various surface debris was said to be present on the site. A large quantity of surface debris was said to be present on the east side of Crossover Road, near the intersection with VOR Road.
10. Buried building rubble, which included asbestos-containing materials, was said to be present on the site.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill three (3) boreholes, completed as groundwater monitor wells, with associated soil and groundwater sampling, to delineate the extent of petroleum hydrocarbon and metals impacts, and the extent of free product, if present.
- Excavation of four (4) test pits, with associated soil sampling to delineate the extent of petroleum hydrocarbon and metals (including mercury) impacts in the soil, to identify the absence or presence and possible extent of PAHs impacts in soil, and to aid in delineation of free product.
- Collection of two (2) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA, and to identify the absence or presence and possible extent of petroleum hydrocarbons, metals (including mercury) and PAHs impacts in surface soil.
- Conduct a groundwater depth survey. If free product is present, determine the thickness of product. Based on the data collected during the groundwater depth and free product survey, the total volume of free product at the site will be estimated.
- If free product is present, conduct a bail down test to determine product recovery rates to assist in planning for remediation.
- Conduct falling head tests on one of the monitor wells to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PAHs, PCBs, and available metals (including mercury).
- Submit select groundwater samples from the monitor wells for analysis of petroleum hydrocarbons, PAHs and metals (including mercury).

1.4.6 Transmitter Building

Data gaps and outstanding actions identified for the transmitter building site area on the former U.S. military facility based on review of existing environmental assessment reports included:

1. Only a limited soil investigation had been carried out at the site, with analysis of only one soil sample. No testing had previously been carried out for PCBs in soil, even though electrical equipment was historically present on the site. No testing had previously been carried out around the earth mound (buried building rubble).
2. It did not appear that surface soil samples had previously been collected from the site. The tested sample was collected from 1.5 m below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.
3. No groundwater monitor wells had previously been installed on the site. Limited groundwater analysis had been carried out on groundwater samples collected from one open test pit. No groundwater samples had been tested around the earth mound. The results of the groundwater analyses indicated that concentrations of some metals and mercury exceeded the CCME freshwater aquatic life guidelines. However, since the groundwater samples were not collected from a properly installed and purged monitor well, the groundwater results are not likely representative of the actual groundwater chemistry on the site. The extent of groundwater exceedances had not been delineated.
4. Site-specific human health and ecological risk assessments had not been completed for the potential chemicals of concern (petroleum hydrocarbons, metals, mercury, PAHs, PCBs) at the site. The results of further soil and groundwater investigations would be used to determine whether or not human health and ecological risk assessments are required and the chemicals of concern for inclusion in the risk assessments.
5. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had previously been collected and analysed for the potential chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.
6. One (1) partly exposed foundation ruin was said to remain on the site. Building rubble was said to be covered by an earth mound east of the visible section of foundation ruin.
7. A small quantity of surface debris was said to be scattered around the site.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill three (3) boreholes, completed as groundwater monitor wells, with associated soil and groundwater sampling, to assess the presence or absence and possible extent of petroleum hydrocarbon and metals impacts.
- Excavation of five (5) test pits, with associated soil sampling to confirm the presence or absence and possible extent of petroleum hydrocarbon, PCBs, and metals (including mercury) impacts in soil.

- Collection of four (2) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA, and to confirm the presence or absence and possible extent of petroleum hydrocarbon, PCBs, and metals (including mercury) impacts in surface soil.
- Conduct a falling head test on one monitor well to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property, if required.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PAHs, PCBs, and available metals (including mercury).
- Submit select groundwater samples from the monitor wells for analysis of petroleum hydrocarbons and metals (including mercury).

1.4.7 Camp Road Dump Site

Data gaps and outstanding actions identified for the Camp Road dump site area on the former U.S. military facility based on review of existing environmental assessment reports included:

1. No soil exceedances were previously identified at the site for TPH/BTEX, PAHs, PCBs, VOCs and metals. However, only a limited soil investigation had been carried out at the site (two samples). No testing for metals had been carried out at the former tower rubble storage area at the west end of the north side of the Dump Access Road 1. Dependent on metals results, metals leachability analysis may also be required.
2. It did not appear that surface soil samples had been collected from the site. The previously tested samples were collected from 1.5 m or deeper below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.
3. No groundwater monitor wells had previously been installed on the site. No groundwater samples had been tested from the site.
4. Site-specific human health and ecological risk assessments had not been completed for the potential chemicals of concern (petroleum hydrocarbons, metals, mercury, PAHs, VOCs and PCBs) at the site. The results of further soil and groundwater investigations would be used to determine whether or not human health and ecological risk assessments are required and the chemicals of concern for inclusion in the risk assessments.
5. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had been collected and analysed for the chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.
6. A sand cover was placed over the dump site in 2001. No testing was previously carried out to verify that the sand used in the cover was obtained from a clean area. Due to the early onset of snow, the cover was not fully completed over the entire site, particularly on the south side of the site. No vegetation was planted on the cover layer to minimize surface erosion.
7. The 2001 remediation program was terminated because of the early onset of snow at the site. It was noted that some surface debris may still be present on the site. Some grubbings

and cut trees from the 2001 remediation program were stated to possibly still remain on the site.

8. If the dump site is to be used in future for storage of non-hazardous wastes from other parts of the site, a suitable access road will be required.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill three (3) boreholes, completed as groundwater monitor wells, with associated soil and groundwater sampling, to further assess the presence or absence and possible extent of petroleum hydrocarbon, PAHs, PCBs, VOCs and metals (including mercury) impacts.
- Excavation of five (5) test pits, with associated soil sampling to confirm the presence or absence and possible extent of petroleum hydrocarbon, PAHs, PCBs, VOCs, and metals (including mercury) impacts in soil.
- Collection of six (6) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA, and to confirm the presence or absence and possible extent of petroleum hydrocarbon, PAHs, PCBs, VOCs, and metals (including mercury) impacts in surface soil.
- Conduct a falling head test on one monitor well to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property, if required.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PAHs, PCBs, VOCs, and available metals (including mercury).
- Submit select groundwater samples from the monitor wells for analysis of petroleum hydrocarbons, PAHs and metals (including mercury).

1.4.8 Camp Road Drum Storage Site

Data gaps and outstanding actions identified for the Camp Road drum storage site area on the former U.S. military facility based on review of the existing environmental assessment reports included:

1. TPH impacted soil had not been fully delineated at the site. No soil exceedances were previously identified at the site for PAHs and PCBs. However, only a limited soil investigation had been carried out at the site (one sample analysed). Metals had not previously been tested in soil samples from the site. Dependent on metals results, metals leachability analysis may also be required.

2. It did not appear that surface soil samples had been collected from the site. The tested sample had been collected from 0.5 m below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.

3. No groundwater monitor wells had previously been installed on the site. No groundwater samples had been tested from the site.

4. Site-specific human health and ecological risk assessments had not been completed for the potential chemicals of concern (petroleum hydrocarbons, metals, mercury, PAHs and PCBs) at the site. The results of further soil and groundwater investigations would be used to determine whether or not human health and ecological risk assessments are required for other than petroleum hydrocarbons and the chemicals of concern for inclusion in the risk assessments.

5. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had been collected and analysed for the potential chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill one (1) borehole, completed as a groundwater monitor well, with associated soil and groundwater sampling to further delineate the extent of petroleum hydrocarbon impacts in soil and to identify the presence or absence of petroleum hydrocarbon and metals (including mercury) impacts in the groundwater.
- Excavation of four (4) test pits, with associated soil sampling to further evaluate the presence or absence and possible extent of petroleum hydrocarbon, PAHs, PCBs, and metals (including mercury) impacts.
- Collection of five (5) bulk soil sample from surface (0 – 0.3 m) to obtain required data for the ERA, and to further evaluate the presence or absence and possible extent of petroleum hydrocarbon, PAHs, PCBs, and metals (including mercury) impacts in surface soil.
- Measure the depth to groundwater. If free product is present, determine the thickness of product.
- If free product is present, conduct a bail down test to determine product recovery rates to assist in planning for remediation.
- Conduct a falling head test on the monitor well to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PAHs, PCBs, and available metals (including mercury).
- Submit groundwater samples from the monitor well for analysis of petroleum hydrocarbons, and metals (including mercury).

1.4.9 Service Site

Data gaps and outstanding actions identified for the service site area on the former U.S. military facility based on review of the existing environmental assessment reports included:

1. Only a limited soil investigation had been carried out at the site. The extent of TPH impacts in soil had not been fully delineated at the site. No testing had previously been carried out for metals (from garage and workshops) and glycols (from freezer) in soil. Dependent on

metals results, metals leachability analysis may also be required. No soil samples had been tested around the earth mound (buried demolition rubble).

2. It did not appear that surface soil samples had been collected from the site. The previously tested samples were collected from 1.5 m or deeper below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.
3. No groundwater monitor wells were previously installed on the site. No groundwater samples had previously been tested from the site.
4. Site-specific human health and ecological risk assessments had not previously been completed for the chemicals of concern (petroleum hydrocarbons and potentially metals, mercury and glycol) at the site. The results of further soil and groundwater investigations would determine the chemicals of concern for inclusion in the risk assessments.
5. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had previously been collected and analysed for the chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.
6. Two (2) concrete foundation ruins were stated as being present on the site.
7. Scattered debris, including a concrete tank, was stated as being present on the site.
8. Buried building rubble, including asbestos-containing materials, was stated as being present on the site. An earthen mound on the west portion of the site was said to cover building rubble.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill three (3) boreholes, completed as groundwater monitor wells, with associated soil and groundwater sampling, to delineate the extent of petroleum hydrocarbon impacts and to identify the presence or absence, and possible extent of metals (including mercury) and glycol impacts.
- Excavation of four (4) test pits, with associated soil sampling to identify the presence or absence, and possible extent of metals (including mercury) and glycol impacts.
- Collection of four (4) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA, and to identify the presence or absence, and possible extent of metals (including mercury) and glycol impacts in surface soil.
- Conduct a groundwater depth survey. If free product is present, determine the thickness of product.
- If free product is present, conduct a bail down test to determine product recovery rates to assist in planning for remediation.
- Conduct a falling head test on one of the monitor wells to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, available metals (including mercury) and glycol.

- Submit groundwater samples from the monitor wells for analysis of petroleum hydrocarbons, metals (including mercury), and glycol.

1.4.10 Oil Shed

Data gaps and outstanding actions identified for the oil shed site area on the former U.S. military facility based on review of the existing environmental assessment reports included:

1. No soil exceedances were previously identified at the site for TPH/BTEX, PAHs and PCBs. However, only a limited soil investigation had been carried out at the site (one sample analysed). TPH and PCBs were detected in the soil sample analysed. Metals were not tested in soil samples from the site. Dependent on metals results, metals leachability analysis may also be required.
2. It did not appear that surface soil samples were previously collected from the site. The previously tested sample was collected from 0.5 m below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.
3. No groundwater monitor wells had previously been installed on the site. No groundwater samples had been tested from the site.
4. Site-specific human health and ecological risk assessments had not been completed for the potential chemicals of concern (petroleum hydrocarbons, metals, mercury, PAHs and PCBs) at the site. The results of further soil and groundwater investigations would determine whether or not human health and ecological risk assessments are required and the chemicals of concern for inclusion in the risk assessments.
5. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had previously been collected and analysed for the potential chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill one (1) borehole, completed as a groundwater monitor well, with associated soil and groundwater sampling, to further evaluate the presence or absence, and possible extent of petroleum hydrocarbon and metals impacts.
- Excavation of four (4) test pits, with associated soil sampling to further evaluate the presence or absence, and possible extent of petroleum hydrocarbon, PAHs, PCBs and metals impacts.
- Collection of three (3) bulk soil sample from surface (0 – 0.3 m) to obtain required data for the ERA, and to further evaluate the presence or absence, and possible extent of petroleum hydrocarbon, PAHs, PCBs and metals impacts.
- Measure the depth to groundwater in the monitor well. If free product is present, determine the thickness of product.
- If free product is present, conduct a bail down test to determine product recovery rates to assist in planning for remediation.

- Conduct a falling head test on the monitor well to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PAHs, PCBs, and available metals (including mercury).
  - Submit groundwater samples from the monitor wells for analysis of petroleum hydrocarbons, and metals (including mercury).

1.4.11 Lake Melville Dump Site

Data gaps and outstanding actions identified for the Lake Melville dump site area on the former U.S. military facility based on review of the existing environmental assessment reports included:

1. Only a limited soil investigation had previously been carried out at the site. The extent of TPH, PAHs and metals impacts in soil had not been fully delineated at the site. No testing had previously been carried out for PCBs in soil.
2. It appears that only one surface soil sample had previously been collected from the site. For an ecological risk assessment, samples are required from 0 – 0.3 m depth.
3. No groundwater monitor wells had previously been installed on the site. No groundwater samples had been tested from the site.
4. Site-specific human health and ecological risk assessments had not been completed for the chemicals of concern (petroleum hydrocarbons, metals, mercury, PAHs and potentially PCBs) at the site. The results of further soil and groundwater investigations would determine the chemicals of concern for inclusion in the risk assessments.
5. No surface water samples, sediment samples, benthic invertebrate samples or fish samples were tested from the portion of Lake Melville adjacent to the northwest part of the dump site. Such information would be necessary to support a site-specific ecological risk assessment.
6. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had previously been collected and analysed for the chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.
7. A sand cover was placed over the dump site in 2001. No testing had been carried out to verify that the sand used in the cover was obtained from a clean area. Due to the early onset of snow, the cover was not fully completed over the entire site. No vegetation was planted on the cover layer to minimize surface erosion.
8. The 2001 remediation program was terminated because of the early onset of snow at the site. It was noted that some surface debris may still be present on the site. Some grubbings and cut trees from the 2001 remediation program were said to possibly still be present on the site.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill three (3) boreholes, completed as groundwater monitor wells, with associated soil and groundwater sampling, to delineate the extent of petroleum hydrocarbon, PAHs and metals (including mercury) impacts.
- Excavation of nine (9) test pits, with associated soil sampling to delineate the extent of petroleum hydrocarbon, PAHs and metals (including mercury) impacts and to identify the absence or presence of PCBs impacts in soil.
- Collection of six (6) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA, and to delineate the presence or absence and possible extent of petroleum hydrocarbons, PCBs, PAHs and metals (including mercury) impacts in surface soil.
- Conduct a groundwater depth survey. If free product is present, determine the thickness of product.
- Conduct a falling head test on one of the monitor wells to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PAHs, PCBs, and available metals (including mercury).
- Submit groundwater samples from the monitor wells for analysis of petroleum hydrocarbons, PAHs, and metals (including mercury).
- Collect nine (9) sediment samples, nine (9) surface water samples from Lake Melville, including one sample to be representative of background conditions. Each surface water sample will be analysed for TPH/BTEX and metals (including mercury); and each sediment sample will be analysed for TPH/BTEX, PAHs, PCBs and metals (including mercury).
- Collect two (2) benthic invertebrate samples for analysis to determine if the benthic community has been affected by impacts on the site.
- Collect thirteen (13) whole body and thirteen tissue fish samples from the four near-shore areas of Lake Melville, including three (3) samples of each to be representative of background conditions. Each fish sample will be analysed for metals (including mercury), PCBs, and lipids to determine if fish populations within Lake Melville have been affected by impacts on the site.

1.4.12 Underground Pipeline System

Data gaps and outstanding actions identified for the underground pipelines on the former U.S. military facility based on review of the existing environmental assessment reports included:

1. Approximately 2,000 m of underground fuel pipelines are estimated to be present on the site. Three of the pipelines are 170 mm diameter, with the remaining pipelines 50 mm diameter. The 170 mm diameter pipelines have a tar coating on them which contains asbestos.

2. All underground pipelines may not have been located on the site. The locations of all the smaller pipelines were not confirmed at the transmitter building site and the west generator site.

3. X-ray testing has confirmed that liquids are present in at least three places along the underground pipelines. The total volume of liquids in the pipelines was not confirmed. Previous site observations had noted that there were open ends on pipelines at several locations on the site. It had not previously been confirmed whether the liquid in the pipelines was fuel or oily water.

Soil, groundwater and free product impacts in the vicinities of the underground pipelines are addressed in the work programs for the specific areas of the overall site.

1.4.13 Sewer System

Data gaps and outstanding actions identified for the sewer system area on the former U.S. military facility based on review of the existing environmental assessment reports included:

1. Free phase petroleum product was previously noted to be present in the sewer system settling tank, but no measurements of product thickness were provided in reports to assist in calculation of free product volume.
2. Soil impacts were noted for TPH around the sewer system and sewer outfall, but the extent of the impacts had not been fully delineated.
3. No testing had previously been carried out for PCBs or metals in soil around the sewer system and sewer outfall. Dependent on metals results, metals leachability analysis may also be required.
4. No testing had been carried out for TPH/BTEX, PCBs or metals in sludge in the sewer system settling tank or sewer lines.
5. No testing had been carried out for PCBs or metals in water in the sewer system settling tank or sewer lines.
6. No groundwater monitor wells had been installed around the sewer system or sewer outfall. Limited groundwater analysis for TPH/BTEX only had been carried out on groundwater samples collected from open test pits. The results of the groundwater analyses indicated that a concentration of TPH in groundwater at the sewer outfall area exceeded the Tier I RBSLs and a concentration of toluene in groundwater at the sewer outfall area exceeded the CCME freshwater aquatic life guidelines. However, since the groundwater samples were not collected from a properly installed and purged monitor well, the groundwater results are not likely representative of the actual groundwater chemistry on the site. The extent of groundwater exceedances had not been delineated.
7. No surface water samples, sediment samples, benthic invertebrate samples or fish samples had been tested from the portion of Lake Melville adjacent to the sewer system outfall. Such information would be necessary to support a site-specific ecological risk assessment.
8. Site-specific human health and ecological risk assessments had not been completed for the chemicals of concern (petroleum hydrocarbons and potentially metals, mercury and PCBs) at the site. The results of further soil and groundwater investigations would be used to determine whether or not human health and ecological risk assessments are required for

other than petroleum hydrocarbons and the chemicals of concern for inclusion in the risk assessments.

9. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had been collected and analysed for the potential chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.

10. A concrete settling tank (with removable access cover) and sewer lines are present on the site. The sewer lines were stated as possibly containing asbestos. At least five manholes are present in the sewer system. A concrete pad structure is present at the sewer outfall.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill thee (3) boreholes, completed as groundwater monitor wells in the area of the sewer system and sewer outfall, with associated soil and groundwater sampling, to identify the absence or presence of petroleum hydrocarbon and metals (including mercury) impacts.
- Excavation of five (5) test pits, with associated soil sampling to delineate the extent of petroleum hydrocarbon impacts in the soil, and to identify the absence or presence and possible extent of PCBs and metals (including mercury) impacts in soil.
- Collection of five (5) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA, and to identify the absence or presence and possible extent of petroleum hydrocarbons, PCBs and metals (including mercury) impacts in surface soil.
- Confirm the presence and determine the thickness of free phase product in the sewer system settling tank.
- Collection of seven (7) sludge samples from the sewer system settling tank and lines, including two (2) samples from the settling tank, and one (1) sample from each of the five (5) manholes.
- Collection of six (6) effluent water samples from the sewer system settling tank and lines, including one (1) sample from the settling tank, and one (1) sample from each of the five manholes.
- Conduct a groundwater depth survey. If free product is present, determine the thickness of product. Based on the data collected during the groundwater depth and free product survey, the total volume of free product at the site will be estimated.
- Conduct a falling head test on the monitor well to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PCBs, and available metals (including mercury).
- Submit groundwater samples from the monitor wells for analysis of petroleum hydrocarbons, and metals (including mercury).
- Submit sewer system sludge samples for petroleum hydrocarbons, PCBs, and available metals (including mercury).
- Submit sewer system effluent water samples for petroleum hydrocarbons, PCBs, and metals (including mercury).

1.4.14 Dock Road Drum Storage Site

Data gaps and outstanding actions identified for the Dock Road drum storage site area on the former U.S. military facility based on review of the existing environmental assessment reports included:

1. No soil exceedances had previously been identified at the site for TPH/BTEX, PAHs, PCBs and metals. However, only a limited soil investigation had been carried out at the site (one sample analysed).
2. It did not appear that surface soil samples were previously collected from the site. The previously tested sample was collected from 1.5 m below the ground surface. However, for an ecological risk assessment, samples are required from 0 – 0.3 m depth.
3. No groundwater monitor wells had previously been installed on the site. No groundwater samples were tested from the site.
4. Site-specific human health and ecological risk assessments had not been completed for the potential chemicals of concern (petroleum hydrocarbons, metals, mercury, PAHs and PCBs) at the site. The results of further soil and groundwater investigations would be used to determine whether or not human health and ecological risk assessments are required and the chemicals of concern for inclusion in the risk assessments.
5. No specific samples (e.g., surface soil, vegetation, berries, small mammals, rabbits) had been collected and analysed for the potential chemicals of concern to support a site-specific human health and ecological risk assessment. The biota samples (e.g., vegetation, berries, small mammals, rabbits) would not normally be required unless metals (including mercury) or PCBs impacted soils are present on the site.
6. The 2001 remediation program was terminated because of the early onset of snow at the site. It was noted that some surface debris may still be present on the site. Some grubbings and cut trees from the 2001 remediation program were also stated ad possibly still being present on the site.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Drill one (1) borehole, completed as a groundwater monitor well, with associated soil and groundwater sampling, to further evaluate the presence or absence, and possible extent of petroleum hydrocarbon and metals (including mercury) impacts.
- Excavation of four (4) test pits, with associated soil sampling to further evaluate the presence or absence, and possible extent of petroleum hydrocarbon, PAHs, PCBs and metals (including mercury) impacts.
- Collection of three (3) bulk soil sample from surface (0 – 0.3 m) to obtain required data for the ERA, to evaluate the presence or absence, and possible extent of petroleum hydrocarbon, PAHs, PCBs and metals (including mercury) impacts in surface soil.
- Measure the depth to groundwater in the monitor well. If free product is present, determine the thickness of product.

- If free product is present, conduct a bail down test to determine product recovery rates to assist in planning for remediation.
- Conduct a falling head test on the monitor well to determine the permeability of the soil stratigraphy. Such information will be useful in evaluating remedial options or conducting a risk assessment on the property.
- Submit select soil samples from bulk soil sampling, the test pits and boreholes for analysis of petroleum hydrocarbons, PAHs, PCBs, and available metals (including mercury).
- Submit groundwater samples from the monitor well for analysis of petroleum hydrocarbons, and metals (including mercury).

1.4.15 Helicopter Pad

The Phase I ESA drawing notes the presence of a helicopter pad on Dock Road west of the dock and north of the Lake Melville dump site. No investigations were previously carried out at the helicopter pad area, even though helicopter pads have historically been known to have petroleum hydrocarbon and/or pesticide impacts.

Based on a review of previous work conducted in this area, the following field/sampling program was recommended to further evaluate sub-surface contamination:

- Excavation of two (2) test pits, with associated soil sampling to investigate the presence or absence of petroleum hydrocarbon and pesticides impacts in soil.
- Collection of three (3) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA and to investigate the presence or absence and possible extent of petroleum hydrocarbon and pesticides impacts in surface soil.
- Submit soil samples from bulk soil sampling, and the test pits for analysis of petroleum hydrocarbons and pesticides.

1.4.16 VOR Site

Data gaps and outstanding actions identified for the VOR site area on the former U.S. military facility during the review of the existing environmental assessment reports included:

1. An abandoned 900 L UST is present on the site. Previous soil investigations indicate there are no petroleum hydrocarbon impacts in the vicinity of the tank.

Based on a review of previous environmental assessments, no further sampling and analysis are deemed a requirement. However, it is recommended to conduct a site inspection as part of the proposed program to ensure no environmental issues related to the abandoned 900 L UST.

1.4.17 Tower Rubble, Foundation Ruins and Various Surface Debris

During operation, the Former U.S. Military site contained two main communications towers and numerous small towers. The main communications towers consisted of a 180 m (600 ft) tower and a 240 m (800 ft) tower made of painted steel girders and associated concrete anchor blocks. The smaller towers were made of painted steel and aluminum. The 180 m tower was located west of VOR road, approximately 500 m southwest of the West Generator Site, and the

240 m tower was located west of the seawater line, approximately 100 north of the main access road. The locations of smaller towers were not provided in previous environmental reports; however, tower rubble was previously noted southwest of the 240 m tower (at the WAC Antannae Site), southwest of the North Bulk Fuel Storage Site and at the east end of Camp Road.

Data gaps and outstanding actions identified for tower rubble, foundation ruins and surface debris on the Former U.S. Military site based on review of the existing environmental assessment reports included:

1. The Phase I ESA report noted the presence of the page warehouse demolition debris dump site. The location of this dump site was not identified or investigated during the subsequent site investigations.
2. Three large concrete guy wire anchor blocks were noted as possibly still being present in wooded areas at the 180 m tower site.
3. No testing had previously been carried out for metals in soil at the 180 m tower site, even though the towers were painted with lead-based paints. Dependent on metals results, metals leachability analysis may also be required.
4. Approximately 40% of the tower rubble still remained at the 240 m tower site in 2001. It was recommended that this tower rubble be removed in 2002, but there is no information available to confirm if this was done.
5. Various debris and rubble were said to remain at the 240 m tower site.
6. Foundation ruins, a concrete tower base and three concrete guy wire anchor blocks remain on the 240 m tower site. Three other concrete guy wire anchor blocks were stated as possibly being present in wooded areas around the 240 m tower site.
7. No testing was previously carried out for metals in soil at the 240 m tower site, even though the towers were painted with lead-based paints. Dependent on metals results, metals leachability analysis may also be required.
8. No testing had been carried out for metals in soil at the WAC antennae site, even though the towers were painted with lead-based paints. Dependent on metals results, metals leachability analysis may also be required.
9. Two concrete tower bases were said to remain at the Camp Road tower site.
10. No testing had been carried out for metals in soil at the Camp Road tower site, even though the towers were painted with lead-based paints. Dependent on metals results, metals leachability analysis may also be required.
11. Miscellaneous surface debris was stated as possibly being present in wooded areas throughout the site, particularly adjacent to access roads.
12. Miscellaneous surface debris was stated as possibly being present at the temporary tower storage area south of Camp Road and 200 m southeast of the intersection with the VOR/Dock Road.

13. The 2001 remediation program was terminated because of the early onset of snow at the site. Some grubbings and cut trees from the 2001 remediation program were stated as possibly still being present at the tower sites.

Based on a review of previous work conducted in this area, the following field/sampling program is recommended to further evaluate sub-surface contamination:

- Excavation of two (2) test pits in various areas of tower rubble, with associated soil sampling to investigate the presence or absence of metals (including mercury) impacts in soil.
- Collection of five (5) bulk soil samples from surface (0 – 0.3 m) to obtain required data for the ERA and to investigate the presence or absence and possible extent of metals (including mercury) impacts in surface soil.
- Carry out a site inspection to locate the reported demolition materials waste site at the former page warehouse area, and excavate three (3) test pits, with the analysis of soil samples for petroleum hydrocarbons and metals (including mercury).
- Submit select soil samples from bulk soil sampling, and the test pits for analysis of petroleum hydrocarbons and metals (including mercury).

1.4.18 General Site Concerns/Additional Field Requirements

1.4.18.1 Surface Debris/Physical Hazards

Several areas of tower rubble, foundation and surface debris (consisting of drums, pump blocks, steel pipeline, etc.) have been identified on the Site. It was understood that surface debris in several areas was either removed or capped in 2001. It was proposed that an investigation of all areas of the Site be conducted to create a log of physical hazards. These areas would be mapped using a GPS. A detailed map would be created identifying all of the areas where these hazards are present. In addition, in areas where the debris has been capped, the field team was to inspect the cap to ensure it is providing sufficient cover.

1.4.18.2 Limited Deep Groundwater Investigation

Based on recommendations in the Implementation Plan, it was recommended that a limited deep groundwater investigation be completed on the Site, involving the drilling of six (6) boreholes completed as monitor wells, including three (3) monitor wells on impacted portions of the Site and three (3) monitor wells around the perimeter of the Site. These monitor wells would be screened at depth within the non-perched regional aquifer to evaluate presence or absence of impacts to regional groundwater quality related to site contamination. Groundwater samples would be collected from each monitor well and sampled for TPH/BTEX and metals including mercury.

1.4.18.3 Vegetation and Mammal Sample Collection

For the ERA, it was recommended to collect a number of vegetation and berry samples from various areas of the Site, as well as background areas where impacts are not likely. In addition, small mammal samples (i.e., voles, shrews, etc.) would be collected in the areas where the vegetation/berry samples were collected, as well as background areas where impacts were not likely, if possible. Samples were to be analysed for metals, mercury, and/or PCBs, depending on the concerns in the area. Small mammal samples would also be analysed for lipid content.

1.4.18.4 Ditches and Streams

It was recommended that surface water and sediment samples be collected from all of the ditches and streams identified on the Site. In addition, whole body and tissue fish samples would be collected from all of the on-site streams (where possible), as well as background areas where impacts were not likely present, to determine if fish populations have been affected by impacts on the Site. Surface water and sediment samples would be analysed for petroleum hydrocarbons, PAHs, PCBs and/or metals (including mercury), depending on the concerns in the area; while fish samples were analysed for metals, mercury, and/or PCBs and lipid content, depending on the concerns in the area.

1.4.18.5 Background Soil Conditions

For the human health and ecological risk assessments, a total of ten (10) soil samples from background areas were required for analysis of metals. In addition, two (2) of these samples would be analysed for pH and total organic carbon, required for the human health risk assessment.

1.5 Land Usage and Regulatory Considerations

1.5.1 Land Usage

The former U.S. military facility at Northwest Point is primarily a vacant “brownfield” site, with no existing buildings or aboveground structures. Foundation ruins and surface debris from former buildings and structures are present on the Site. Abandoned underground fuel pipelines and a sewer system are present on the Site.

Existing reports indicate that portions of the Site are regularly used by the Innu and the residents of Northwest River as campgrounds and meeting places. The eastern side of the Point, near Camp Road, contains several Innu owned summer cabins (refer to Drawing No. 121410105-EE-01B in Appendix 1). Existing reports indicate that some on-site streams are used by the Innu as a source of drinking water. Area residents reportedly pick berries on and around the site. Small mammals such as mice, rabbits and partridge and larger mammals such as moose are reported to be present on and around the Site. Area residents reportedly hunt rabbits and partridge in the general site area. Atlantic salmon are harvested near the shore on the northern and western side of the Point by the Innu and the residents of Northwest River.

1.5.2 Regulatory Considerations

NLDEC Policy Directive PPD05-01 allows a site owner to use either of two approaches when remediating chemical impacts on a site. Remediation of chemical impacts in various site media (e.g., soil, sediment, groundwater, surface water) can be completed using a criteria-based approach or a risk-based approach. Under the criteria-based remedial approach, the defined site impacts are remediated to levels below existing regulatory guidelines for the appropriate media. Under the risk-based remedial approach, the defined site impacts are remediated to levels below site-specific target levels (SSTLs) that are developed for the Site during a site-specific human health and ecological risk assessment.

For simple sites and sites with limited impacts, criteria-based remediation is often used to remove the impacted media from the site. For more complex sites and sites with extensive impacts from multiple chemicals of concern (COCs), a human and ecological risk assessment is often completed, based on the actual site conditions and the actual human and ecological usage of the site, to derive SSTLs for a risk-based remedial approach. Experience at other former U.S. Military sites in Newfoundland and Labrador indicates that a risk-based remedial approach is most appropriate for such complex sites.

For the most part, the existing environmental assessment reports have used the Canadian Council of Ministers of the Environment (CCME) commercial guidelines (1999 + Updates) as screening levels for BTEX, PAHs, PCBs, VOCs, and metals (including mercury) in soil, the NLDEC Class B non-sensitive guideline as a screening level for TPH in soil, the CCME freshwater aquatic life (FWAL, 1999) guidelines as screening levels for BTEX, PAHs, VOCs and metals (including mercury) in groundwater and surface water, and the Canadian Drinking Water Quality Guidelines (CDWQGs, 1998) as screening levels for potable surface water.

While the usage of the CCME commercial guidelines is considered appropriate as screening levels or remediation levels for human receptors for PAHs, PCBs, VOCs, and metals (including mercury) in soil, the commercial guidelines are not considered to be the appropriate screening levels or remediation levels for all ecological receptors for PAHs, PCBs, VOCs, and metals (including mercury) in soil. The CCME (2007) residential/parkland guidelines are considered to be the more appropriate screening levels for both human and ecological receptors at the site for PCBs, VOCs, and metals (including mercury) in soil. The CCME (2008) residential/parkland guidelines are considered to be the more appropriate screening levels for both human and ecological receptors at the site for PAHs.

While the Risk-Based Corrective Action (RBCA) Tier I Risk-Based Screening Levels (RBSLs) for a residential site with non-potable groundwater and coarse soil may be overly conservative as remediation guidelines for human and ecological receptors for petroleum hydrocarbons (TPH and BTEX) in soil and groundwater on the former U.S. military site, the RBCA Tier I RBSLs for a residential site with non-potable groundwater and coarse soil are considered to be the most appropriate screening level guidelines for petroleum hydrocarbons (TPH and BTEX) in soil and groundwater on the site. One (1) Tier I RBSL for modified TPH for a residential site with non-potable groundwater and coarse grained soil (i.e., fuel oil or lube oil impacts) was selected for each individual site. Tier I RBSLs for modified TPH were selected based on the predominant type of product impacting soil and groundwater samples at the site, as indicated by the laboratory (i.e., resemblance), and the petroleum hydrocarbon fraction range with the highest concentrations at the site.

The Canadian Drinking Water Quality Guidelines (CDWQGs) (2007) are considered to be the appropriate screening levels and remediation guidelines for surface water that is used as a source of potable water. However, for fresh surface water that is not used as a source of potable water (e.g., various ditches and streams), the CCME guidelines for the protection of freshwater aquatic life (FWAL) (2007) are considered to be the more appropriate screening level guidelines, where such guidelines exist. Similarly, for non-potable groundwater, the Ontario Ministry of Environment (MOE) guidelines for non-potable groundwater (2009) are considered to be the more appropriate screening level guidelines, where such guidelines exist. The CCME freshwater sediment quality guidelines (2007) are considered to be the appropriate screening level guidelines for freshwater sediment on the site, but may not be the appropriate remediation guidelines.

There are no applicable Federal or Provincial guidelines for petroleum hydrocarbons in sediments and the Tier I RBSLs do not apply to sediment. There is an Ontario guideline (1993) that states that the total oil and grease concentration of sediments to be used as lake fill material should not exceed 0.15% (i.e., 1,500 mg/kg). If necessary, the MOE sediment guideline would be applied for petroleum hydrocarbons in sediments.

While these guidelines may be appropriate as screening levels for a risk-based remedial approach (i.e., where the remediation levels are established by a site-specific human health and ecological risk assessment), some of the screening level guidelines may be overly conservative if used as remediation levels for a criteria-based remedial approach for the Former U.S. Military Site, based on the actual human and ecological receptor usage of the site.

2.0 METHODOLOGY

2.1 Field Procedures

The field component of this project consisted of the identification of debris and physical hazards, the excavation of test pits, borehole drilling and monitor well installation, and the collection of soil, sediment, surface water, groundwater, benthic invertebrate, vegetation, berry, small mammal, rabbit and fish samples. Field work was performed during the periods of August 5 – August 12, 2009, August 26 – August 30, 2009, October 18 – October 22, 2009, November 14, 2009 and November 23 – November 26, 2009. Field work and site supervision were conducted by environmental consulting field personnel, which included environmental technicians and environmental scientists. Drilling services were provided by Logan Geotech Inc. of Stewiacke, Nova Scotia. Excavator services were provided by Cox's Construction Limited (CCL) of Kilbride, NL.

2.1.1 Phase III Environmental Site Assessment

The Phase III Environmental Site Investigation involved the excavation of test pits, borehole drilling complete with monitor well installation and the associated soil and groundwater sampling and analysis as well as collection of surface soil, sediment, surface water, benthic invertebrate, vegetation, berry, small mammal, rabbit and fish samples.

2.1.1.1 Borehole / Monitor Well Installation and Sampling Program

A total of 44 boreholes were drilled past the groundwater table using a track-mounted geotechnical drill rig supplied and operated by Logan Geotech Inc. of Stewiake, Nova Scotia and were terminated at depths ranging from 3.05 to 10.67 m below ground surface. The

100 mm diameter hollow stem boreholes were augered through overburden soils. Bedrock was not encountered in any of the boreholes. Continuous soil sampling was conducted preceding casing advance. A track-mount drill rig was used since several areas of the site are not easily accessible. Road construction/brush removal was not required.

Subsurface conditions encountered in the boreholes were logged by field personnel at the time of drilling. Borehole locations were selected based on areas with known or suspected impacts. The locations of the boreholes were established in the field by field personnel by measurements from existing aboveground site infrastructure and through collection of GPS coordinates.

Where possible, soil samples were collected by split spoon methods at 0.61 m intervals from the boreholes during the performance of the Standard Penetration Test and N values were recorded. The soil samples were examined for any field evidence of impacts, and where possible duplicate soil samples were collected. The samples were placed in clean glass jars with aluminum foil under the lids. Head space soil vapour concentrations was measured in the duplicate sample jars using a MiniRAE 2000 photoionization detector (PID). The samples were placed on ice in sample coolers and returned to the environmental consultant's office in St. John's, NL for sample selection and submission to the laboratory. Based on the measured soil vapor concentrations, field observations and site usage and history, select soil samples were submitted for required laboratory analysis, according to the chemical parameters of concern.

Following drilling, monitor wells were installed in each of the boreholes. The monitor wells consisted of 50 mm diameter, flush-threaded, Schedule 40 PVC casing and No. 10 slot screen. Silica sand was placed around the screened section to inhibit silt intrusion into the well and facilitate well development. A total of 35 shallow groundwater wells and 9 deep groundwater wells were completed at the Site. Each deep groundwater well was drilled adjacent to a shallow well. For the shallow groundwater monitor wells, the screened section of the monitor wells was placed to span the water table as measured at the time of drilling. For the deep groundwater monitor wells, the screened section of the monitor well was placed at depth within the non-perched regional groundwater aquifer. A bentonite seal was placed above the sand pack in each well, followed by backfill sand and gravel to the surface.

Each monitor well was developed by pumping out the equivalent of four (4) to five (5) times the well volume. Following monitor well development, groundwater samples were collected in clean, new sample bottles and submitted for required laboratory analysis. Groundwater samples for metals analysis were filtered in the field using a 0.45 µm in-line filter and acidified. The samples were placed on ice in sample coolers and returned to the environmental consultant's laboratory in St. John's, NL for sample selection and submission to the laboratory. A water level measurement and free-product survey was carried out in each monitor well prior to monitor well development and groundwater sampling. A summary of borehole/monitor wells drilled during this investigation is provided below in Table 2.1.

Hydraulic response (bail-down) tests were carried out on 15 monitor wells, including 09-MW35D, 09-MW25, 09-MW4, 09-MW8, 09-MW12, 09-MW2S, 09-MW14, 09-MW24, 09-MW22, 09-MW20, 09-MW16, 09-MW31, 09-MW33S, 09-MW26 and 09-MW27D, to determine the permeability of the underlying stratigraphy at each site. While bail-down testing was only performed on one (1) monitor well at each site, test results are considered to provide a reasonable general estimate of the permeability of the uppermost (i.e., water table) aquifer in each area of the property. Bail-down tests were conducted by removing a volume of water from each well and recording the water levels in the well at specific time intervals as the water levels recovered. Results of bail-down testing are provided by site in Appendices 2 to 19.

Table 2.1 Monitor Well and Borehole Summary

Monitor Well ID	BH Depth (m)	MW screen depth (mbgs)	August 26-27, 2009		October 18-21, 2009		Site Name
			Product Thickness (mm)	Depth to Water (mbgs)	Product Thickness (mm)	Depth to Water (mbgs)	
09-MW1	3.05	0.31 - 3.05	-	0.46	-	0.60	North Bulk Fuel Storage Site
09-MW2S	3.05	0.31 - 3.05	Sheen	0.14	-	0.54	North Bulk Fuel Storage Site
09-MW2D	7.62	6.10 - 7.62	Sheen	3.58	-	3.39	North Bulk Fuel Storage Site
09-MW3	3.66	0.61 - 3.66	-	1.37	-	1.71	North Bulk Fuel Storage Site
09-MW4	3.66	0.61 - 3.66	Sheen	1.79	4	1.39	Service Site
09-MW5	3.66	0.61 - 3.66	-	1.27	-	0.75	Service Site
09-MW6	3.66	0.61 - 3.66	-	1.88	-	1.55	Service Site
09-MW7	3.66	0.61 - 3.66	Sheen	0.65	-	0.33	West Generator Site
09-MW8	3.66	0.61 - 3.66	-	0.40	-	0.45	West Generator Site
09-MW9	3.96	0.91 - 3.96	-	0.46	-	0.61	West Generator Site
09-MW10	3.66	0.61 - 3.66	-	0.24	-	0.50	Transmitter Building
09-MW11	3.66	0.61 - 3.66	-	0.49	-	0.77	Transmitter Building
09-MW12	3.66	0.61 - 3.66	-	0.68	-	0.80	Transmitter Building
09-MW13S	3.66	0.30 - 3.66	-	0.24	-	0.24	South Bulk Fuel Storage Site
09-MW13D	7.62	6.10 - 7.62	-	Dry	-	Dry	South Bulk Fuel Storage Site
09-MW14	3.66	0.61 - 3.66	Sheen	0.75	-	0.71	South Bulk Fuel Storage Site
09-MW15	3.05	0.61 - 3.05	-	0.31	-	0.42	East Bulk Fuel Storage Site
09-MW16	3.05	0.61 - 3.05	Sheen	0.37	-	0.50	East Bulk Fuel Storage Site
09-MW17	3.05	0.61 - 3.05	Sheen	0.29	-	0.37	East Bulk Fuel Storage Site
09-MW18	3.05	0.61 - 3.05	-	1.07	-	0.30	East Generator Site
09-MW19	4.27	0.30 - 3.05	-	1.05	-	0.49	East Generator Site
09-MW20	3.05	0.61 - 3.05	100	0.30	1	0.31	East Generator Site
09-MW21S	3.66	0.61 - 3.66	Not Surveyed (Re-drilled)				Camp Road Dump Site
09-MW21D	7.62	4.57 - 7.62	-	6.20	-	6.37	Camp Road Dump Site
09-MW22S	3.96	0.91 - 3.96	Not Surveyed (Re-drilled)				Camp Road Dump Site
09-MW22D	7.62	4.57 - 7.62	-	5.95	-	6.02	Camp Road Dump Site
09-MW23S	5.48	0.91 - 5.48	Not Surveyed (Re-drilled)				Camp Road Dump Site
09-MW23D	7.62	4.57 - 7.62	-	5.65	-	5.70	Camp Road Dump Site
09-MW24	3.66	0.61 - 3.66	-	3.20	-	3.51	Camp Road Drum Storage Site
09-MW25	3.66	0.61 - 3.66	-	0.69	-	1.40	Oil Shed Site
09-MW26	4.57	0.91 - 4.57	-	0.56	-	Dry	Dock Road Drum Storage Site
09-MW27S	3.96	0.91 - 3.96	-	1.46	-	1.60	Lake Melville Dump Site
09-MW27D	7.62	6.10 - 7.62	-	3.94	-	3.03	Lake Melville Dump Site
09-MW28	6.10	0.91 - 6.10	-	5.66	-	4.80	Lake Melville Dump Site
09-MW29	4.57	0.91 - 4.57	-	2.26	-	2.31	Lake Melville Dump Site

Monitor Well ID	BH Depth (m)	MW screen depth (mbgs)	August 26-27, 2009 Product Thickness (mm)	August 26-27, 2009 Depth to Water (mbgs)	October 18-21, 2009 Product Thickness (mm)	October 18-21, 2009 Depth to Water (mbgs)	Site Name
09-MW30	3.05	0.61 - 3.05	-	0.45	-	0.44	Sewer System
09-MW31	3.05	0.61 - 3.05	Sheen	0.72	-	0.64	Sewer System
09-MW32	3.05	0.61 - 3.05	-	0.52	-	0.42	Sewer System
09-MW33S	7.62	1.52 - 7.62	-	5.75	-	5.81	Innu Healing Ground
09-MW33D	10.67	5.48 - 7.01	-	6.64	-	6.09	Innu Healing Ground
09-MW34S	3.05	0.61 - 3.05	-	0.05	-	0.00	South Bulk Fuel Storage Site
09-MW34D	7.62	6.10 - 7.62	-	5.30	-	4.74	South Bulk Fuel Storage Site
09-MW35S	8.83	1.52 - 6.10	-	Dry	Not surveyed		Clean Background Area
09-MW35D	10.67	9.14 - 10.67	-	8.83	-	7.54	Clean Background Area
AMEC 1	7.20	Not reported	Not surveyed		-	Dry	South Bulk Fuel Storage Area
AMEC 2	Not recorded	Not reported	Not surveyed		-	0.63	South Bulk Fuel Storage Area
AMEC 3	13.26	Not reported	Not surveyed		-	Dry	South Bulk Fuel Storage Area
AMEC 4	Not recorded	Not reported	-	1.74	-	1.45	South Bulk Fuel Storage Area
AMEC 5	6.94	Not reported	-	Dry	-	Dry	South Bulk Fuel Storage Area

Notes:
Bedrock was not encountered at any of the borehole locations
mbgs = metres below ground surface
Sheens were observed on groundwater extracted from the identified wells during bail-down testing

2.1.1.2 Test Pit Excavation and Sampling Program

A total of 70 test pits were excavated using a Cat 320 track mounted excavator supplied by Cox's Construction Limited (CCL) of Kilbride, NL. The test pits were excavated using a track-mounted excavator, in order to minimize disturbance to the site.

The test pits were excavated to the maximum reach of the excavator and were backfilled with excavated material upon completion. Subsurface conditions encountered in the test pits were logged by field personnel at the time of excavating. The test pit locations were selected in order to delineate previously identified areas of impacts and to investigate areas of concern. The locations of the test pits were established in the field by field personnel by measurements from existing aboveground site infrastructure. In addition, GPS coordinates of each location were collected.

Soils were sampled from the test pits by bulk sample methods. Soil samples were recovered from the test pits at frequent intervals over their respective depths, the number of which varied with the test pit depth. The soil samples were visually examined in the field for any evidence of petroleum hydrocarbon impacts. Duplicate soil samples were collected at each sample location, where possible. The samples were placed in clean glass jars with aluminum foil under the lids. Head space soil vapour concentrations were measured in the duplicate sample jars using a MiniRAE 2000 PID. The samples were placed on ice in sample coolers and returned to the environmental consultant's office in St. John's, NL for sample selection and submission to the laboratory. Based on the measured soil vapor concentrations, field observations and site usage and history, select soil samples were submitted to Maxxam Analytics Inc. for required laboratory analysis, according to the chemical parameters of concern.

A summary of test pits excavated during this investigation is provided below in Table 2.2.

Table 2.2 Test Pit Summary

Test Pit ID	GW Depth (mbgs)	TP Depth (m)	Debris Encountered	Site Name
09-TP1	0.5	1.2	-	North Bulk Fuel Storage Site
09-TP2	0.9	1.5	-	North Bulk Fuel Storage Site
09-TP3	1.3	2.5	-	North Bulk Fuel Storage Site
09-TP4	1.5	2.0	-	North Bulk Fuel Storage Site
09-TP5	1.4	2.0	-	North Bulk Fuel Storage Site
09-TP6	1.6	1.8	-	North Bulk Fuel Storage Site
09-TP7	1.8	2.6	Pipe, culvert	Service Site
09-TP8	1.7	2.5	-	Service Site
09-TP9	1.6	2.0	-	Service Site
09-TP10	1.4	2.4	-	Service Site
09-TP11	0.5	0.8	Some metal debris	West Generator Site
09-TP12	0.9	2.5	-	West Generator Site
09-TP13	1.9	2.4	-	West Generator Site
09-TP14	1.5	2.0	Trace metal debris	West Generator Site
09-TP15	1.3	2.0	-	West Generator Site
09-TP16	1.5	2.0	-	Transmitter Building
09-TP17	0.9	1.5	-	Transmitter Building
09-TP18	1.3	1.8	-	Transmitter Building
09-TP19	2.4	2.8	Concrete, metal, pipe	Transmitter Building
09-TP20	0.5	1.0	-	South Bulk Fuel Storage Site
09-TP21	0.6	1.2	-	South Bulk Fuel Storage Site
09-TP22	0.8	1.6	-	South Bulk Fuel Storage Site
09-TP23	1.5	2.0	-	South Bulk Fuel Storage Site
09-TP24	1.2	2.5	-	South Bulk Fuel Storage Site
09-TP25	1.5	2.5	-	South Bulk Fuel Storage Site
09-TP26	0.9	1.6	-	East Bulk Fuel Storage Site
09-TP27	0.6	1.4	-	East Bulk Fuel Storage Site
09-TP28	0.8	1.4	-	East Bulk Fuel Storage Site
09-TP29	0.8	1.4	-	East Bulk Fuel Storage Site
09-TP30	1.0	1.6	-	East Bulk Fuel Storage Site
09-TP31	0.9	1.5	-	East Bulk Fuel Storage Site
09-TP32	0.9	1.4	-	East Generator Site
09-TP33	1.1	1.5	50 mm fuel line	East Generator Site
09-TP34	0.9	1.5	-	East Generator Site
09-TP35	1.0	1.7	-	East Generator Site
09-TP36	1.1	1.8	-	East Generator Site
09-TP37	-	4.2	-	Camp Road Dump Site
09-TP38	-	4.2	Car chassis, cable, creosote utility pole, sheet metal, wood, glass	Camp Road Dump Site
09-TP39	1.4	1.9	Steel drums, cable, glass, wood	Camp Road Dump Site
09-TP40	2.0	2.5	Cans, bottles	Camp Road Dump Site
09-TP41	1.4	2.0	Trace debris	Camp Road Dump Site
09-TP42	2.2	4.0	-	Lake Melville Dump Site
09-TP43	3.2	4.0	Cable, metal, cans, bottles	Lake Melville Dump Site
09-TP44	-	3.6	Metal, wire	Lake Melville Dump Site
09-TP45	2.2	2.5	-	Camp Road Drum Storage Site

Test Pit ID	GW Depth (mbgs)	TP Depth (m)	Debris Encountered	Site Name
09-TP46	0.6	1.0	-	Camp Road Drum Storage Site
09-TP47	2.2	2.6	-	Camp Road Drum Storage Site
09-TP48	-	2.5	-	Camp Road Drum Storage Site
09-TP49	1.1	1.6	Metal, concrete, wood	Service Site
09-TP50	1.6	2.5	Trace debris	Service Site
09-TP51	1.8	2.4	-	Oil Shed Site
09-TP52	2.6	3.0	-	Oil Shed Site
09-TP53	2.0	2.5	-	Oil Shed Site
09-TP54	2.2	2.5	-	Underground Pipeline Site
09-TP55	2.1	2.7	-	Underground Pipeline Site
09-TP56	3.8	4.0	-	Helicopter Pad
09-TP57	3.8	4.0	-	Helicopter Pad
09-TP58	3.2	3.8	-	Dock Road Drum Storage Site
09-TP59	3.2	3.8	-	Dock Road Drum Storage Site
09-TP60	3.3	3.8	-	Dock Road Drum Storage Site
09-TP61	1.3	2.0	-	Lake Melville Dump Site
09-TP62	1.8	2.0	Drums, metal, cans, bottles, plastic, wood	Lake Melville Dump Site
09-TP63	0.6	0.8	-	Lake Melville Dump Sie
09-TP64	0.6	0.8	-	Lake Melville Dump Site
09-TP65	0.6	2.4	Asphalt, shingles, glass, cans, metal	Lake Melville Dump Site
09-TP66	2.1	2.5	Asphalt, shingles, metal, plastic, wood, insulation	Lake Melville Dump Site
09-TP67	0.5	1.2	-	Sewer System
09-TP68	1.0	1.4	-	Sewer System
09-TP69	1.6	2.0	-	Sewer System
09-TP70	1.4	2.0	-	Sewer System

Notes :
mbgs = metres below ground surface

2.1.1.3 Sediment Sampling, Surface Water Sampling, Benthic Invertebrate and Fish Sampling

A sediment and surface water sampling program was carried out as part of the Phase III site investigation. This included collection of sediment and surface water samples from Lake Melville, near discharge points, as well as from ditches and streams identified on the Site. In addition to the collection of sediment, surface water, benthic and fish samples in the areas of concern, samples were collected from background locations. This included samples in Lake Melville, at least 400 m from the areas of concern. A total of six (6) sediment, five (5) benthic and six (6) surface water samples were collected from Lake Melville, near the shoreline, and one (1) benthic sample was collected from an area of standing water near the Lake Melville Dump Site. A total of nine (9) sediment and six (6) surface water samples were collected from ditches and streams identified on the Site.

Sediment and benthic invertebrate samples in Lake Melville were collected using drop samplers and grab samplers from a locally rented boat. Sediment and benthic invertebrate samples from the ditches and brooks were collected from the shore using bulk sampling methods, if possible. The sediment samples were examined for any field evidence of impacts, and where possible duplicate soil samples were collected. The samples were placed in clean glass jars with aluminum foil under the lids. The benthic invertebrate sediment samples were field screened and preserved. The samples were placed on ice in sample coolers and returned to the environmental consultant’s office in St. John’s, NL for sample selection and submission to the laboratories.

Surface water samples were collected at the same locations as the sediment samples, where there was a sufficient depth of water to collect a water sample. The surface water samples were collected into clean, new sample bottles. The samples were placed on ice in sample coolers and returned to the environmental consultant’s office in St. John’s, NL for sample selection and submission to the laboratory.

Fish samples were collected from Lake Melville and on-site streams using hook and line, fyke net and minnow trap techniques. Fish samples were collected from the areas of concern and the background areas, if possible, for whole-body and tissue analysis of metals, PCBs and lipids. Permits for the collection of fish were obtained from the federal Department of Fisheries and Oceans prior to proceeding with this sampling and are presented in Appendix 22. A summary of fish caught during this investigation is provided below in Table 2.3.

Table 2.3 Fish Summary

Fish Sample ID	Species	# Fish in Sample	Site Name
Dump Site - FS01	Atlantic Tom Cod	1	Lake Melville Dump Site
Dump Site - FS02	Atlantic Tom Cod	1	Lake Melville Dump Site
Dump Site - FS03	Rainbow Smelt	1	Lake Melville Dump Site
Dump Site - FS04	Rainbow Smelt	1	Lake Melville Dump Site
Dump Site - FS05	Rainbow Smelt	1	Lake Melville Dump Site
Dump Site - FS06	Atlantic Tom Cod	1	Lake Melville Dump Site
Dump Site - FS07	Rainbow Smelt	1	Lake Melville Dump Site
Dump Site - FS08	Atlantic Tom Cod	1	Lake Melville Dump Site
Dump Site - FS09	Three Spine Stickleback	25	Lake Melville Dump Site
Dump Site - FS10	Three Spine Stickleback	25	Lake Melville Dump Site
Sewer Site - FS01	Atlantic Tom Cod	1	Sewer System Site
Sewer Site - FS02	Atlantic Tom Cod	1	Sewer System Site
Sewer Site - FS03	Atlantic Tom Cod	1	Sewer System Site
Sewer Site - FS04	Atlantic Tom Cod	1	Sewer System Site
Sewer Site - FS05	Brook Trout	1	Sewer System Site
Sewer Site - FS06	Brook Trout	1	Sewer System Site
Sewer Site - FS07	Rainbow Smelt	1	Sewer System Site
Sewer Site - FS08	Rainbow Smelt	1	Sewer System Site
Sewer Site - FS09	Three Spine Stickleback	25	Sewer System Site
Sewer Site - FS10	Three Spine Stickleback	25	Sewer System Site
Camp Road - FS01	Three Spine Stickleback	25	Camp Road Dump Site
Camp Road - FS02	Three Spine Stickleback	25	Camp Road Dump Site
Camp Road - FS03	Three Spine Stickleback	25	Camp Road Dump Site
Camp Road - FS04	Three Spine Stickleback	25	Camp Road Dump Site
Camp Road - FS05	Three Spine Stickleback	25	Camp Road Dump Site
Camp Road - FS06	Three Spine Stickleback	25	Camp Road Dump Site
Camp Road - FS07	Three Spine Stickleback	25	Camp Road Dump Site
Camp Road - FS08	Three Spine Stickleback	25	Camp Road Dump Site
Camp Road - FS09	Three Spine Stickleback	25	Camp Road Dump Site
Camp Road - FS10	Three Spine Stickleback	25	Camp Road Dump Site
Background - FS01	Three Spine Stickleback	25	Clean Background Area
Background - FS02	Three Spine Stickleback	25	Clean Background Area
Background - FS03	Three Spine Stickleback	25	Clean Background Area
Background - FS04	Three Spine Stickleback	25	Clean Background Area
Background - FS05	Three Spine Stickleback	25	Clean Background Area
Background - FS06	Three Spine Stickleback	25	Clean Background Area
Background - FS07	Three Spine Stickleback	25	Clean Background Area
Background - FS08	Three Spine Stickleback	25	Clean Background Area
Background - FS09	Three Spine Stickleback	25	Clean Background Area

2.1.1.4 Surface Soil, Vegetation, Berry, Small Mammal and Rabbit Sampling

Surface soil, vegetation, berry, small mammal and rabbit sampling was required to obtain information for input into the human health and ecological risk assessments. This included the collection of vegetation, berry, small mammal and rabbit samples from areas of concern as well as background areas (i.e., areas where impacts are not likely to be present). In addition, surface soil samples were collected throughout the site for analysis.

A total of 57 near-surface (i.e., 0 – 0.15 m depth) bulk soil samples were collected at various locations on the Site. Surface soil samples were collected in clean background areas as well as in suspected impacted areas. The near-surface soil samples were collected manually using clean sampling equipment. The soil samples were visually examined in the field for any evidence of petroleum hydrocarbon impacts. The samples were placed in clean glass jars with aluminum foil under the lids. Head space soil vapour concentrations were measured in the sample jars using a MiniRAE 2000 PID. The samples were placed on ice in sample coolers and returned to the environmental consultant's office in St. John's, NL for sample selection and submission to the laboratory.

A total of 24 vegetation samples, consisting mainly of grasses and leaves, were collected at or near the ground surface by hand. Approximately 200 grams of sample were collected at each location. During collection, samples were placed into pre-cleaned laboratory-supplied plastic bags. The collected samples were stored and transported in sample coolers and stored in a freezer until they were delivered to the laboratory for analysis of PCBs and metals.

A total of 19 berry samples, consisting of blueberries, raspberries and cranberries, were collected by hand. Approximately 200 grams of berries were collected at each sampling location. During collection, samples were placed into pre-cleaned laboratory-supplied plastic bags. The collected samples were transported in sample coolers and stored in a freezer until they were delivered to the laboratory for analysis of PCBs and metals.

A total of 29 small mammal (i.e., voles, shrews, mice, etc.) samples were collected from the areas of concern and clean background areas, where possible, for analysis of metals and/or PCBs, dependent on the contaminants of potential concern in the area. The small mammals were caught with traps and placed into pre-cleaned laboratory-supplied plastic bags. Traps were set at each of the sites and checked periodically. The collected samples were placed in a sample cooler until they were delivered to the laboratory for whole-body laboratory analysis of PCBs and metals. A permit for the collection of small mammals was obtained from provincial Department of Wildlife prior to proceeding with this sampling and is included in Appendix 22. A summary of small mammal samples collected during this investigation is provided below in Table 2.4.

Table 2.4 Small Mammal Summary

Sample ID	Species	Site Name
09-SM1	Mouse	Clean Background Area
09-SM2	Mouse	Oil Shed Site
09-SM3	Mouse	Service Site
09-SM4	Red Backed Vole	Clean Background Area
09-SM5	Red Backed Vole	West Generator Site
09-SM6	Masked Shrew	North Bulk Fuel Storage Site
09-SM7	Meadow Vole	South Bulk Fuel Storage Site
09-SM8	Meadow Vole	North Bulk Fuel Storage Site
09-SM9	Meadow Jumping Mouse	Camp Road Dump Site
09-SM10	Masked Shrew	Sewer System
09-SM11	Masked Shrew	Lake Melville Dump Site
09-SM12	Meadow Vole	Clean Background Area
09-SM13	Masked Shrew	East Generator Site
09-SM14	Masked Shrew	Sewer System
09-SM15	Meadow Jumping Mouse	East Generator Site
09-SM16	Masked Shrew	Lake Melville Dump Site
09-SM17	Red Backed Vole	Dock Road Drum Storage Site
09-SM18	Red Backed Vole	Camp Road Dump Site
09-SM19	Masked Shrew	West Generator Site
09-SM20	Masked Shrew	Service Site
09-SM21	Masked Shrew	North Bulk Fuel Storage Site
09-SM22	Meadow Vole	Dock Road Drum Storage Site
09-SM23	Masked Shrew	Dock Road Drum Storage Site
09-SM24	Masked Shrew	Dock Road Drum Storage Site
09-SM25	Masked Shrew	West Generator Site
09-SM26	Red Backed Vole	North Bulk Fuel Storage Site
09-SM27	Masked Shrew	South Bulk Fuel Storage Site
09-SM28	Masked Shrew	South Bulk Fuel Storage Site
09-SM29	Red Backed Vole	Lake Melville Dump Site

A total of seven (7) rabbits were caught at the Site. Four (4) to six (6) snares were set at each site, in the vicinity of small mammal traps. Rabbits were caught at five (5) of the sites and were retained for whole body analysis of PCBs, lipids and mercury. The collected samples were stored and transported in sample coolers and stored in a freezer until they were delivered to the laboratory for analysis. A permit for the collection of rabbits was obtained from the provincial Department of Wildlife prior to proceeding with this sampling and is presented in Appendix 22.

2.1.2 Surface Debris and Physical Hazards Survey

Several areas of foundation and surface debris (consisting of drums, pump blocks, steel pipeline, etc.) were identified on the Site. A walk-through of all areas of the Site was conducted on October 18, 2009 and a log of surface debris and physical hazards was created. These areas were mapped using a GPS. Summaries of surface debris and physical hazards identified at the individual sites are provided in Sections 3.1 to 3.19, and a summary of debris and physical hazards indentified outside the individual sites is provided in Section 3.20. A detailed map identifying all of the areas where these hazards are present and a log of surface debris and physical hazards are provided in Appendix 20.

2.2 Laboratory Analysis

2.2.1 Laboratory Work

Maxxam Analytics Inc. (Maxxam) conducted all laboratory analysis. Table 2.5 provides a summary of laboratory work for the Phase III ESA, subdivided by site. Methodologies utilised by Maxxam in analysis of the samples are noted on laboratory reports in Appendix 21.

Table 2.5 Summary of Laboratory Analyses

Site Name	TPH/ BTEX	TPH Frac.	VOCs	Metals	PAHs	PCBs	General Chemistry	Mercury	Glycol
North Bulk Fuel Storage Site	Soil - 6 GW - 4 SW - 1 Sed - 1	Soil - 1		Soil - 3 GW - 4 SW - 1 Sed - 1	Soil - 2	Veg - 2 Berries - 2 SM - 4	GW - 4 SW - 1	SM - 2	
South Bulk Fuel Storage Site	Soil - 6 GW - 3 Standing Water - 1 SW - 1	GW - 1		Soil - 2 GW - 4 SW - 1 SM - 1	Soil - 1	Veg - 2 Berries - 2 SM - 4 Rabbits - 1	GW - 4 SW - 1	SM - 1 Rabbits - 1	
East Bulk Fuel Storage Site	Soil - 9 GW - 2 Sed - 1	GW - 1		Soil - 5 GW - 3 Sed - 1	Soil - 3	Veg - 2	GW - 3		
East Generator Site	Soil - 6 GW - 2 Sed - 1	GW - 1		Soil - 3 GW - 3 Sed - 1	Soil - 1 GW - 1	Soil - 3 Veg - 1 SM - 2	GW - 3		
West Generator Site	Soil - 6 GW - 2 SW - 2 Sed - 1	Soil - 1 GW - 1		Soil - 4 GW - 3 SW - 1 Sed - 1	Soil - 3 GW - 1	Soil - 2 Veg - 1 Berries - 1	GW - 3 SW - 1	SM - 2	
Transmitter Building	Soil - 6 GW - 3			Soil - 6 GW - 3	Soil - 2	Soil - 3 Veg - 2 Berries - 1 SM - 3	GW - 3	SM - 1	
Camp Road Dump Site	Soil - 6 GW - 3 SW - 1 Sed - 1		Soil - 3	Soil - 7 GW - 3 SW - 1 Sed - 1 Fish - 4	Soil - 1 GW - 1	Soil - 1 Veg - 2 Berries - 2 SM - 2 Fish - 4	GW - 3 SW - 1	SM - 1	
Camp Road Drum Storage Site	Soil - 4			Soil - 5	Soil - 2	Soil - 2 Veg - 1 Berries - 1 Rabbits - 1		Rabbits - 1	
Service Site	Soil - 6 GW - 2	GW - 1		Soil - 10 GW - 3		Veg - 2 Berries - 3 SM - 1	GW - 3		GW - 1
Oil Shed Site	Soil - 4 GW - 1			Soil - 4 GW - 1	Soil - 1	Soil - 1 Veg - 1	GW - 1		
Lake Melville Dump Site	Soil - 8 GW - 4 SW - 2			Soil - 11 GW - 4 SW - 2	Soil - 7	Soil - 2 Veg - 2 Berries -	GW - 4 SW - 2	Rabbits - 1	

Site Name	TPH/ BTEX	TPH Frac.	VOCs	Metals	PAHs	PCBs	General Chemistry	Mercury	Glycol
	Sed - 2			Sed - 2 Fish - 4		2 SM - 3 Fish - 4 Rabbits - 1			
Underground Pipeline System	Soil - 3 Standing Water - 1 Sed - 1			Soil - 1 Sed - 1					
Sewer System	Soil - 5 GW - 3 Sewer Water - 1 SW – 1 Sed - 1			Soil - 5 GW - 3 Sewer Water - 1 SW - 1 Sed - 1 SM - 1 Fish - 4		Soil - 2 Veg - 2 Berries - 2 SM - 3 Fish - 4 Rabbits - 2	GW - 3 Sewer Water - 1 SW - 1 SM - 1	Rabbits - 1	
Dock Road Drum Storage Site	Soil - 4 SW - 1 Sed - 1			Soil - 5 SW - 1 Sed - 1	Soil - 1	Soil - 2 Veg - 1 Berries - 1 SM - 4	SW - 1		
Helicopter Pad	Soil - 2				Soil - 2	Soil - 2			
Streams	SW - 1 Sed - 1			SW - 1 Sed - 1			SW - 1		
Innu Healing Ground	Soil - 2 GW - 2			Soil - 1 GW - 2		Soil - 1 Veg - 1 Berries - 1	GW - 1		
Clean Background Area	Soil - 1 GW - 1 SW - 3 Sed - 3			GW - 1 SW - 3 Sed - 3 SM - 1 Fish - 3		Veg - 2 SM - 3 Fish - 3 Rabbits - 2	GW – 1 SW - 3	SM - 1 Rabbits -1	
Total	**Soil - 84 GW - 30 Standing Water - 2 Sewer Water - 1 SW - 13 Sed - 14**	**Soil - 2 GW - 5**	**Soil - 3**	**Soil – 71 GW – 37 Sewer Water - 1 SW – 12 Sed – 13 SM – 3 Fish - 15**	**Soil-26 GW - 3**	**Soil – 21 Veg – 24 Berries - 18 SM – 29 Fish - 15 Rabbits - 7**	**GW – 36 Sewer Water - 1 SW – 12**	**SM - 8 Rabbits - 5**	**GW - 1**

Notes:
GW = Groundwater; SW = Surface water; Sed = Sediment; SM = Small mammal; Veg = Vegetation

2.2.2 Quality Assurance/Quality Control

Replicate sampling is a standard QA / QC procedure carried out by Maxxam and comprises 10% of the total number of samples being analysed. The analytical results of the duplicate samples analysed for this sampling program were acceptably consistent with the original samples. Duplicate samples are not included on the laboratory work summary table and individual site laboratory analysis schedules. Analytical results for duplicate samples are provided in analytical summary tables in Appendices 2 to 19. Note that on the analytical summary tables, laboratory duplicates are denoted by the extension “Lab Dup”.

3.0 RESULTS OF THE PHASE III ESA INVESTIGATION

3.1 North Bulk Fuel Storage Site

3.1.1 Site Description

The North Bulk Fuel Storage Site is a former AST location approximately 170 m north of the Main Access Road. A site plan is provided in Appendix 2a (Drawing No. 121410105-EE-02A). The site is accessible from a rough excavator path off Main Access Road. The original road to the site is overgrown and obscured. Based on information collected to date, the tank was filled via a 150 mm – 200 mm outside diameter (OD) underground steel pipeline and from there supplied fuel to different areas of the facility via a single run of smaller 50 mm – 75 mm OD underground steel fuel line. The former AST capacity is estimated at 1.1 million litres. Photos taken of the site during the current investigation are presented in Appendix 2b.

The site is made up of an area of little to no vegetation surrounded by moderate tree and bush cover with some boggy areas. The terrain is relatively level. Surface water runoff is directed to a ditch which runs to the north and which is located adjacent to the sewer line.

Previous subsurface investigations revealed significant quantities of weathered free product and groundwater entering test pits at shallow depths. TPH impacts were identified in subsurface soil (0.5 m below ground surface) and in groundwater entering two (2) of the test pits. Chromatograms for soil and groundwater samples with elevated concentrations of TPH resembled diesel. In 2001, free product removal was conducted at the site. A cache of tower sections, which were painted with lead-based paints (see Drawing 121410105-EE-02B in Appendix 2a), was also removed from the site in 2001.

3.1.2 Field Work

Field work at this site comprised the excavation of six (6) test pits, the installation of four (4) monitor wells, and the collection of four (4) surface soil samples, three (3) groundwater samples, one (1) surface water sample, one (1) sediment sample, two (2) vegetation samples, two (2) berry samples and four (4) small mammal samples. A site plan (Drawing No. 121410105-EE-02A) showing the location of these as well as general site features is provided in Appendix 2a. Coordinates of each sample location are provided in Appendix 2c.

3.1.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 2d. A layer of brown sand (SP) with varying percentages of organics, cobbles and boulders was generally encountered at or near the surface in monitor wells and test pits and ranged in thickness from 0.6 m to 1.6 m. This layer of sand (SP) was underlain by grey clay (CL) and/or grey silt (ML).

In test pits 09-TP01, 09-TP02 and 09-TP03, a layer of organics ranging in thickness from 0.2 m to 1.2 m occurred above the layer of sand (SP).

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.1.4 Debris and Physical Hazards

Buried debris was not encountered in any of the six (6) test pits, as identified in Table 2.2 and documented on the Test Pit Records in Appendix 2d.

Surface debris and physical hazards at the North Bulk Fuel Storage Site were generally found along the southern portion of the site. Drawing No. 121410105-EE-02A in Appendix 2a shows the locations of the surface debris encountered. Items encountered on the North Bulk Fuel Storage Site consisted of the following:

- 09-SD23 - Domestic debris, old snowmobile, outboard motor, tire
- 09-SD24 - Manhole cover
- 09-SD25 - 12 m long 200 mm diameter steel pipe, valve
- 09-SD26 - 0.3 m of 50 mm diameter steel pipe protruding from ground, valve
- 09-SD27 - 2 empty 200 L steel drums

3.1.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 0.14 metres below ground surface (mbgs) to 1.71 mbgs in shallow groundwater wells at the site, and from 3.39 mbgs to 3.58 mbgs in the deep groundwater well at the site during the two (2) groundwater survey events. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed during the excavation of test pits on August 5, 2009 in 09-TP1 to 09-TP6 at depths ranging from 0.50 mbgs in 09-TP1 to 1.60 mbgs in 09-TP6. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations, the direction of groundwater flow is inferred to be to the northeast towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-02A in Appendix 2a. Monitor well elevations were not surveyed as part of this investigation due to the dense tree cover at several areas of the site and the scarcity of wells.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW2S to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 2f. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 2f. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW2S with a value of 3×10^{-6} m/s determined using the Bouwer & Rice method and 4×10^{-6} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 4×10^{-6} m/s is determined for the underlying stratigraphy at the site.

3.1.6 Free Phase Petroleum Hydrocarbons

During the current investigation, a sheen was observed on groundwater encountered in test pits 09-TP1 to 09-TP5. Sheens were also observed on groundwater extracted from monitor wells 09-MW2S and 09-MW2D during purging on August 27, 2009; however, no measurable product was detected on groundwater in monitor wells at the site with the product interface probe.

3.1.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the North Bulk Fuel Storage Site are provided on the Test Pit Records and Monitor Well Records in Appendix 2d. The soil vapour concentrations measured ranged from 0.0 ppm in soil samples 09-TP2-BS1, 09-TP6-BS2 and 09-MW1-SS1 to SS4, to 206 ppm in soil sample 09-TP1-BS2 during excavation. Slight to moderate hydrocarbon odours were detected in monitor wells 09-MW2S, 09-MW2D and 09-MW3 during drilling.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations exceeded 50 ppm in eight (8) soil samples collected at the site (i.e., 09-TP1-BS2, 09-TP1-BS3, 09-TP2-BS2, 09-TP3-BS2, 09-TP4-BS2, 09-MW02D-SS2, 09-MW02D-SS3 and 09-MW02-SS4). Soil vapour concentrations, along with field observations, site usage and site history were used to select samples for petroleum hydrocarbon analysis.

3.1.8 Laboratory Analysis and Results

A laboratory analysis schedule for the North Bulk Fuel Storage Site is presented in Table 3.1.

Table 3.1 Laboratory Analysis Schedule (North Bulk Fuel Storage Site)

<table>
<tr><th rowspan="2">Issues</th><th rowspan="2">Sample Locations</th><th colspan="4">Sample Matrix</th></tr>
<tr><th>Soil/ Sediment</th><th>Groundwater/ Surface Water</th><th>Veg./ Berries</th><th>Small Mammals</th></tr>
<tr><td>• Surface debris identified during previous investigations – characterization required.
• Free Product removal conducted in 2001 – follow up required.
• Petroleum hydrocarbon impacts in soil – delineation required.
• Metals and PAH concentrations in surface soil (<0.3 m) required for the ecological risk assessment.
• Possible petroleum hydrocarbons and metals in shallow groundwater.
• Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.</td><td>09-TP1 to 09-TP6
09-SS40 to 09-SS43
09-MW1, 09-MW2S, 09-MW2D & 09-MW3
09-SW8
09-SED8
09-VEG7 & 09-VEG8
09-BERRY6 & 09-BERRY7
09-SM6, 09-SM8, 09-SM21 & 09-SM9</td><td>Soil:
TPH/BTEX (6)
TPH. Frac/ BTEX (1)
PAHs (2)
Metals (3)

Sediment:
TPH (1)
Metals (1)</td><td>Groundwater:
TPH/BTEX (4)
Metals (4)
General Chemistry (4)

Surface Water:
TPH (1)
Metals (1)
General Chemistry (1)</td><td>Veg:
PCBs (2)

Berries:
PCBs (2)</td><td>SM:
PCBs (4)
Mercury (2)</td></tr>
</table>

Results of laboratory analysis of soil, groundwater, surface water, sediment, vegetation, berry and small mammal samples obtained from this site during the current and previous investigations are presented in Tables 2.1 to 2.16 in Appendix 2e. Corresponding analytical reports from Maxxam Analytics for samples obtained during the current investigations are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on six (6) soil samples collected from the site including five (5) test pit samples (09-TP1-BS2, 09-TP2-BS2, 09-TP3-BS2, 09-TP4-BS2 and 09-TP5-BS2) and 1 monitor well sample (09-MW2-SS2). Petroleum hydrocarbon fractionation was also performed on one (1) test pit sample (09-TP1-BS3). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 2.1 and Table 2.2 in Appendix 2e. Modified TPH was detected in six (6) soil samples, with concentrations ranging from 790 mg/kg to 12,000 mg/kg. Concentrations of modified TPH exceeded the applicable Tier I RBSL for fuel oil impacts (i.e., 140mg/kg) in all soil samples analysed (i.e., 09-TP1-BS3, 09-TP2-BS2, 09-TP3-BS2, 09-TP4-BS2, 09-TP5-BS2 and 09-MW2D-SS2). Laboratory analytical results indicated that products impacting soil samples on this site resembled a mixture of weathered fuel oil fractions.

Benzene, toluene, ethylbenzene and xylenes were detected in sample 09-TP1-BS3 at concentrations below the applicable Tier I RBSLs. BTEX parameters were not detected in the remaining samples analysed.

Metals in Soil

Available metals analysis was conducted on three (3) surface soil samples collected from the site (09-SS41 to 09-SS43). Results of the laboratory analysis of soil samples for available metals are presented in Table 2.3 in Appendix 2e. Concentrations of various metals were detected in all three (3) soil samples, but only one (1) sample (09-SS42) had an exceedance of the applicable CCME criteria for metals in soil on a residential/parkland site. The concentration of lead detected in soil sample 09-SS42 (170 mg/kg) exceeded the applicable CCME residential/parkland guideline for lead (140 mg/kg).

PAHs in Soil

PAH analysis was conducted on two (2) surface soil samples collected from the site (09-SS40 and 09-SS42). Results of the laboratory analysis of this soil sample for PAHs are presented in Table 2.4 in Appendix 2e. PAHs were not detected in sample 09-SS42. Detectable concentrations of PAH parameters in sample 09-SS40 were below the applicable CCME soil quality guidelines for a residential/parkland site, where such guidelines exist.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on four (4) groundwater samples collected from the site (09-MW1, 09-MW2S, 09-MW2D and 09-MW3). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 2.5 in Appendix 2e. Modified TPH was detected in all four (4) groundwater samples at concentrations ranging from 0.5 mg/L in groundwater sample 09-MW3 to 22 mg/L in 09-MW2S. Concentrations of modified TPH exceeded the applicable Tier I RBSL for fuel oil impacts (i.e., 20 mg/L) in groundwater samples 09-MW1 and 09-MW2S. Laboratory analytical results indicated that products impacting groundwater samples on this site resembled weathered fuel oil or lube oil fractions. Furthermore, detected concentrations of BTEX parameters (detected in samples 09-MW2S and 09-MW2D) were below the applicable Tier I RBSLs.

Metals in Groundwater

Dissolved metals analysis was conducted on four (4) groundwater samples collected from the site (09-MW1, 09-MW2S, 09-MW2D and 09-MW3). Results of the laboratory analysis of the groundwater samples are presented in Table 2.6 in Appendix 2e. Concentrations of various metals were detected in the groundwater samples. None of the detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

General Chemistry in Groundwater

General chemistry analysis was conducted on four (4) groundwater samples collected from the site (09-MW1, 09-MW2S, 09-MW2D and 09-MW3). Results of the laboratory analysis of the groundwater samples are presented in Table 2.7 in Appendix 2e. The pH values for samples 09-MW2S and 09-MW3 were outside the applicable CCME freshwater aquatic life range of 6.5 to 9.0. None of the remaining concentrations of general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Surface Water

Petroleum hydrocarbon analysis was conducted on one (1) surface water sample collected from the site (09-SW8). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 2.8 in Appendix 2e. Modified TPH was detected in the surface water sample at a concentration of 0.06 mg/L. There are no applicable CCME guidelines for TPH in surface water. The laboratory report noted that the product in the sample had no resemblance to petroleum hydrocarbons.

Dissolved Metals in Surface Water

Dissolved metals analysis was conducted on one (1) surface water sample collected from the site (09-SW8). Results of the laboratory analysis of this surface water sample are presented in Table 2.9 in Appendix 2e. The detected concentration of aluminum, iron and mercury (i.e., 117 µg/L, 0.075 µg/L and 484 µg/L, respectively) exceeded the CCME guidelines for the protection of freshwater aquatic life (i.e., 100 µg/L, 0.026 µg/L and 300 µg/L, respectively). Similar concentrations of aluminum and iron were detected in the background surface water samples (i.e., 98 to 442 µg/L and 281 to 1,080 µg/L), as indicated in Section 3.17.3, which may suggest that aluminum and iron concentrations are naturally elevated in surface water in the area.

General Chemistry in Surface Water

General chemistry analysis was conducted on one (1) surface water sample collected from the site (09-SW8). Results of the laboratory analysis of this surface water sample are presented in Table 2.10 in Appendix 2e. The pH value (6.42) recorded in the sample was outside the applicable CCME freshwater aquatic life range (6.5 to 9.0). None of the remaining general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) sediment sample collected from the site (09-SED8). Results of the laboratory analysis of the sediment sample for petroleum hydrocarbons are presented in Table 2.11 in Appendix 2e. Modified TPH was detected in the sediment sample at a concentration of 280 mg/kg. The concentration of modified TPH did not exceed the applicable MOE guideline for oil and grease in sediment (i.e., 1,500 mg/kg). Laboratory analytical results indicated that products impacting the sediment sample on this site resembled a weathered fuel oil fraction and there was no resemblance to petroleum hydrocarbons in the lube oil range.

BTEX parameters were not detected in the sediment sample analysed.

Metals in Sediment

Available metals analysis was conducted on one (1) sediment sample collected from the site (09-SED8). Results of the laboratory analysis of the sediment sample for available metals are presented in Table 2.12 in Appendix 2e. Concentrations of various metals were detected in the sediment sample, but none of the detected concentrations of available metals in sediment exceeded the applicable CCME ISQGs or PELs for freshwater sediment.

PCBs in Vegetation

PCBs analysis was conducted on two (2) vegetation samples collected from the site (09-VEG7 and 09-VEG8) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these vegetation samples for PCBs are presented in Table 2.13 in Appendix 2e. PCBs were not detected in the vegetation samples.

PCBs in Berries

PCBs analysis was conducted on two (2) berry samples collected from the site (09-BERRY6 & 09-BERRY7) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these berry samples for PCBs are presented in Table 2.14 in Appendix 2e. PCBs were not detected in the berry samples.

PCBs in Small Mammals

PCBs analysis was conducted on four (4) small mammals caught at the site (09-SM6, 09-SM8, 09-SM21 and 09-SM26) in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals for PCBs are presented in Table 2.15 in Appendix 2e. PCBs were not detected in the small mammal samples.

Mercury in Small Mammals

Mercury analysis was conducted on two (2) small mammals caught at the site (09-SM6 and 09-SM8) in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals for mercury are presented in Table 2.16 in Appendix 2e. Mercury was not detected in the small mammal samples.

3.1.9 Discussions and Conclusions

A Phase III ESA was completed at the North Bulk Fuel Storage site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of the assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of a layer of brown sand (SP) with varying percentages of organics, cobbles and boulders overlying grey clay (CL) and/or grey silt (ML). A layer of organics was encountered at the surface of three (3) test pits. Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. Buried debris was not encountered in test pits dug at the site. Surface debris and physical hazards at the site were found along the southern portion of the site and consisted of domestic debris, an old snowmobile, an outboard motor, a tire, a manhole cover, steel pipes and valves and empty 200 L steel drums.
3. Groundwater was encountered at depths ranging from 0.14 mbgs to 1.71 mbgs in test pits and shallow monitor wells completed at this site and at depths ranging from 3.39 mbgs to

3.58 mbgs in the deep monitor wells completed at this site. Based on local topography and site observations, the direction of groundwater flow is inferred to be to the northeast towards Lake Melville.

4. A hydraulic conductivity of 4 x 10^{-6} m/s was determined for the underlying stratigraphy at the site, which is within the range expected for silty sands (i.e., 10^{-3} m/s to 10^{-7} m/s).
5. In 1999, weathered free product was observed entering test pits at shallow depths. In 2001, free product removal was conducted at the site. As part of the current investigation, follow-up free product survey was conducted at the site. Sheens were observed on groundwater extracted from monitor wells 09-MW2S and 09-MW2D and on groundwater encountered in test pits 09-TP1 to 09-TP5; however, no measurable product was detected on groundwater in monitor wells.
6. With the exception of the two (2) test pits dug east of the ditch (i.e., 09-TP5 and 09-TP6) and the monitor well drilled in the centre of the site (09-MW1), slight to moderate petroleum hydrocarbon odours were detected on soil in test pits and monitor wells at the site.
7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.2 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.2 Summary of Exceedances (North Bulk Fuel Storage Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	NF-TP1 (1999) NF-TP5 (1999) P-TP22 (1999) 09-TP1-BS3 09-TP2-BS2 09-TP3-BS2 09-TP4-BS2 09-TP5-BS2 09-MW2D-SS3	12,102 mg/kg 8,566 mg/kg 15,969 mg/kg 11,000 mg/kg / 12,000 mg/kg 2,700 mg/kg 3,000 mg/kg 790 mg/kg 1,600 mg/kg 4,000 mg/kg	140 mg/kg (Tier I RBSL, 2003)
	Lead	09-SS42	170 mg/kg	140 mg/kg (CCME SQG, 2007)
Groundwater	TPH	NF-TP6 (1999) S-TP2 (1999) 09-MW1 09-MW2S	4,500 mg/L 177 mg/L 21 mg/L 22 mg/L	20 mg/L (Tier I RBSL, 2003)
	Mercury	NF-TP6 (1999)	1 µg/L	0.29 µg/L (MOE, 2009)
	pH	09-MW2S 09-MW2D	6.24 6.07	6.5 to 9.0 (CCME FWAL, 2007)
Surface Water	Aluminum*	09-SW8	117 µg/L	5 µg/L (CCME FWAL, 2007)
	Iron*	09-SW8	484 µg/L	300 µg/L (CCME FWAL, 2007)
	Mercury	09-SW8	0.075 µg/L	0.026 µg/L (CCME FWAL, 2007)
	pH	09-SW8	6.42	6.5 to 9.0 (CCME FWAL, 2007)

Note: Details of Referenced Guidelines are provided in Section 1.5.2
*Aluminum and iron concentrations are naturally elevated in surface water in the area based on the results of background sampling conducted in 2001 (SW-C1 to SW-C3)

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless

a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

- **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pits NF-TP1, NF-TP5, P-TP22, 09-TP1, 09-TP2, 09-TP3, 09-TP4, 09-TP5 and 09-MW2D and petroleum hydrocarbon remediation of shallow groundwater would be required in the vicinity of samples NF-TP6, S-TP2 and monitor wells 09-MW1 and 09-MW2S in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-2B in Appendix 2a shows the estimated extent of the petroleum hydrocarbon-impacted soil and groundwater at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 1,711 m^2 has TPH levels in soil above 140 mg/kg and an estimated area of approximately 523 m^2 has petroleum hydrocarbon levels in groundwater above 20 mg/L.
- **Metals** remediation of site soil would be required in the vicinity of surface soil sample 09-SS42, metals remediation of shallow groundwater would be required in the vicinity of sample NF-TP6 and metals remediation of surface water would be required in the drainage ditch in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-2C in Appendix 2a shows the estimated extent of the metal (i.e., lead) impacted soil, metal (i.e., mercury) impacted groundwater and metal (i.e., mercury) impacted surface water at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 42 m^2 has lead levels in soil above 140 mg/kg and an estimated area of approximately 87 m^2 has mercury levels in groundwater above 0.12 µg/L.

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH and metals impacts on soil, TPH, metals and general chemistry impacts groundwater, and metals and general chemistry impacts in surface water above the generic guidelines.

3.2 South Bulk Fuel Storage Site

3.2.1 Site Description

The South Bulk Fuel Storage Site is a former above-ground storage tank (AST) location south of VOR road. A site plan is provided in Drawing No. 121410105-EE-03A. The site is accessible from VOR Road via a former roadway which is now alder covered. Based on information collected to date, the tank was filled via a 150 mm – 200 mm outside diameter (OD) underground steel pipeline. As with other AST locations, no information has been obtained to indicate the presence of smaller 50 mm – 75 mm OD underground steel fuel lines associated with this AST. It is possible that this tank served as a back-up to the other two (2) tanks (at the North and East Bulk Fuel Sites, respectively) via the fill pipeline. The former AST capacity is estimated at 1.1 million litres.

The site is a sandy, open area with sparse to low vegetation. The terrain slopes mildly downwards in a southerly direction. There is a drainage swell located within the southern portion of the site and some boggy areas surrounding the site. Surface runoff drains to a boggy area to the south. Light hydrocarbon odours were noticed downwind of the site during previous investigations.

Previous subsurface investigations revealed significant quantities of weathered free product and groundwater entering test pits at shallow depths. TPH impacts were identified in subsurface soil (> 0.5 mbgs) and in groundwater entering two (2) of the test pits and mercury impacts were identified in groundwater entering two (2) of the test pits and in monitor wells. Chromatograms for soil and groundwater samples with elevated concentrations of TPH resembled diesel and heavy oil. In 2001, trenching activities were carried out at the site for free product removal. A sheen of weathered fuel was observed on the surface of groundwater within the trenches and was removed using oil absorbent pads. The volume of free product removed from the site was not specified in the 2001 site remediation report. Trenches were backfilled following the removal of free product.

3.2.2 Field Work

Field work at this site comprised the excavation of six (6) test pits, the installation of five (5) monitor wells, and the collection of three (3) surface soil samples, four (4) groundwater samples, one (1) surface water sample, one (1) sediment sample, one (1) standing water sample from the open end of a partially buried pipe, two (2) vegetation samples, two (2) berry samples, four (4) small mammal samples and one (1) rabbit sample. A site plan (Drawing No. 121410105-EE-03A) showing the sampling locations as well as general site features is provided in Appendix 3a. Coordinates of each sample location are provided in Appendix 3b.

3.2.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 3c. The stratigraphy encountered in test pits and monitor wells generally consisted of a discontinuous layer of brown to grey sand (SP) with varying percentages of silt and clay interbedded with a layer of clay (CL) or dense grey silt (ML) with some clay. The continuous portion of the brown to grey sand (SP) layer ranged in thickness from 0.6 m in 09-TP20 to >3.6 m in 09-MW14. In 09-MW34S and 09-MW34D, a 0.3 m layer of peat was encountered at the surface.

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.2.4 Debris and Physical Hazards

Buried debris was not encountered in any of the six (6) test pits, as identified in Table 2.2 and documented on the Test Pit Records in Appendix 3c. No surface debris or physical hazards were encountered at the South Bulk Fuel Storage Site.

3.2.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells at the site on August 27, 2009 and October 18, 2009. Groundwater levels ranged from ground surface (i.e., 0.00 mbgs) to 0.75 mbgs in shallow groundwater wells and from 4.74 mbgs to 5.30 mbgs in deep groundwater wells during the two (2) groundwater survey events. Monitor well 09-MW13D was dry on August 27, 2009 and October 18, 2009. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed during the excavation of test pits on August 5 and 6, 2009 in 09-TP20 to 09-TP25 at depths ranging from 0.5 mbgs in 09-TP20 to 1.5 mbgs in 09-TP23 and 09-TP25. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the east towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-03A in Appendix 3a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW14 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 3e. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 3f. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW14 with a value of 1×10^{-8} m/s determined using the Bouwer & Rice method and 2×10^{-8} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 1×10^{-8} m/s is determined for the underlying stratigraphy at the site.

3.2.6 Free Phase Petroleum Hydrocarbons

During the current investigation, a sheen was observed on groundwater encountered in test pit 09-TP20 and a skim of fuel (i.e., <1 mm) was observed on groundwater encountered in test pit 09-TP21. A sheen was also observed on groundwater extracted from monitor well 09-MW14 during purging on August 27, 2009; however, no measurable product was detected on groundwater in monitor wells at the site with the product interface probe.

3.2.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the South Bulk Fuel Storage Site are provided on the test pit and monitor well records in Appendix 3c. The soil vapour concentrations measured ranged from 0.0 ppm in soil sample 09-TP25-BS1 and all soil samples collected from 09-MW34S and 09-MW34D to 281 ppm in soil sample 09-MW14-SS4. Slight to moderate petroleum hydrocarbon odours were detected in test pits 09-TP20 to 09-TP23 and 09-TP25 during excavation and in monitor wells 09-MW13S and 09-MW13D during drilling. Slight to heavy petroleum hydrocarbon odours were detected in monitor well 09-MW14 during drilling.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations exceeded 50 ppm in 11 soil samples collected at the site (i.e., 09-TP20-BS1 & BS2, 09-TP21-BS1 & BS2, 09-TP22-BS1 & BS2, 09-TP25-BS2, 09-MW13D-SS1, 09-MW14-SS2, SS3 & SS4). Soil vapour concentrations, along with field observations, site usage and site history were used to select samples for petroleum hydrocarbon analysis.

3.2.8 Laboratory Analysis and Results

A laboratory analysis schedule for the South Bulk Fuel Storage Site is presented in Table 3.3 below.

Table 3.3 Laboratory Analysis Schedule (South Bulk Fuel Storage Site)

Issues	Sample Locations	Sample Matrix			
		Soil/ Sediment	Groundwater/ Surface Water/ Standing Water	Veg./ Berries	Small Mammals/ Rabbits
• Surface debris identified during previous investigations – characterization required. • Free Product removal conducted in 2001 – follow up required. • Petroleum hydrocarbon impacts in soil – delineation required. • Metals and PAH concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbons and metals in shallow groundwater. Possible migration of petroleum hydrocarbon impacted groundwater (if detected) towards the adjacent bog. • Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.	09-TP20 to 09-TP25 09-SS1 to 09-SS3 09-MW13S, 09-MW13D, 09-MW14, 09-MW34S & 09-MW34D 09-SW1 09-SED1 09-VEG9 & 09-VEG10 09-BERRY8 & 09-BERRY9 09-SM2, 09-SM7, 09-SM27 & 09-SM28 09-SM36 09-PIPE1	Soil: TPH/ BTEX (6) Metals (2) PAHs (1)	Groundwater: TPH/BTEX (3) TPH Frac./ BTEX (1) Metals (4) General Chemistry (4) Surface Water: TPH/BTEX (1) Metals (1) General Chemistry (1) Standing water: TPH (1)	Veg: PCBs (2) Berries: PCBs (2)	SM: PCBs (4) Metals (1) Mercury (1) Rabbits: PCBs (1) Metals (1)

Results of laboratory analysis of soil, groundwater, surface water, standing water, vegetation, berry, small mammal and rabbit samples obtained from this site are presented in Tables 3.1 to 3.15 in Appendix 3d. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on six (6) soil samples collected from the site including four (4) test pit samples (09-TP21-BS2, 09-TP22-BS2, 09-TP23-BS2 and 09-TP25-BS2) and two (2) monitor well samples (09-MW14-SS4 and 09-MW34D-SS1). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 3.1 in Appendix 3d. Modified TPH was detected in all six (6) soil samples, with concentrations ranging from 1,600 mg/kg to 26,000 mg/kg. Concentrations of modified TPH exceeded the applicable Tier I RBSL (i.e., 140 mg/kg) in all soil samples (i.e., 09-TP21-BS2, 09-TP22-BS2, 09-TP23-BS2, 09-TP25-BS2, 09-MW14-SS2 and 09-MW-34D-SS1). Laboratory analytical results indicated that products impacting soil samples on this site resembled the weathered fuel oil and fuel oil fractions.

The detected concentrations of benzene in 09-MW14-SS4 (1.7 mg/kg) and xylenes in 09-TP23-BS2 (28 mg/kg) and 09-MW14-SS4 (82 mg/kg) exceeded the applicable Tier I RBSLs (0.16 mg/kg and 17 mg/kg, respectively). Detected concentrations BTEX parameters in the remaining samples analysed from the site were below the applicable Tier I RBSLs.

Metals in Soil

Available metals analysis was conducted on two (2) surface soil samples collected from the site (09-SS1 and 09-SS3). Results of the laboratory analysis of soil samples for available metals are presented in Table 3.3 in Appendix 3d. Concentrations of various metals were detected in both soil samples, but none of the detected concentrations of available metals in soils exceeded the applicable CCME residential/parkland criteria.

PAHs in Soil

PAH analysis was conducted on one (1) surface soil sample collected from the site (09-SS2). Results of the laboratory analysis of this soil sample for PAHs are presented in Table 3.4 in Appendix 3d. The detectable concentration of fluoranthene (0.007 mg/kg) in the sample was below the applicable CCME soil quality guideline for a residential/parkland site (50 mg/kg). None of the remaining PAHs parameters were detected in the sample analysed.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on four (4) groundwater samples collected from the site (09-MW13S, 09-MW14, 09-MW34S and 09-MW34D) and one (1) standing water sample collected from a pipe protruding from the ground (09-PIPE1). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 3.5 and Table 3.6 in Appendix 3d. Modified TPH was detected in the four (4) groundwater samples. The concentrations of TPH in samples 09-MW13S (55 mg/L) and 09-MW14 (970,000 mg/L) exceeded the applicable Tier I RBSL for fuel oil impacts (20 mg/L). Laboratory analytical results indicated that the product impacting these groundwater samples resembled fuel oil. Laboratory analytical results indicated that the products impacting groundwater samples 09-MW34S and 09-MW34D resembled weathered fuel oil or lube oil.

The detected concentrations of ethylbenzene (560 mg/L) and xylenes (2,500 mg/L) in sample 09-MW14 exceeded the applicable Tier I RBSLs (20 mg/L and 20 mg/L, respectively). The detected concentrations of toluene, ethylbenzene and xylenes parameters in samples 09-MW13S and 09-MW34S were below the applicable Tier I RBSLs.

Metals in Groundwater

Dissolved metals analysis was conducted on four (4) groundwater samples collected from the site (09-MW13S, 09-MW14, 09-MW34S and 09-MW34D). Results of the laboratory analysis of the groundwater samples are presented in Table 3.7 in Appendix 3d. Concentrations of various metals were detected in the groundwater samples. None of the detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

General Chemistry in Groundwater

General chemistry analysis was conducted on four (4) groundwater sample collected from the site (09-MW13S, 09-MW14, 09-MW34S and 09-MW34D). Results of the laboratory analysis of the groundwater samples are presented in Table 3.8 in Appendix 3d. The pH value recorded for sample 09-MW34S (6.00) was outside the CCME freshwater aquatic life range of 6.5 to 9.0. None of the remaining general chemistry parameters analysed exceeded the applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Surface Water

Petroleum hydrocarbon analysis was conducted on one (1) surface water sample collected from the site (09-SW1). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 3.9 in Appendix 3d. Modified TPH was detected in the surface water sample at a concentration of 0.4 mg/L. There are no applicable CCME guidelines for TPH in surface water. The laboratory report noted that the product in the sample had a resemblance to a mixture of the weathered fuel oil fraction and lube oil fraction. No BTEX parameters were detected in the surface water sample.

Dissolved Metals in Surface Water

Dissolved metals analysis was conducted on one (1) surface water sample (09-SW1). Results of the laboratory analysis of this surface water sample are presented in Table 3.10 in Appendix 3d. The detected concentrations of aluminum, cadmium, chromium, copper, iron and mercury (i.e., 725 µg/L, 0.041 µg/L, 10.0 µg/L, 9.5 µg/L, 4,610 µg/L and 0.065 µg/L, respectively) exceeded the CCME guidelines for the protection of freshwater aquatic life (i.e., 100 µg/L, 0.017 µg/L, 8.9 µg/L, 4 µg/L, 300 µg/L, 0.026 µg/L, respectively).

General Chemistry in Surface Water

General chemistry analysis was conducted on one (1) surface water sample (09-SW1). Results of the laboratory analysis of this surface water sample are presented in Table 3.11 in Appendix 3d. The pH value recorded in the sample (5.99) was outside the applicable CCME freshwater aquatic life guideline (6.5 to 9.0). None of the remaining general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

PCBs in Vegetation

PCBs analysis was conducted on two (2) vegetation samples collected from the site (09-VEG9 and 09-VEG10). Results of the laboratory analysis of these vegetation samples for PCBs are presented in Table 3.12 in Appendix 3d. PCBs were not detected in the vegetation samples.

PCBs in Berries

PCBs analysis was conducted on two (2) berry samples collected from the site (09-BERRY8 & 09-BERRY9). Results of the laboratory analysis of these berry samples for PCBs are presented in Table 3.13 in Appendix 3d. PCBs were not detected in the berry samples.

PCBs in Small Mammals and Rabbits

PCBs analysis was conducted on four (4) small mammals (09-SM2, 09-SM7, 09-SM27 and 09-SM28) and one (1) rabbit (09-SM36) caught at the site in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals and rabbits for PCBs are presented in Table 3.14 in Appendix 3d. PCBs were not detected in the small mammal or rabbit samples.

Metals in Small Mammals and Rabbits

Available metals analysis was conducted on one (1) small mammal (09-SM2) and one (1) rabbit (09-SM26) caught at the site in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals and rabbits for metals are presented in Table 3.15 in Appendix 3d. Concentrations of various available metals were detected in the small mammal and rabbit samples analysed. There are presently no provincial or federal criteria for available metal levels in small mammals or rabbits.

Mercury in Small Mammals

Mercury analysis was conducted on one (1) small mammal caught at the site (09-SM7) in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals for mercury are presented in Table 3.15 in Appendix 3d. Mercury was not detected in the small mammal sample.

3.2.9 Discussions and Conclusions

A Phase III ESA was completed at the South Bulk Fuel Storage site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of the assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of a discontinuous layer of brown to grey sand (SP) with varying percentages of silt and clay interbedded with a layer of clay (CL) or silt (ML). A layer of peat was encountered at the surface of two (2) monitor wells. Bedrock was not encountered in any of the test pits or monitor wells at the site.

2. Buried debris was not encountered in test pits dug at the site. No surface debris or physical hazards were observed at the site.
3. Groundwater was encountered at depths ranging from ground surface (i.e., 0.00 mbgs) to 1.50 mbgs in test pits and shallow monitor wells completed at this site and at depths ranging from 4.74 mbgs to 5.30 mbgs in deep monitor wells completed at this site. Based on local topography and site observations the direction of groundwater flow is inferred to be to the east towards Lake Melville.
4. A hydraulic conductivity of 1 x 10^{-8} m/s was determined for the underlying stratigraphy at the site, which is within the range expected for silt (i.e., 10^{-5} m/s to 10^{-9} m/s).
5. In 1999, weathered free product was observed entering test pits at shallow depths. In 2001, trenching activities were carried out at the site for free product removal. A sheen of weathered fuel was observed on the surface of groundwater within the trenches and was removed using oil absorbent pads. As part of the current investigation, a follow-up free product survey was conducted at the site. A sheen was observed on groundwater encountered in 09-TP20 and a skim (i.e., <1 mm) of fuel was observed on groundwater encountered in test pit 09-TP21; both test pits are located near the former AST location. A sheen was observed on groundwater extracted from monitor well 09-MW14, located in the vicinity of the pipeline. No measurable product was detected on groundwater in monitor wells at the site.
6. Slight to heavy petroleum hydrocarbon odours were detected on soil in test pits and monitor wells in the vicinity of the former AST (i.e., 09-TP20, 09-TP21, 09-TP22, and 09-MW13S, 09-MW13D and 09-MW14) and slight hydrocarbon odours were detected on subsurface soil (>1 mbgs) in test pits in the vicinity of the pipeline (09-TP23 and 09-TP25).
7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.4 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.4 Summary of Exceedances (South Bulk Fuel Storage Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	SF-TP1 (1999) SF-TP8 (1999) SF-TP10 (1999) SF-TP14 (1999) SF-TP31 (1999) SF-TP15 (2001) SF-TP16 (2001) SF-TP16 (2001) SF-MW1 (2001) SF-MW1 (2001) 09-TP21-BS2 09-TP22-BS2 09-TP23-BS2 09-TP25-BS2 09-MW14-SS4 09-MW34D-SS1	21,580 mg/kg 678 mg/kg 470 mg/kg 2,695 mg/kg 1,494 mg/kg 564.94 mg/kg 3,597.73 mg/kg 6,950 mg/kg 3,476.9 mg/kg 1,441.90 mg/kg 6,900 mg/kg 31,000 mg/kg 14,000 mg/kg 5,800 mg/kg 26,000 mg/kg 1,600 mg/kg	140 mg/kg (Tier I RBSL, 2003)
	Benzene	SF-TP14 (1999) SF-TP14 (1999) 09-MW14-SS4	4.1 mg/kg 5.0 mg/kg 1.7 mg/kg	0.16 mg/kg (Tier I RBSL, 2003)
	Xylenes	SF-TP14 (1999) SF-TP14 (1999)	49.3 mg/kg 38.7 mg/kg	17 mg/kg (Tier I RBSL, 2003)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
		09-TP23-BS2 09-MW14-SS4	28 mg/kg 82 mg/kg	
Groundwater	TPH	SF-TP7 (1999) SF-MW1 (2001) 09-MW13S 09-MW14	4,800.36 mg/L 37.5 mg/L 55 mg/L 970,000 mg/L	20 mg/L (Tier I RBSL, 2003)
	Ethylbenzene	09-MW14	560 mg/L	20 mg/L (Tier I RBSL, 2003)
	Toluene	09-MW14	2,500 mg/L	20 mg/L (Tier I RBSL, 2003)
	Mercury	SF-TP7 (1999) SF-TP11 (1999) SF-MW1D (2001)	0.8 µg/L 0.8 µg/L 0.3 µg/L	0.29 µg/L (MOE, 2009)
	pH	SF-MW1S (2001) 09-MW34S	5.42 6.00	6.5 to 9.0 (CCME FWAL, 2007)
Surface Water	Aluminum	09-SW1	725 µg/L	5 µg/L (CCME FWAL, 2007)
	Cadmium	09-SW1	0.041 µg/L	0.010 µg/L (CCME FWAL, 2007)
	Chromium	09-SW1	10.0 µg/L	8.9 µg/L (CCME FWAL, 2007)
	Copper	09-SW1	9.5 µg/L	2 µg/L (CCME FWAL, 2007)
	Iron	09-SW1	4,610 µg/L	300 µg/L (CCME FWAL, 2007)
	Lead	09-SW1	1.02 µg/L	1 µg/L (CCME FWAL, 2007)
	Mercury	09-SW1	0.065 µg/L	0.026 µg/L (CCME FWAL, 2007)
	pH	09-SW1	5.99	6.5 to 9.0 (CCME FWAL, 2007)
Note: Details of Referenced Guidelines are provided in Section 1.5.2. No drawing was provided with the 2001 sample results				

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pits SF-TP1 (1999), SF-TP8 (1999), SF-TP10 (1999), SF-TP14 (1999), SF-TP31 (1999), SF-TP15 (2001), SF-TP16 (2001), SF-MW1 (2001), 09-TP21, 09-TP22, 09-TP23, 09-TP25 and monitor wells 09-MW14 and 09-MW34D, and petroleum hydrocarbon remediation of shallow groundwater would be required in the vicinity of test pit SF-TP7 (1999) and monitor wells SF-MW1 (2001), 09-MW13S and 09-MW14 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-3B in Appendix 3a shows the estimated extent of the petroleum hydrocarbon-impacted soil and groundwater at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 1,222 m^2 has TPH levels in soil above 140 mg/kg and an estimated area of approximately 483 m^2 has petroleum hydrocarbon levels in groundwater above 20 mg/L.
   - **BTEX** remediation of site soil would be required in the vicinity of test pits SF-TP14 (1999) and 09-TP23 and monitor well 09-MW14, and BTEX remediation of shallow groundwater would be required in the vicinity of monitor well 09-MW14 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a

risk-based remedial approach for the site. Drawing No. 121410105-EE-3C in Appendix 3a shows the estimated extent of the BTEX-impacted soil and groundwater at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 546 m^2 has benzene and xylenes levels in soil above the Tier I RBSLs (0.16 mg/kg and 17 mg/kg, respectively) and an estimated area of approximately 93 m^2 has ethylbenzene and xylene levels in groundwater above 20 mg/L.

- **Metals** remediation of shallow groundwater would be required in the vicinity of test pits SF-TP7 (1999), SF-TP11 (1999) and monitor well SF-MW1D (2001) and metals remediation of surface water would be required in the ditch at the site in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-3D in Appendix 3a shows the estimated extent of the metal (i.e., mercury) impacted groundwater and metals (i.e., aluminum, cadmium, chromium, copper, iron, lead and mercury) impacted surface water at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 174 m^2 has mercury levels in groundwater above 0.12 µg/L.

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH and BTEX impacts on soil, TPH, BTEX, metals and general chemistry impacts groundwater and metals and general chemistry impacts on surface water above the generic guidelines.

10. Petroleum hydrocarbon impacted groundwater is not expected to be migrating towards the adjacent bog; however, further delineation is required.

3.3 East Bulk Fuel Storage Site

3.3.1 Site Description

The East Bulk Fuel Storage Site is a former diesel fuel AST location on the west side of Dock Road. A site plan is provided in Drawing No. 121410105-EE-04A. The site is easily accessible from Dock Road. Based on information collected to date, the tank was filled via a 150 mm – 200 mm outside diameter underground steel pipeline and from there supplied fuel to different areas of the facility via two (2) separate runs of smaller 50 – 75 mm OD underground steel fuel lines. The former AST capacity is estimated at 1.1 million litres. Photos taken of the site during the current investigation are presented in Appendix 4b.

The centre of the site is a sandy open area with little to no vegetation. The perimeter of the site is heavily treed with tall stands of common native deciduous trees and scattered native coniferous trees. The terrain is relatively level and surface water runoff is directed to a ditch on the west side of Dock Road. Modest to strong hydrocarbon odours were noted downwind of the site during previous investigations.

Previous subsurface investigations revealed significant quantities of weathered free product and groundwater entering test pits at shallow depths. TPH impacts were identified in subsurface soil (> 0.5 mbgs) and in groundwater entering one (1) of the test pits. Chromatograms for soil and groundwater samples with elevated concentrations of TPH resembled diesel.

3.3.2 Field Work

Field work at this site comprised the excavation of six (6) test pits, the installation of three (3) monitor wells, and the collection of five (5) surface soil samples, three (3) groundwater samples, one (1) sediment sample and two (2) vegetation samples. A site plan (Drawing No. 121410105-EE-04A) showing the location of these as well as general site features is provided in Appendix 4a. Coordinates of each sample location are provided in Appendix 4c.

3.3.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 4d. Compact brown sand (SP) extended from the surface to the base of all test pits at a maximum depth of 1.6 mbgs in 09-TP26 and 09-TP30. The stratigraphy encountered in monitor wells generally consisted of layers of dark brown to black sand (SP) interbedded with layers of grey silty clay (CL-ML) and/or brown sand (SP) with some cobbles.

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.3.4 Debris and Physical Hazards

Buried debris was not encountered in any of the six (6) test pits, as identified in Table 2.2 and documented on the Test Pit Records in Appendix 4d. No surface debris or physical hazards were observed at the East Bulk Fuel Storage Site.

3.3.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 0.29 mbgs to 0.50 mbgs in the shallow groundwater wells at the site during the two (2) groundwater survey events. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed during the excavation of test pits on August 6 and 7, 2009 in 09-TP26 to 09-TP31 at depths ranging from 1.4 mbgs in 09-TP27, 09-TP28 and 09-TP29 to 1.6 mbgs in 09-TP26. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the east towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-04A in Appendix 4a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW16 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 4f. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 4f. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW16 with a value of 3×10^{-6} m/s determined using the Bouwer & Rice method and 4×10^{-6} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 4×10^{-6} m/s is determined for the underlying stratigraphy at the site.

3.3.6 Free Phase Petroleum Hydrocarbons

During the current investigation, a sheen was observed on groundwater encountered in test pits 09-TP26, 09-TP27 and 09-TP28. Sheens were observed on groundwater extracted from monitor wells 09-MW16 and 09-MW17 during purging on August 27, 2009; however, no measurable product was detected on groundwater in monitor wells at the site with the product interface probe.

3.3.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the East Bulk Fuel Storage Site site are provided on the test pit and monitor well records in Appendix 4c. The soil vapour concentrations measured ranged from 2.0 ppm in soil samples 09-TP26-BS1 to 517 ppm in soil sample 09-MW16-SS4. Slight to moderate petroleum hydrocarbon odours were detected in test pits 09-TP26 to 09-TP30, monitor wells 09-MW15 and 09-MW17 and surface soil samples 09-SS18 and 09-SS19 during excavation. Moderate to strong petroleum hydrocarbon odours were detected in surface soil samples 09-SS16 and 09-SS17.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations exceeded 50 ppm in 21 soil samples collected at the site (i.e., 09-TP27-BS1 & BS2, 09-TP28-BS1 & BS2, 09-TP29-BS1 & BS2, 09-TP30-BS1 & BS2, 09-MW15-SS1, SS2, SS3, SS4 & SS5, 09-MW16-SS1, SS2, SS3 & SS4 and 09-MW17-SS1, SS2, SS3 & SS4). Soil vapour concentrations, along with field observations, site usage and site history were used to select samples for petroleum hydrocarbon analysis.

3.3.8 Laboratory Analysis and Results

A laboratory analysis schedule for the East Bulk Fuel Storage Site is presented in Table 3.5 below.

Table 3.5 Laboratory Analysis Schedule (East Bulk Fuel Storage Site)

Issues	Sample Locations	Sample Matrix			
		Soil/ Sediment	Groundwater	Veg./ Berries	Small Mammals
• Surface debris identified during previous investigations – characterization required. • Free Product noted during previous investigations – volume calculation required. • Petroleum hydrocarbon impacts in soil – delineation required. • COC (petroleum hydrocarbons, PAHs and metals) concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbons and metals in shallow groundwater. • Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.	09-TP26 to 09-TP31 09-SS15 to 09-SS19 09-MW15 to 09-MW17 09-SED3 09-VEG15 & 09-VEG16	Soil: TPH/ BTEX (9) Metals (5) PAHs (3) Sediment: TPH/BTEX (1) Metals (1)	Groundwater: TPH/BTEX (2) TPH Frac/ BTEX (1) Metals (3) General Chemistry (3)	Veg: PCBs (2)	-

Results of laboratory analysis of soil, groundwater, sediment and vegetation samples obtained from this site are presented in Tables 4.1 to 4.10 in Appendix 4e. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on eight (8) soil samples collected from the site including six (6) test pit samples (09-TP26-BS2, 09-TP27-BS2, 09-TP28-BS2, 09-TP29-BS2, 09-TP30-BS2 and 09-TP31-BS2) and two (2) monitor well samples (09-MW16-SS4 and 09-MW17-SS3). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 4.1 in Appendix 4e. Modified TPH was detected in all eight (8) soil samples, with concentrations ranging from 62 mg/kg to 16,000 mg/kg. Concentrations of modified TPH exceeded the applicable Tier I RBSLs (i.e., 140 mg/kg) in all but one soil sample (i.e., 09-TP26-BS2). Laboratory analytical results indicated that products impacting soil samples on this site resembled the fuel oil fraction.

BTEX was not detected in any of the soil samples analysed, except for 09-MW17-SS3. Ethylbenzene and xylenes were detected in sample 09-MW17-SS3 (0.46 mg/kg and 1.1 mg/kg, respectively), but the concentrations were below the applicable Tier I RBSLs (58 mg/kg and 17 mg/kg, respectively).

Metals in Soil

Available metals analysis was conducted on five (5) surface soil samples collected from the site (09-SS15 to 09-SS19). Results of the laboratory analysis of soil samples for available metals are presented in Table 4.2 in Appendix 4e. Concentrations of various metals were detected in all soil samples, but none of the detected concentrations of available metals in soils exceeded the applicable CCME residential/parkland criteria.

PAHs in Soil

PAH analysis was conducted on two (2) surface soil samples collected from the site (09-SS16 and 09-SS17). Results of the laboratory analysis of these soil samples for PAHs are presented in Table 4.3 in Appendix 4e. Various PAHs were detected in both samples. Detectable concentrations of PAH parameters in samples 09-SS16 and 09-SS17 were below the applicable CCME soil quality guidelines for a residential/parkland site, where such guidelines exist.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on three (3) groundwater samples collected from the site (09-MW15 to 09-MW17). Fractionation analysis was carried out on the sample from 09-MW16. Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 4.4 and Table 4.5 in Appendix 4e. Modified TPH was detected in three (3) groundwater samples at concentrations ranging from 53 mg/L to 230 mg/L. The TPH concentrations in 09-MW15, 09-MW16 and 09-MW17 (53 mg/L, 230 mg/L and 230 mg/L, respectively) all exceeded the applicable Tier I RBSL for fuel oil impacts (i.e., 20 mg/L). Laboratory analytical results indicated that the products impacting the groundwater samples resembled either weathered fuel oil or fuel oil. BTEX was not detected in the groundwater samples.

Metals in Groundwater

Dissolved metals analysis was conducted on three (3) groundwater samples collected from the site (09-MW15 to 09-MW17). Results of the laboratory analysis of the groundwater samples are presented in Table 4.6 in Appendix 4e. Concentrations of various metals were detected in the groundwater samples. None of the detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

General Chemistry in Groundwater

General chemistry analysis was conducted on three (3) groundwater samples collected from the site (09-MW15 to 09-MW17). Results of the laboratory analysis of the groundwater samples are presented in Table 4.7 in Appendix 4e. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) sediment sample collected from the site (09-SED3). Results of the laboratory analysis of the sediment sample for petroleum hydrocarbons are presented in Table 4.8 in Appendix 4e. Modified TPH was detected in the sediment sample, at a concentration of 470 mg/kg. The concentration of modified TPH did not exceed the applicable MOE guideline for oil and grease in sediment (i.e., 1,500 mg/kg). Laboratory analytical results indicated that products impacting the sediment sample on this site resembled a weathered fuel oil fraction. BTEX was not detected in the sediment sample analysed.

Metals in Sediment

Available metals analysis was conducted on one (1) sediment sample collected from the site (09-SED3). Results of the laboratory analysis of the sediment sample for available metals are presented in Table 4.9 in Appendix 4e. Concentrations of various metals were detected in the sediment sample, but none of the detected concentrations of available metals in sediment exceeded the applicable CCME ISQGs or PELs for freshwater sediment.

PCBs in Vegetation

PCBs analysis was conducted on two (2) vegetation samples collected from the site (09-VEG15 and 09-VEG16) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these vegetation samples for PCBs are presented in Table 4.10 in Appendix 4e. PCBs were not detected in the vegetation samples.

3.3.9 Discussions and Conclusions

A Phase III ESA was completed at the East Bulk Fuel Storage site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of the assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of layers of dark brown to black sand (SP) interbedded with layers of grey silty clay (CL-ML) and/or brown sand (SP) with some cobbles. Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. Buried debris was not encountered in test pits dug at the site and surface debris and physical hazards were not observed at the site.
3. Groundwater was encountered at depths ranging from 0.29 mbgs to 1.60 mbgs in test pits and shallow monitor wells completed at this site. Based on local topography and site observations the direction of groundwater flow is inferred to be to the east towards Lake Melville.
4. A hydraulic conductivity of 4 x 10^{-6} m/s is determined for the underlying stratigraphy at the site, which is within the range expected for silty sands (i.e., 10^{-3} m/s to 10^{-7} m/s).
5. In 1999, weathered free product was observed entering test pits at shallow depths. As part of the current investigation, a follow-up free product survey was conducted at the site. A sheen was observed on groundwater encountered in test pits 09-TP26, 09-TP27 and 09-TP28 and on groundwater extracted from monitor wells 09-MW16 and 09-MW17; however, no measurable product was detected on groundwater in monitor wells at the site.
6. Slight to moderate petroleum hydrocarbon odours were detected in test pits 09-TP26 to 09-TP30, monitor wells 09-MW15 and 09-MW17 and surface soil samples 09-SS18 and 09-

SS19 during excavation. Moderate to strong petroleum hydrocarbon odours were detected in surface soil samples 09-SS16 and 09-SS17.

7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.6 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.6 Summary of Exceedances (East Bulk Fuel Storage Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	EF-TP1 (1999) EF-TP8 (1999) EF-TP9 (1999) EF-TP35 (1999) EF-TP37 (1999) 09-TP27-BS2 09-TP28-BS2 09-TP29-BS2 09-TP30-BS2 09-MW16-SS3 09-MW17-SS3 09-SS18 09-SS19	23,387 mg/kg 535 mg/kg 360 mg/kg 22,263 mg/kg 9,498 mg/kg 9,100 mg/kg 6,500 mg/kg 11,000 mg/kg 11,000 mg/kg 14,000 mg/kg 16,000 mg/kg 2,300 mg/kg 19,000 mg/kg	140 mg/kg (Tier I RBSL, 2003)
Groundwater	TPH	EF-TP3 (1999) 09-MW15 09-MW16 09-MW17	12,380 mg/L 53 mg/L 230 mg/L 120 mg/L	20 mg/L (Tier I RBSL, 2003)
	pH	09-MW15 09-MW16 09-MW17	5.95 6.03 6.10	6.5 to 9.0 (CCME FWAL, 2007)

Note: Details of Referenced Guidelines are provided in Section 1.5.2

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

- **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pits EF-TP1 (1999), EF-TP8 (1999), EF-TP9 (1999), EF-TP35 (1999), EF-TP37 (1999), 09-TP27, 09-TP28, 09-TP29, 09-TP30, monitor wells 09-MW16 and 09-MW17, and surface soil samples 09-SS18 and 09-SS19, and petroleum hydrocarbon remediation shallow groundwater would be required in the vicinity of test pit EF-TP3 (1999) and monitor wells 09-MW15, 09-MW16 and 09-MW17 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-4B in Appendix 4a shows the estimated extent of the petroleum hydrocarbon-impacted soil and groundwater at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 2,609 m^2 has TPH levels in soil above 140 mg/kg and an estimated area of approximately 353 m^2 has petroleum hydrocarbon levels in groundwater above 20 mg/L. (Note: area of impacted soil surrounding P-TP37 and area of impacted groundwater surrounding 09-MW17 are not included in these areas, but are included in the areas calculated for the East Generator Site)

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH impacts on soil and TPH and general chemistry impacts groundwater above the generic guidelines.

3.4 East Generator Site

3.4.1 Site Description

The East Generator Site was one of two sites used by the US Military for diesel generation of electric power. As indicated in Drawing No. 121410105-EE-05A, the site is located on the north side of Camp Road about 120 m east of the intersection of Camp Road and Dock Road. The site is easily accessible from Camp Road and Dock Road. Photos taken of the site during the current investigation are presented in Appendix 5b.

Based on the presence of ruins of a tank crib array at the site, at least two diesel day aboveground fuel storage tanks were present at the site, immediately west of the foundation ruins. It is likely that these tanks were filled via 50 – 75 mm OD underground steel fuel lines running from the East Bulk Fuel Storage Site. The site was likely used as a primary power source during construction of the facility. After the facility was constructed, it may have been decommissioned or used as a back-up to the West Generator Site.

The site is now covered with low alder and scrub brush. A few small areas of the ground surface have no vegetation and consist of sand with light to moderate staining. The terrain is level and no preferred direction of surface water flow could be determined. A drainage ditch is present along Camp Road, southeast of the main site area. Modest hydrocarbon odours were previously noticed downwind of the site during previous investigations.

Previous subsurface investigations revealed significant quantities of weathered free product and groundwater entering test pits at shallow depths. TPH impacts were identified in subsurface soil (> 0.5 mbgs) and mercury impacts were noted in groundwater entering two (2) test pits. Chromatograms for soil samples with elevated concentrations of TPH resembled diesel. However, since the groundwater samples were not collected from a properly installed and purged monitor well, some of the groundwater results are not likely representative of the actual groundwater chemistry on the site.

3.4.2 Field Work

Field work at this site comprised the excavation of five (5) test pits, the installation of three (3) monitor wells, and the collection of two (2) surface soil samples, three (3) groundwater samples, one (1) sediment sample, one (1) vegetation sample and two (2) small mammal sample. A site plan (Drawing No. 121410105-EE-05A) showing the location of these as well as general site features provided in Appendix 5a. Coordinates of each sample location are provided in Appendix 5c.

3.4.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 5d. Compact brown sand (SP) extended from the surface to the base of all test pits at a maximum depth of 1.8 mbgs in 09-TP36. The stratigraphy encountered in monitor wells generally consisted of layers of dark brown to black sand (SP) underlain by a layers of brown to black sand (SP) with varying percentages of cobbles or silt. In 09-MW18, the sand layer was underlain by grey clay (CL) at a depth of 1.5 mbgs.

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.4.4 Debris and Physical Hazards

Buried debris was not encountered in any of the six (6) test pits, as identified in Table 2.2 and documented on the Test Pit Records in Appendix 5d. No surface debris or physical hazards were identified at the East Generator Site.

3.4.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 0.30 mbgs to 1.07 mbgs in the shallow monitor wells at the site during the two (2) groundwater survey events. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed during the excavation of test pits on August 6 and 7, 2009 in 09-TP32 to 09-TP36 at depths ranging from 0.9 mbgs in 09-TP32 and 09-TP34 to 1.1 mbgs in 09-TP33 and 09-TP36. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the east towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-05A in Appendix 5a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW20 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 5f. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 5f. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW20 with a value of 3×10^{-6} m/s determined using the Bouwer & Rice method and 4×10^{-6} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 3 x 10^{-6} m/s is determined for the underlying stratigraphy at the site.

3.4.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil in test pits, monitor wells or surface soil samples during the current investigation. No measurable product was detected on groundwater in monitor wells 09-MW18 or 09-MW19 at the site with the product interface probe.

On August 27, 2009, 100 mm of free product was detected on groundwater in monitor well 09-MW20 with the product interface probe. Free product/groundwater was removed from the well prior to conducting the slug test using a dedicated bailer and was stored in a 20 L plastic container. The collected free product/groundwater was transported to St. John's by Stantec and disposed of at Crosbie Industrial Services Limited, a licensed waste oil disposal contractor. When the monitor well was re-surveyed on October 18, 2009, 1 mm of product was detected on groundwater. It is assumed that the majority of the product present on groundwater in the area of 09-MW20 was extracted on August 27, 2009.

3.4.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the East Generator Site are provided on the Test Pit Records and Monitor Well Records in Appendix 5d. The soil vapour concentrations measured ranged from 8.2 ppm in soil samples 09-TP36-BS1 & BS2 to 565 ppm in soil sample 09-TP33-BS2. Slight to moderate petroleum hydrocarbon odours were detected in test pits 09-TP32 to 09-TP35 during excavation and monitor wells 09-MW19 and 09-MW20 during drilling.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations exceeded 50 ppm in seven (7) soil samples collected at the site (i.e., 09-TP32-BS2, 09-TP33-BS2, 09-TP34-BS2, 09-MW20-SS1, SS2, SS3 & SS4). Soil vapour concentrations, along with field observations, site usage and site history were used to select samples for petroleum hydrocarbon analysis.

3.4.8 Laboratory Analysis and Results

A laboratory analysis schedule for the East Generator Site is presented in Table 3.7 below.

Table 3.7 Laboratory Analysis Schedule (East Generator Site)

Issues	Sample Locations	Sample Matrix			
		Soil/ Sediment	Groundwater	Veg./ Berries	Small Mammals
• Free Product noted during previous investigations – volume calculation required. • Petroleum hydrocarbon impacts in soil – delineation required. • Electrical equipment historically present on site – possible PCBs in soil. • COC (petroleum hydrocarbons, PAHs, metals and possibly PCBs) concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbons, metals and PAHs in shallow groundwater. • Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.	09-TP32 to 09-TP36 09-SS20 & 09-SS21 09-MW18 to 09-MW20 09-SED2 09-VEG14 09-SM13 & 09-SM15	Soil: TPH/ BTEX (6) Metals (1) PCBs (3) Sediment: TPH/ BTEX (1) Metals (1)	Groundwater: TPH/BTEX (2) TPH Frac/ BTEX (1) Metals (3) PAHs (1) General Chemistry (3)	Veg: PCBs (1)	SM: PCBs (2)

Results of laboratory analysis of soil, groundwater, sediment, vegetation and small mammal samples obtained from this site are presented in Tables 5.1 to 5.13 in Appendix 5e. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on eight (8) soil samples collected from the site including four (4) test pit samples (09-TP32-BS2, 09-TP33-BS2, 09-TP34-BS2 and 09-TP35-BS2) and two (2) monitor well samples (09-MW19-SS3 and 09-MW20-SS2). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 5.1 in Appendix 5e. Modified TPH was detected in four (4) soil samples (09-TP32-BS2, 09-TP33-BS2, 09-MW19-SS3 and 09-MW20-SS2) at concentrations of 2,200 mg/kg, 9,900 mg/kg, 190 mg/kg and 9,300 mg/kg, respectively. The detected concentrations of modified TPH exceeded the applicable Tier I RBSLs (i.e., 140 mg/kg) in all four (4) soil samples. Laboratory analytical results indicated that products impacting soil samples on this site resembled the fuel oil fraction.

Xylenes were detected in sample 09-MW20-SS2 (0.06 mg/kg), but the concentration was below the applicable Tier I RBSL (17 mg/kg). BTEX parameters were not detected in any of the other soil samples analysed.

Metals in Soil

Available metals analysis was conducted on one (1) monitor well sample (09-MW20-SS2) and two (2) surface soil samples collected from the site (09-SS20 and 09-SS21). Results of the laboratory analysis of soil samples for available metals are presented in Table 5.2 in Appendix

5e. Concentrations of various metals were detected in all soil samples, but none of the detected concentrations of available metals in soils exceeded the applicable CCME residential/parkland criteria.

PAHs in Soil

PAH analysis was conducted on one (1) surface soil sample collected from the site (09-SS20). Results of the laboratory analysis of these soil samples for PAHs are presented in Table 5.3 in Appendix 5e. Various PAHs were detected in the sample. Detectable concentrations of PAH parameters in sample 09-SS20 were below the applicable CCME soil quality guidelines for a residential/parkland site, where such guidelines exist.

PCBs in Soil

PCB analysis was conducted on two (2) surface soil samples collected from the site (09-SS20 and 09-SS21) and one monitor well sample (09-MW20-SS2). Results of the laboratory analysis of these soil samples for PCBs are presented in Table 5.4 in Appendix 5e. PCBs were not detected in samples 09-SS21 and 09-MW20-SS2. A low concentration of PCBs (0.16 mg/kg) was detected in sample 09-SS20 which was below the applicable CCME soil quality guidelines for a residential/parkland site.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on three (3) groundwater samples collected from the site (09-MW18 to 09-MW20). Fractionation analysis was carried out on the sample from 09-MW20. Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 5.5 and Table 5.6 in Appendix 5e. Modified TPH was detected in the three (3) groundwater samples at concentrations ranging from 1.3 mg/L to 760 mg/L. The TPH concentration in 09-MW20 (760 mg/L) exceeded the applicable Tier I RBSL for fuel oil impacts (i.e., 20 mg/L). Laboratory analytical results indicated that the products impacting the groundwater sample resembled either weathered fuel oil or fuel oil.

BTEX parameters were not detected in samples 09-MW18 and 09-MW19. The detected concentrations of ethylbenzene (0.02 mg/L) and xylenes (0.09 mg/L) in sample 09-MW20 were below the applicable Tier I RBSLs.

Metals in Groundwater

Dissolved metals analysis was conducted on three (3) groundwater samples collected from the site (09-MW18 to 09-MW20). Results of the laboratory analysis of the groundwater samples are presented in Table 5.7 in Appendix 5e. Concentrations of various metals were detected in the groundwater samples. None of the detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

PAHs in Groundwater

PAHs analysis was conducted on one (1) groundwater sample collected from the site (09-MW20). Results of the laboratory analysis of the groundwater sample are presented in Table 5.8 in Appendix 5e. Concentrations of all PAH parameters were detected in the groundwater sample. The detected concentrations of the following PAH parameters in groundwater sample 09-MW20 exceeded guidelines:

- Acenaphthylene (42 µg/L) exceeded the MOE guideline (1.8 µg/L);
- Anthracene (18 µg/L) exceeded the MOE guideline (2.4 µg/L);
- Benzo[a]anthracene (5.9 µg/L) exceeded the MOE guideline (4.7 µg/L);
- Benzo[a]pyrene (2.7 µg/L) exceeded the MOE guideline (0.81 µg/L);
- Benzo[b]fluoranthene (2.5 µg/L) exceeded the MOE guideline (0.75 µg/L);
- Benzo[ghi]perylene (1.3 µg/L) exceeded the MOE guideline (0.2 µg/L);
- Benzo[k]fluoranthene (2.5 µg/L) exceeded the MOE guideline (0.4 µg/L);
- Chrysene (5.4 µg/L) exceeded the MOE guideline (1 µg/L);
- Fluorene (410 µg/L) exceeded the MOE guideline (400 µg/L); and,
- Indeno[1,2,3-cd]pyrene (1.5 µg/L) exceeded the MOE guideline (0.2 µg/L).

General Chemistry in Groundwater

General chemistry analysis was conducted on (3) three groundwater samples collected from the site (09-MW18 to 09-MW20). Results of the laboratory analysis of the groundwater samples are presented in Table 5.9 in Appendix 5e. Neither of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) sediment sample collected from the site (09-SED2). Results of the laboratory analysis of the sediment sample for petroleum hydrocarbons are presented in Table 5.10 in Appendix 5e. Modified TPH and BTEX parameters were not detected in the sediment sample.

Metals in Sediment

Available metals analysis was conducted on one (1) sediment sample collected from the site (09-SED2). Results of the laboratory analysis of the sediment sample for available metals are presented in Table 5.11 in Appendix 5e. Concentrations of various metals were detected in the sediment sample, but none of the detected concentrations of available metals in sediment exceeded the applicable CCME ISQGs or PELs for freshwater sediment.

PCBs in Vegetation

PCBs analysis was conducted on one (1) vegetation sample collected from the site (09-VEG14) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these vegetation samples for PCBs are presented in Table 5.12 in Appendix 5e. PCBs were not detected in the vegetation samples.

PCBs in Small Mammals

PCBs analysis was conducted on two (2) small mammals caught at the site (09-SM13 and 09-SM15) in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals for PCBs are presented in Table 5.13 in Appendix 5e. PCBs were not detected in the small mammal samples.

3.4.9 Discussions and Conclusions

A Phase III ESA was completed at the East Generator Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of the assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of dark brown to black sand (SP) with percentages of cobbles or silt increasing with depth. In 09-MW18, the sand layer was underlain by grey clay (CL) at a depth of 1.5 mbgs. Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. Buried debris was not encountered in test pits dug at the site and surface debris and physical hazards were not observed at the site.
3. Groundwater was encountered at depths ranging from 0.30 mbgs to 1.10 mbgs in test pits and shallow monitor wells completed at this site. Based on local topography and site observations the direction of groundwater flow is inferred to be to the east towards Lake Melville.
4. A hydraulic conductivity of 3×10^{-6} m/s is determined for the underlying stratigraphy at the site, which is within the range expected for silty sands (i.e., 10^{-3} m/s to 10^{-7} m/s).
5. In 1999, weathered free product was observed entering test pits at shallow depths. As part of the current investigation, a follow-up free product survey was conducted at the site. There was no visual evidence of free phase petroleum hydrocarbons on soil in test pits, monitor wells or surface soil samples during the current investigation and no measurable product was detected on groundwater in monitor wells 09-MW18 and 09-MW19 at the site. On August 27, 2009 and October 18, 2009, free product was detected on groundwater in monitor well 09-MW20 with the product interface probe (i.e., 100 mm and 1 mm, respectively). It is assumed that the majority of the product present on groundwater in the area of 09-MW20 was extracted from the well on August 27, 2009.
6. Slight to moderate petroleum hydrocarbon odours were detected in test pits 09-TP32 to 09-TP35 during excavation and monitor wells 09-MW19 and 09-MW20 during drilling.
7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.8 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.8 Summary of Exceedances (East Generator Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	EG-TP1 (1999) EG-TP3 (1999) EG-TP4 (1999) EG-TP7 (1999) 09-TP32-BS2 09-TP33-BS2 09-MW19-SS3 09-MW20-SS2	14,820 mg/kg 4,102 mg/kg 3,528 mg/kg 793 mg/kg 2,200 mg/kg 9,900 mg/kg 190 mg/kg 9,300 mg/kg	140 mg/kg (Tier I RBSL, 2003)
Groundwater	TPH	09-MW20	760 mg/L	20 mg/L (Tier I RBSL, 2003)
	Acenaphthylene	09-MW20	1.8 µg/L	42 µg/L (MOE, 2009)
	Anthracene	09-MW20	18 µg/L	2.4 µg/L (MOE, 2009)
	Benzo(a)anthracene	09-MW20	5.9 µg/L	4.7 µg/L (MOE, 2009)
	Benzo(a)pyrene	09-MW20	2.7 µg/L	0.81 µg/L (MOE, 2009)
	Benzo(ghi)perylene	09-MW20	1.3 µg/L	0.2 µg/L (MOE, 2009)
	Benzo(k)fluoranthene	09-MW20	2.5 µg/L	0.4 µg/L (MOE, 2009)
	Chrysene	09-MW20	5.4 µg/L	1 µg/L (MOE, 2009)
	Fluorene	09-MW20	410 µg/L	400 µg/L (MOE, 2009)
	Ideno(1,2,3-cd)pyrene	09-MW20	1.5 µg/L	0.2 µg/L (MOE, 2009)
	Mercury	EG-TP2 (1999)* P-TP34 (1999)*	1.0 µg/L 1.2 µg/L	0.29 µg/L (MOE, 2009)
	pH	09-MW18 09-MW19 09-MW20	6.24 6.20 5.73	6.5 to 9.0 (CCME FWAL, 2007)

Note: Details of Referenced Guidelines are provided in Section 1.5.2
* = Samples were collected from water entering the test pits and may not be representative of groundwater conditions at the site

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Free product** recovery would be required in the vicinity of monitor well 09-MW20. It appears that the free product is localized to the area surrounding monitor well 09-MW20, in the area of the former diesel ASTs; however, given that no wells were drilled immediately southwest of 09-MW20, the extent of free product has not been fully delineated. Based on an estimated area of approximately 100 m^2 and a product thickness of 1 mm, there is an estimated 100 L of free product present on groundwater in the vicinity of monitor well 09-MW20. Additional monitor wells would be required to fully delineate the extent of free product present in this area. Additional monitor wells would also provide additional locations to facilitate removal if the free product plume was found to be more extensive.
   - **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pits EG-TP1 (1999), EG-TP3 (1999), EG-TP4 (1999), EG-TP7 (1999), 09-TP32-BS2 and 09-TP33-BS2, and monitor wells 09-MW19 and 09-MW20, and petroleum hydrocarbon remediation shallow groundwater would be required in the vicinity of monitor well 09-

MW20 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-5B in Appendix 5a shows the estimated extent of the petroleum hydrocarbon-impacted soil and groundwater at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 1,158 m^2 has TPH levels in soil above 140 mg/kg and an estimated area of approximately 507 m^2 has petroleum hydrocarbon levels in groundwater above 20 mg/L.

- **Metals** remediation of site groundwater would be required in the vicinity of test pits EG-TP2 and P-TP34 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-5C in Appendix 5a shows the estimated extent metals (i.e., mercury) impacted groundwater at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 127 m^2 has levels of metals (i.e., mercury) parameters in groundwater above the applicable MOE guidelines.
- **PAH** remediation of site groundwater would be required in the vicinity of monitor well 09-MW20 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-5D in Appendix 5a shows the estimated extent PAH impacted groundwater at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 96 m^2 has levels of PAH parameters in groundwater above the applicable MOE guidelines.

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH impacts on soil and TPH, PAH and general chemistry impacts groundwater above the generic guidelines.

3.5 West Generator Site

3.5.1 Site Description

The West Generator Site was one of two sites used by the US Military for diesel generation of electric power. As indicated in Drawing No. 121410105-EE-06A, the site is located near the centre of the facility on the west side of the Transmitter Building. The site is accessible from Crossover Road which is heavily overgrown with alders via a rough excavator road. Photos taken of the site during the current investigation are presented in Appendix 6b.

Based on information collected to date, the site contained at least two large diesel day fuel tanks which supplied the generators. The capacity of these ASTs is estimated at 45,000 litres each. It is likely that these tanks were filled via 50 – 75 mm OD underground steel fuel lines, however the locations and orientations of these lines has not been confirmed. The site is larger than the East Generator Site and is likely to have been the main source of power for the facility during operation.

With the exception of the areas where foundation ruins are present, the site is heavily overgrown with alders. The terrain is level and some boggy areas have developed in the west and southern fringes of the site. Foundations, steel and concrete debris are scattered throughout the site.

Previous subsurface investigations revealed significant quantities of weathered free product and groundwater entering test pits at shallow depths. TPH impacts were identified in subsurface soil (> 0.5 mbgs). Chromatograms for soil samples with elevated concentrations of TPH resembled diesel.

3.5.2 Field Work

Field work at this site comprised the excavation of five (5) test pits, the installation of three (3) monitor wells, and the collection of three (3) surface soil samples, three (3) groundwater samples, one (1) surface water sample, one (1) sediment sample, one (1) vegetation sample and one (1) berry sample. A site plan (Drawing No. 121410105-EE-06A) showing the location of these as well as general site features is provided in Appendix 6a. Coordinates of each sample location are provided in Appendix 6c.

3.5.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 6d. Loose to compact brown to grey sand (SP, SM) with varying percentages of silt, gravel and cobbles was encountered at the surface of all test pits and extended to a maximum depth of 2.4 mbgs in 09-TP13. In test pits 09-TP12 and 09-TP14 this layer was underlain by a layer of dense grey silt with sand (ML) and some clay. The stratigraphy encountered in monitor wells generally consisted of brown to grey sand (SP) extending to depths of 0.61 m to 1.22 mbgs, underlain by grey clay (CL) and grey silt (ML). The layer of grey silt (ML) was encountered at the surface of 09-MW09.

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.5.4 Debris and Physical Hazards

Some metal debris was encountered near the surface of test pit 09-TP11 as identified in Table 2.2 and documented on the Test Pit Records in Appendix 6d. Buried debris was not encountered in the other four (4) test pits.

Surface debris and physical hazards at the West Generator Site were generally found along the southern portion of the site. Drawing No. 121410105-EE-06A in Appendix 6a shows the locations of the surface debris encountered. Items encountered on the West Generator Site consisted of the following:

- 09-SD29 - 10 m^3 of partially buried pipe, metal and concrete debris
- 09-SD30 - 100 m stretch of partially buried metal and concrete debris (50 mm, 200 mm and 300 mm diameter pipes, metal sheeting, drums, valves, cable, etc.)

3.5.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 0.33 mbgs to 0.65 mbgs in shallow groundwater wells at the site during the two (2) groundwater survey events. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed during the excavation of test pits on August 5, 2009 in 09-TP11 to 09-TP15 at depths ranging from 0.5 mbgs in 09-TP11 to 1.9 mbgs in 09-TP13. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the northeast towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-06A in Appendix 6a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW8 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 6f. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 6f. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW8 with a value of 2×10^{-6} m/s determined using the Bouwer & Rice method and 2×10^{-6} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 2×10^{-6} m/s is determined for the underlying stratigraphy at the site.

3.5.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil in test pits, monitor wells or surface soil samples during the current investigation. A sheen was observed on groundwater extracted from monitor well 09-MW7 during purging on August 27, 2009; however, no measurable product was detected on groundwater in monitor wells at the site with the product interface probe.

3.5.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the West Generator Site are provided on the Test Pit Records and Monitor Well Records in Appendix 6d. The soil vapour concentrations measured ranged from 0.0 ppm in soil samples from test pits 09-TP11, 09-TP12, 09-TP14 and 09-TP15 to 409 ppm in soil sample 09-MW7-BS3. Slight to moderate petroleum hydrocarbon odours were detected in test pits 09-TP13 and 09-TP14 during excavation and in monitor wells 09-MW7 to 09-MW9 during drilling.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations exceeded 50 ppm in five (5) soil samples collected at the site (09-MW7-SS2, SS3, SS4 & SS5, 09-MW9-SS4). Soil vapour concentrations, along with field observations, site usage and site history were used to select samples for petroleum hydrocarbon analysis.

3.5.8 Laboratory Analysis and Results

A laboratory analysis schedule for the West Generator Site is presented in Table 3.9 below.

Table 3.9 Laboratory Analysis Schedule (West Generator Site)

Issues	Sample Locations	Sample Matrix			
		Soil/ Sediment	**Groundwater/ Surface Water**	**Veg./ Berries**	**Small Mammals**
• Various surface debris was previously identified on the site, including on the east side of Crossover Road, near the intersection with VOR Road –characterization required. • Free Product noted during previous investigations – volume calculation required. • Petroleum hydrocarbon impacts in soil – delineation required. • Electrical equipment historically present on site – possible PCBs in soil. • COC (petroleum hydrocarbons, PAHs, metals and possibly PCBs) concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbons, metals and PAHs in shallow groundwater. • Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.	09-TP11 to 09-TP15 09-SS51 to 09-SS53 09-MW7 to 09-MW9 09-SW10 09-SED10 09-VEG4 09-BERRY4	Soil: TPH/ BTEX (6) Metals (4) PAHs (3) PCBs (2) Sediment: TPH/BTEX (1) Metals (1)	Groundwater: TPH/BTEX (2) TPH Frac./ BTEX (1) Metals (3) PAHs (1) General Chemistry (3) Surface Water: TPH/ BTEX (1) Metals (1) General Chemistry (3)	Veg: PCBs (1) Berries: PCBs (1)	-

Results of laboratory analysis of soil, groundwater, sediment, surface water, vegetation and berry samples obtained from this site are presented in Tables 6.1 to 6.17 in Appendix 6e. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on six (6) soil samples collected from the site including three (3) test pit samples (09-TP11-BS112, 09-TP13-BS2 and 09-TP14-BS2) and three (3) monitor well samples (09-MW7-SS3, 09-MW8-SS3 and 09-MW9-SS4). Fractionation analysis was carried out on the sample from 09-TP14-BS2. Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 6.1 and Table 6.2 in Appendix 6e. Modified TPH was detected in all six (6) soil samples

(09-TP11-BS112, 09-TP13-BS2, 09-TP14-BS2, 09-MW7-SS3, 09-MW8-SS3 and 09-MW9-SS4) with concentrations of 220 mg/kg, 2,100 mg/kg, 220 mg/kg / 350 mg/kg, 9,000 mg/kg, 1,100 mg/kg and 810 mg/kg, respectively. Concentrations of modified TPH exceeded the applicable Tier I RBSLs (i.e., 140 mg/kg) in all six (6) soil samples. Laboratory analytical results indicated that products impacting soil samples on this site resembled the fuel oil fraction, the weathered fuel oil fraction or a mixture of weathered fuel oil and lube oil fractions.

BTEX was not detected in any of the soil samples analysed, except for 09-MW7-SS3. Toluene (0.08 mg/kg), ethylbenzene (1.4 mg/kg) and xylenes (7.2 mg/kg) were detected in sample 09-MW7-SS3, but the concentrations were below the applicable Tier I RBSLs (14 mg/kg, 58 mg/kg and 17 mg/kg, respectively).

Metals in Soil

Available metals analysis was conducted on one (1) test pit soil sample (09-TP14-BS1), one (1) monitor well soil sample (09-MW7-SS1) and two (2) surface soil samples collected from the site (09-SS51 and 09-SS53). Results of the laboratory analysis of soil samples for available metals are presented in Table 6.3 in Appendix 6e. Concentrations of various metals were detected in all soil samples, but none of the detected concentrations of available metals in soils exceeded the applicable CCME residential/parkland criteria.

PAHs in Soil

PAH analysis was conducted on three (3) surface soil samples collected from the site (09-SS51 to 09-SS53). Results of the laboratory analysis of these soil samples for PAHs are presented in Table 6.4 in Appendix 6e. Various PAHs were detected in all three (3) samples. Detectable concentrations of PAH parameters were below the applicable CCME soil quality guidelines for a residential/parkland site, where such guidelines exist, except for anthracene and the calculated benzo(a)pyrene total potency equivalent (TPE) in sample 09-SS51. The concentrations of anthracene (6.3 mg/kg) and benzo(a)pyrene TPE (12.0 mg/kg) in sample 09-SS51 were above the CCME soil quality guidelines (2.5 mg/kg and 5.3 mg/kg, respectively) for a residential/parkland site.

PCBs in Soil

PCB analysis was conducted on one (1) monitor well soil sample (09-MW9-SS4) and one (1) surface soil sample collected from the site (09-SS51). Results of the laboratory analysis of these soil samples for PCBs are presented in Table 6.5 in Appendix 6e. PCBs were not detected in either sample.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on three (3) groundwater samples collected from the site (09-MW7 to 09-MW9). Fractionation analysis was carried out on the sample from 09-MW7. Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 6.6 and Table 6.7 in Appendix 6e. Modified TPH was detected in all three (3) groundwater samples with concentrations of 29 mg/L in 09-MW7, 33 mg/L in 09-MW8 and 1.8 mg/L in 09-MW9. The TPH concentrations in 09-MW7 and 09-MW8 exceeded the applicable Tier I RBSL for fuel oil impacts (i.e., 20 mg/L). Laboratory analytical results indicated that the products impacting the groundwater samples resembled either fuel oil, weathered fuel oil or a mixture of weathered fuel oil and lube oil. BTEX parameters were not detected in samples 09-MW8 and 09-MW9. The detected concentrations of ethylbenzene (0.02 mg/L) and xylenes (0.05 mg/L) in sample 09-MW7 were below the applicable Tier I RBSLs.

Metals in Groundwater

Dissolved metals analysis was conducted on three (3) groundwater samples collected from the site (09-MW7 to 09-MW9). Results of the laboratory analysis of the groundwater samples are presented in Table 6.8 in Appendix 6e. Concentrations of various metals were detected in the groundwater samples. None of the detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

PAHs in Groundwater

PAHs analysis was conducted on one (1) groundwater sample collected from the site (09-MW7). Results of the laboratory analysis of the groundwater sample are presented in Table 6.9 in Appendix 6e. Concentrations of almost all PAH parameters were detected in the groundwater sample. The detected concentrations of the following PAH parameters in the groundwater sample 09-MW7 exceeded guidelines:

- Acenaphthylene (2.1 µg/L) exceeded the MOE guideline (1.8 µg/L);
- Anthracene (39 µg/L) exceeded the MOE guideline (2.4 µg/L);
- Benzo[a]anthracene (51 µg/L) exceeded the MOE guideline (4.7 µg/L);
- Benzo[a]pyrene (42 µg/L) exceeded the MOE guideline (0.81 µg/L);
- Benzo[b]fluoranthene (35 µg/L) exceeded the MOE guideline (0.75 µg/L);
- Benzo[ghi]perylene (25 µg/L) exceeded the MOE guideline (0.2 µg/L);
- Benzo[k]fluoranthene (35 µg/L) exceeded the MOE guideline (0.4 µg/L);
- Chrysene (53 µg/L) exceeded the MOE guideline (1 µg/L);
- Dibenz[a,h]anthracene (6.5 µg/L) exceeded the MOE guideline (0.52 µg/L);
- Fluoranthene (160 µg/L) exceeded the MOE guideline (130 µg/L);
- Indeno[1,2,3-cd]pyrene (30 µg/L) exceeded the MOE guideline (0.2 µg/L);
- Pyrene (130 µg/L) exceeded the MOE guideline (68 µg/L).

General Chemistry in Groundwater

General chemistry analysis was conducted on three (3) groundwater samples collected from the site (09-MW7 to 09-MW9). Results of the laboratory analysis of the groundwater samples are presented in Table 6.10 in Appendix 6e. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Surface Water

Petroleum hydrocarbon analysis was conducted on one (1) surface water sample collected from the site (09-SW10). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Tables 6.11 in Appendix 6e. Modified TPH was not detected in the surface water sample. Toluene was detected in the surface water sample at a concentration of 0.002 mg/L which was equivalent to the CCME guideline for the protection of freshwater aquatic life (i.e., 0.002 mg/L).

Dissolved Metals in Surface Water

Dissolved metals analysis was conducted on one (1) surface water sample collected from the site (09-SW10). Results of the laboratory analysis of this surface water sample are presented in Table 6.12 in Appendix 6e. The detected concentrations of aluminum, cadmium, copper, iron and zinc (i.e., 151 µg/L, 0.027 µg/L, 2.2 µg/L and 1,000 µg/L, respectively) exceeded the CCME guidelines for the protection of freshwater aquatic life (i.e., 100 µg/L, 0.017 µg/L, 2 µg/L, 300 µg/L and 30 µg/L, respectively). Similar concentrations of aluminum, copper and iron were detected in the background surface water samples (i.e., 98 to 442 µg/L, <1 to 5 µg/L and 281 to 1,080 µg/L), as indicated in Section 3.17.3, which may suggest that aluminum, copper and iron concentrations are naturally elevated in surface water in the area.

General Chemistry in Surface Water

General chemistry analysis was conducted on one (1) surface water sample collected from the site (09-SW10). Results of the laboratory analysis of this surface water sample are presented in Table 6.13 in Appendix 6e. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) sediment sample collected from the site (09-SED10). Results of the laboratory analysis of the sediment sample for petroleum hydrocarbons are presented in Table 6.14 in Appendix 6e. Modified TPH was detected in the sediment sample, at a concentration of 3,200 mg/kg. The concentration of modified TPH exceeded the applicable MOE guideline for oil and grease in sediment (i.e., 1,500 mg/kg). Laboratory analytical results indicated that products impacting the sediment sample on this site resembled a product in the fuel/lube range. BTEX parameters were not detected in the sediment sample analysed.

Metals in Sediment

Available metals analysis was conducted on one (1) sediment sample collected from the site (09-SED10). Results of the laboratory analysis of the sediment sample for available metals are presented in Table 6.15 in Appendix 6e. Concentrations of various metals were detected in the sediment sample. The concentration of cadmium (0.9 mg/kg) in the sediment sample exceeded the CCME ISQG (0.6 mg/kg) for freshwater sediment. The concentration of zinc (910 mg/kg) in the sediment sample exceeded both the CCME ISQG (123 mg/kg) and the CCME PEL (315 mg/kg) for freshwater sediment.

PCBs in Vegetation

PCBs analysis was conducted on one (1) vegetation sample collected from the site (09-VEG4) in support of the human health and ecological risk assessments. Results of the laboratory analysis of this vegetation sample for PCBs are presented in Table 6.16 in Appendix 6e. PCBs were not detected in the vegetation sample.

PCBs in Berries

PCBs analysis was conducted on one (1) berry sample collected from the site (09-BERRY4) in support of the human health and ecological risk assessments. Results of the laboratory analysis of this berry sample for available metals are presented in Table 6.17 in Appendix 6e. PCBs were not detected in the berry sample.

3.5.9 Discussions and Conclusions

A Phase III ESA was completed at the West Generator Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of the assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of brown to grey sand (SP, SM) with varying percentages of silt, gravel and cobbles underlain by grey clay (CL) and grey silt (ML). Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. Buried metal debris was encountered in test pit 09-TP11. Surface debris and physical hazards were observed along the southern portion of the site and consisted of partially buried metal and concrete debris (i.e., pipes, metal sheeting, drums, valves, cable, etc.).
3. Groundwater was encountered at depths ranging from 0.33 mbgs to 1.90 mbgs in test pits and shallow monitor wells completed at this site. Based on local topography and site observations the direction of groundwater flow is inferred to be to the northeast towards Lake Melville.
4. A hydraulic conductivity of 2×10^{-6} m/s is determined for the underlying stratigraphy at the site, which is within the range expected for silty sands (i.e., 10^{-3} m/s to 10^{-7} m/s).
5. In 1999, weathered free product was observed entering test pits at shallow depths. As part of the current investigation, a follow-up free product survey was conducted at the site. There was no visual evidence of free phase petroleum hydrocarbons on soil in test pits, monitor wells or surface soil samples during the current investigation. A sheen was observed on groundwater extracted from monitor well 09-MW7; however, no measurable product was detected on groundwater in monitor wells at the site.
6. Slight to moderate petroleum hydrocarbon odours were detected in test pits 09-TP13 and 09-TP14 during excavation and in monitor wells 09-MW7 to 09-MW9 during drilling.

7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.10 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.10 Summary of Exceedances (West Generator Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	WG-TP3 (1999) WG-TP6 (1999) WG-TP10 (1999) WG-TP11 (1999) WG-TP12 (1999) 09-TP11-BS1 09-TP13-BS2 09-TP14-BS2 09-MW7-SS3 09-MW8-SS4 09-MW9-SS4	32,340 mg/kg 16,739 mg/kg 923 mg/kg 4,819 mg/kg 2,431 mg/kg 220 mg/kg 2,100 mg/kg 220 mg/kg 9,000 mg/kg 1,100 mg/kg 810 mg/kg	140 mg/kg (Tier I RBSL, 2003)
	Benzene	WG-TP11 (1999)	4.2 mg/kg	0.16 mg/kg (Tier I RBSL, 2003)
	Anthracene	09-SS51	6.3 mg/kg	2.5 mg/kg (CCME SQG, 2007)
	Benzo(a)pyrene TPE	09-SS51	12.0 mg/kg	5.3 mg/kg (CCME SQG, 2007)
Groundwater	TPH	09-MW7 09-MW8	29 mg/L 33 mg/L	20 mg/L (Tier I RBSL, 2003)
	Mercury	WG-TP10 (1999)**	0.9 µg/L	0.29 µg/L (MOE, 2009)
	Acenaphthylene	09-MW7	2.1 µg/L	1.8 µg/L (MOE, 2009
	Anthracene	09-MW7	39 µg/L	2.4 µg/L (MOE, 2009)
	Benzo(a)anthracene	09-MW7	51 µg/L	4.7 µg/L (MOE, 2009)
	Benzo(a)pyrene	09-MW7	42 µg/L	0.81 µg/L (MOE, 2009)
	Benzo(b)fluoranthene	09-MW7	35 µg/L	0.75 µg/L (MOE, 2009)
	Benzo(ghi)perylene	09-MW7	25 µg/L	0.2 µg/L (MOE, 2009)
	Benzo(k)fluoranthene	09-MW7	35 µg/L	0.4 µg/L (MOE, 2009)
	Chrysene	09-MW7	53 µg/L	1 µg/L (MOE, 2009)
	Dibenz(a,h)anthracene	09-MW7	6.5 µg/L	0.52 µg/L (MOE, 2009)
	Fluoranthene	09-MW7	160 µg/L	130 µg/L (MOE, 2009)
	Ideno(1,2,3-cd)pyrene	09-MW7	30 µg/L	0.2 µg/L (MOE, 2009)
	Pyrene	09-MW7	130 µg/L	68 µg/L (MOE, 2009)
Surface Water	Aluminum*	09-SW10	151 µg/L	100 µg/L (CCME FWAL, 2007)
	Cadmium	09-SW10	0.027 µg/L	0.017 µg/L (CCME FWAL, 2007)
	Copper*	09-SW10	2.2 µg/L	2 µg/L (CCME FWAL, 2007)
	Iron*	09-SW10	1,000 µg/L	300 µg/L (CCME FWAL, 2007)
	Zinc	09-SW10	117 µg/L	30 µg/L (CCME FWAL, 2007)
Sediment	TPH	09-SED10	3,200 mg/kg	1,500 mg/kg (MOE)
	Cadmium	09-SED10	0.9 mg/kg	0.6 mg/kg (CCME ISQG, 2002)
	Zinc	09-SED10	910 mg/kg	123 mg/kg (CCME ISQG, 2002) 315 mg/kg (CCME PEL, 2002)

Note: Details of Referenced Guidelines are provided in Section 1.5.2
* Aluminum copper and iron concentrations are naturally elevated in surface water in the area based on the results of background sampling conducted in 2001 (SW-C1 to SW-C3)
* *= Samples were collected from water entering the test pits and may not be representative of groundwater conditions at the site

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pits WG-TP3 (1999), WG-TP6 (1999), WG-TP10 (1999), WG-TP11 (1999), WG-TP12 (1999), 09-TP11, 09-TP13, 09-TP14, and monitor wells 09-MW7, 09-MW8 and 09-MW9, petroleum hydrocarbon remediation shallow groundwater would be required in the vicinity of monitor wells 09-MW7 and 09-MW8a and petroleum hydrocarbon remediation of site sediment would be required in the drainage ditch at the site in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-6B in Appendix 6a shows the estimated extent of the petroleum hydrocarbon-impacted soil, groundwater and sediment at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 120 m^2 has TPH levels in soil above 140 mg/kg, an estimated area of approximately 161 m^2 has petroleum hydrocarbon levels in groundwater above 20 mg/L and an estimated area of approximately 38 m^2 has TPH levels in sediment above 1,500 mg/kg.
   - **Metals** remediation of site surface water and sediment would be required in the drainage ditch on the site in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-6C in Appendix 6a shows the estimated extent metals impacted surface water and sediment at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 40 m^2 has cadmium and zinc levels in surface water and sediment above the applicable MOE and CCME guidelines.
   - **PAH** remediation of site soil would be required in the vicinity of test pit WG-TP11 (1999) and surface soil sample 09-SS51, and PAH remediation of site groundwater would be required in the vicinity of monitor well 09-MW7 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-6D in Appendix 6a shows the estimated extent PAH impacted soil and groundwater at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 120 m^2 has PAH levels in soil above the applicable CCME guidelines and an estimated area of approximately 96 m^2 has levels of PAH parameters in groundwater above the applicable MOE guidelines.

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH, BTEX and PAH impacts on soil, TPH and PAH impacts groundwater, metals impacts on surface water, and TPH and metals impacts on sediment above the generic guidelines.

3.6 Transmitter Building

3.6.1 Site Description

The Transmitter Building Site is located at the centre of the military facility. A site plan is provided in Drawing 121410105-EE-07A. Access to the site is via the Crossover Road, the Main Access Road and the VOR Road. Based on information collected to date, the site was the centre of the facility containing a single, large, two-storey building. The building is reported to have housed electronic communications equipment, barracks and recreational areas. The building may have also contained a boiler for heating purposes.

The terrain is hummocky, likely due to stockpiling of the Transmitter Building demolition debris. It is reported that upon closure of the facility, all re-usable materials were salvaged and the structure bull-dozed and covered with a layer of sand fill. The entire site is covered with heavy alder and willow re-growth. Boggy areas have developed in low lying areas to the south of the building. A small section of the building ruins are visible at the surface on the west end of the building location.

Previous subsurface investigations at the site indicated the presence of covered and intact concrete floor and wall slabs at the east end of the building location. A small amount of surface debris is scattered throughout the site.

3.6.2 Field Work

Field work at this site comprised the excavation of five (5) test pits, the installation of three (3) monitor wells, and the collection of four (4) surface soil samples, three (3) groundwater samples, two (2) vegetation samples, one (1) berry sample and three (3) small mammal samples. A site plan (Drawing No. 121410105-EE-07A) showing the location of these as well as general site features is provided in Appendix 7a. Coordinates of each sample location are provided in Appendix 7c.

3.6.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 7c. In the test pits, compact brown to grey sand (SP) with varying percentages of silt and cobbles extended from the surface to depths of 1.3 mbgs in 09-TP18 and 2.8 mbgs in 09-TP19. In monitor wells, brown sand with gravel (SP) was encountered at or near the surface and extended to depths ranging from 1.22 mbgs to 1.83 mbgs. Below the layer of brown sand with gravel (SP), grey silt (ML) and grey clay (CL) were encountered. A layer of organics was present at the surface of 09-MW11.

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.6.4 Debris and Physical Hazards

Debris was encountered near the surface in monitor well 09-MW11 and test pit 09-TP19 and consisted of concrete, metal and pipe as identified in Table 2.2 and documented on the Monitor

Well and Test Pit Records in Appendix 7c. Buried debris was not encountered in the other four (4) test pits.

Surface debris and physical hazards at the Transmitter Building Site were generally found along the northern and eastern portions of the site and to the south of the site near VOR road. Drawing Nos. 121410105-EE-07A in Appendix 7a and 121410105-EE-20A in Appendix 20a show the locations of the surface debris encountered. Items encountered on the Transmitter Building Site consisted of the following:

- 09-SD18 - 0.4 m of 75 mm diameter steel pipe protruding from the ground
- 09-SD31 - 6 m long 200 mm diameter steel pipe (partially buried), 1 m^3 of concrete debris
- 09-SD33 - Tower Debris

3.6.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 0.24 mbgs to 0.80 mbgs in shallow groundwater wells at the site during the two (2) groundwater survey events. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed during the excavation of test pits on August 5 and 7, 2009 in 09-TP16 to 09-TP19 and 09-TP44 at depths ranging from 0.9 mbgs in 09-TP17 to 2.4 mbgs in 09-TP19. No groundwater seepage was observed in test pit 09-TP44. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the northeast towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-07A in Appendix 7a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW12 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 7e. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 7e. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW12 with a value of 2×10^{-6} m/s determined using the Bouwer & Rice method and 2×10^{-6} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 2×10^{-6} m/s is determined for the underlying stratigraphy at the site.

3.6.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits, monitor wells or surface soil samples during the current investigation. No measurable product was detected on groundwater in monitor wells at the site with the product interface probe.

3.6.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Transmitter Building Site are provided on the Test Pit Records and Monitor Well Records in Appendix 7c. The soil vapour concentrations measured ranged from 0.0 ppm in soil samples from test pits 09-TP11, 09-TP12, 09-TP14 and 09-TP15 to 510 ppm in soil sample 09-MW10-BS5. Slight to moderate petroleum hydrocarbon odours were detected in test pit 09-TP19 and monitor well 09-MW10 during excavation.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations exceeded 50 ppm in two (2) soil samples collected at the site (i.e., 09-MW10-SS1 & SS5). Soil vapour concentrations, along with field observations, site usage and site history were used to select samples for petroleum hydrocarbon analysis.

3.6.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Transmitter Building is presented in Table 3.11 below.

Table 3.11 Laboratory Analysis Schedule (Transmitter Building)

Issues	Sample Locations	Sample Matrix			
		Soil	Groundwater	Veg./ Berries	Small Mammals
• Surface debris identified during previous investigations – characterization required. • Electrical equipment historically present on site – possible PCBs in soil. • Possible petroleum hydrocarbons, PAHs and metals in soil. • COC (petroleum hydrocarbons, PAHs, metals and possibly PCBs) concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbons and metals in shallow groundwater. • Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.	09-TP44, 09-TP16 to 09-TP19 09-SS47 to 09-SS50 09-MW10 to 09-MW12 09-VEG5 and 09-VEG6 09-BERRY5 09-SM5, 09-SM19 & 09-SM25	TPH/ BTEX (6) Metals (6) PAHs (2) PCBs (3)	TPH/ BTEX (3) Metals (3) General Chemistry (3)	<u>Veg:</u> PCBs (2) <u>Berries:</u> PCBs (1)	PCBs (3) Mercury (1)

Results of laboratory analysis of soil, groundwater, vegetation, berry and small mammal samples obtained from this site are presented in Tables 7.1 to 7.12 in Appendix 7d. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on six soil samples collected from the site including three (3) test pit samples (09-TP16-BS2, 09-TP18-BS2 and 09-TP19-BS2) and three (3) monitor well samples (09-MW10-SS4, 09-MW11-SS3 and 09-MW12-SS3). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 7.1 in Appendix 7d. Modified TPH was detected in four (4) soil samples (09-TP18-BS2, 09-TP19-BS2, 09-MW10-SS4 and 09-MW12-SS3) with concentrations of 28 mg/kg, 5,800 mg/kg, 27 mg/kg and 55 mg/kg, respectively. Concentrations of modified TPH exceeded the applicable Tier I RBSLs (i.e., 140 mg/kg) in one (1) soil sample (09-TP19-BS2 with a concentration of 5,800 mg/kg). Laboratory analytical results indicated that products impacting soil samples on this site either had no resemblance to petroleum hydrocarbons, resembled the weathered fuel oil fraction or had a mixture of fuel oil and lube oil fractions.

BTEX was not detected in any of the soil samples analysed.

Metals in Soil

Available metals analysis was conducted on two (2) monitor well soil samples (09-MW10-SS1 and 09-MW11-SS2) and four (4) surface soil samples collected from the site (09-SS47 to 09-SS50). Results of the laboratory analysis of soil samples for available metals are presented in Table 7.2 in Appendix 7d. Concentrations of various metals were detected in all soil samples, but none of the detected concentrations of available metals in soils exceeded the applicable CCME residential/parkland criteria.

PAHs in Soil

PAH analysis was conducted on two (2) surface soil samples collected from the site (09-SS47 and 09-SS50). Results of the laboratory analysis of these soil samples for PAHs are presented in Table 7.3 in Appendix 7d. Various PAHs were detected in both samples. Detectable concentrations of PAH parameters were below the applicable CCME soil quality guidelines for a residential/parkland site, where such guidelines exist, with the exception of anthracene in sample 09-SS50 and the benzo(a)pyrene TPE in samples 09-SS47 and 09-SS50. The concentration of anthracene in sample 09-SS50 (7.6 mg/kg) and the benzo(a)pyrene TPEs for samples 09-SS47 (5.64 mg/kg) and 09-SS50 (15.5 mg/kg) were above the applicable CCME soil quality guidelines (2.5 mg/kg and 5.3 mg/kg, respectively) for a residential/parkland site.

PCBs in Soil

PCB analysis was conducted on two (2) monitor well soil samples (09-MW10-SS4 and 09-MW11-SS3) and one (1) surface soil sample collected from the site (09-SS47). Results of the laboratory analysis of these soil samples for PCBs are presented in Table 7.4 in Appendix 7d. PCBs were not detected in the samples.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on three (3) groundwater samples collected from the site (09-MW10 to 09-MW12). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 7.5 in Appendix 7d. Modified TPH was detected in all three (3) groundwater samples with concentrations ranging from 0.4 mg/L to 77 mg/L. The TPH concentration in 09-MW11 (77 mg/L) exceeded the applicable Tier I RBSL for fuel oil impacts (i.e., 20 mg/L). Laboratory analytical results indicated that the products impacting the groundwater samples resembled either a mixture of weathered fuel oil and lube oil or a mixture of weathered fuel oil and no resemblance to products in the lube oil range. BTEX was not detected in samples 09-MW11 and 09-MW12. The detected concentration of ethylbenzene (0.002 mg/L) in sample 09-MW10 was below the applicable Tier I RBSL (20 mg/L).

Metals in Groundwater

Dissolved metals analysis was conducted on three (3) groundwater samples collected from the site (09-MW10 to 09-MW12). Results of the laboratory analysis of the groundwater samples are presented in Table 7.6 in Appendix 7d. Concentrations of various metals were detected in the groundwater samples. None of the detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

General Chemistry in Groundwater

General chemistry analysis was conducted on three (3) groundwater samples collected from the site (09-MW10 to 09-MW12). Results of the laboratory analysis of the groundwater samples are presented in Table 7.8 in Appendix 7d. The concentration of nitrite in sample 09-MW10 (0.18 mg/L as N) and the pH of sample 09-MW12 (6.47) exceeded the applicable CCME freshwater aquatic life guidelines (0.06 mg/L as N and 6.5 to 9.0, respectively). None of the remaining general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

PCBs in Vegetation

PCBs analysis was conducted on two (2) vegetation samples collected from the site (09-VEG5 and 09-VEG6) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these vegetation samples for PCBs are presented in Table 7.9 in Appendix 7d. PCBs were not detected in the vegetation samples.

PCBs in Berries

PCBs analysis was conducted on one (1) berry sample collected from the site (09-BERRY5) in support of the human health and ecological risk assessments. Results of the laboratory analysis of this berry sample for available metals are presented in Table 7.10 in Appendix 7d. PCBs were not detected in the berry sample.

PCBs in Small Mammals

PCBs analysis was conducted on three (3) small mammals caught at the site (09-SM5, 09-SM19 and 09-SM25) in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals for PCBs are presented in Table 7.11 in Appendix 7d. PCBs were not detected in the small mammal samples.

Mercury in Small Mammals

Mercury analysis was conducted on one (1) small mammal caught at the site (09-SM5) in support of the human health and ecological risk assessments. The results of the laboratory analysis of the small mammal for mercury are presented in Table 7.12 in Appendix 7d. Mercury was not detected in the small mammal sample.

3.6.9 Discussions and Conclusions

A Phase III ESA was completed at the Transmitter Building Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of the assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of compact brown to grey sand (SP) with varying percentages of gravel, silt and cobbles underlain by grey silt (ML) and grey clay (CL). A layer of organics was present at the surface of 09-MW11. Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. Buried metal debris was encountered near the surface in monitor well 09-MW11 and test pit 09-TP19 and consisted of concrete, metal and pipe. Surface debris and physical hazards were observed along the northern and eastern portions of the site and consisted of a partially buried pipe, concrete debris and tower debris.
3. Groundwater was encountered at depths ranging from 0.24 mbgs to 2.40 mbgs in test pits and shallow monitor wells completed at this site. Based on local topography and site observations the direction of groundwater flow is inferred to be to the northeast towards Lake Melville.
4. A hydraulic conductivity of 2×10^{-6} m/s is determined for the underlying stratigraphy at the site, which is within the range expected for silty sands (i.e., 10^{-3} m/s to 10^{-7} m/s).
5. There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits, monitor wells or surface soil samples during the current investigation. No measurable product was detected on groundwater in monitor wells at the site with the product interface probe.
6. Slight to moderate petroleum hydrocarbon odours were detected in test pit 09-TP19 during excavation and monitor well 09-MW10 during drilling.
7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.12 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.12 Summary of Exceedances (Transmitter Building)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	WG-TP10 (1999) 09-TP19-BS2	923 mg/kg 5,800 mg/kg	140 mg/kg (Tier I RBSL, 2003)
	Anthracene	09-SS50	7.6 mg/kg	2.5 mg/kg (CCME SQG, 2007)
	Benzo(a)pyrene TPE	09-SS47 09-SS50	5.64 mg/kg 15.5 mg/kg	5.3 mg/kg (CCME SQG, 2007)
Groundwater	TPH	09-MW11	77 mg/L	20 mg/L (Tier I RBSL, 2003)
	Mercury	WG-TP10 (1999)*	0.9 µg/L	0.29 µg/L (MOE, 2009)
	Nitrite	09-MW10	0.18 mg/L as N	63 µg/L (CCME FWAL, 2007)
	pH	09-MW12	6.47	6.5 – 9.0 (CCME FWAL, 2007)

Note: Details of Referenced Guidelines are provided in Section 1.5.2
* = Samples were collected from water entering the test pits and may not be representative of groundwater conditions at the site

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pits WG-TP10 (1999) and 09-TP18, and petroleum hydrocarbon remediation shallow groundwater would be required in the vicinity of monitor well 09-MW11 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-7B in Appendix 7a shows the estimated extent of the petroleum hydrocarbon-impacted soil and groundwater at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 203 m^2 has TPH levels in soil above 140 mg/kg and an estimated area of approximately 37 m^2 has petroleum hydrocarbon levels in groundwater above 20 mg/L.
   - **Metals** remediation of site groundwater would be required in the vicinity of sample WG-TP10 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-7C in Appendix 7a shows the estimated extent metals (i.e., mercury) impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 31 m^2 has metals (i.e., mercury) levels in groundwater above the applicable MOE guideline.
   - **PAH** remediation of site soil would be required in the vicinity of samples 09-SS47 and 09-SS50 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-7D in Appendix 7a shows the estimated extent PAH impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 405 m^2 has PAH levels in soil above the applicable CCME guidelines.

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH and

PAH impacts on soil and TPH and general chemistry impacts groundwater above the generic guidelines.

3.7 Camp Road Dump Site

3.7.1 Site Description

The Camp Road Dump Site is located on the south side of Camp Road near the Innu Meeting Ground. A site plan showing the extent of debris is provided in Drawing No. 121410105-EE-08A in Appendix 8A. The terrain is hummocky with light to heavy tree cover. The site is accessible from Camp Road via a meandering trail through the Innu Meeting Ground.

In 1999, the site was characterized by a significant quantity of surface debris including empty steel drums, machinery parts, pipe, cans and domestic waste. Previous subsurface investigations indicated that most waste material was at or very near the surface. In 2001, a site clean-up program was carried out at various areas of the Former U.S. Military site, including the Camp Road Dump Site. All non-recyclable, non-hazardous waste recovered from the overall site during the clean-up program was consolidated and disposed of in 4 m deep pits along the north side of the existing landfill at the Camp Road Dump Site. A 300 mm thick sand cap was spread over the majority of the site; however, due to the onset of winter, the south perimeter of the site was not capped. The cover material used was excess material excavated during the non-recyclable rubble burial activities at the site.

3.7.2 Field Work

Field work at this site comprised the excavation of five (5) test pits, the installation of six (6) monitor wells, and the collection of six (6) surface soil samples, three (3) groundwater samples, one (1) surface water sample, one (1) sediment sample, one (1) benthic invertebrate sample, two (2) vegetation samples, two (2) berry samples, two (2) small mammal samples and ten (10) fish samples. A site plan (Drawing No. 121410105-EE-08A) showing the location of these as well as general site features is provided in Appendix 8a. Coordinates of each sample location are provided in Appendix 8b.

Initially, three (3) monitor wells were drilled at the site on August 8, 2009. On August 10, 2009 the water levels were verified and all three (3) wells were dry; therefore the three (3) wells were re-drilled at that time.

3.7.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 8c. In the test pits, loose to compact brown sand (SP) was encountered at or near the surface. In test pits 09-TP40 and 09-TP41, this layer was underlain by compact grey silt with sand (ML) and trace clay. A layer of rootmat was encountered at a depth of 0.9 mbgs in 09-TP-41. In the monitor wells, the stratigraphy consisted of discontinuous layers of grey silt (ML), brown sand (SP) with varying percentages of organics and cobbles, and clay (CL).

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.7.4 Debris and Physical Hazards

Debris was encountered near the surface in monitor wells 09-MW23S and 09-MW23D and test pits 09-TP39, 09-TP40 and 09-TP41, and consisted of a car chassis, cable, a creosote utility pole, sheet metal, wood, glass, steel drums, cans and bottles as identified in Table 2.2 and documented on the Monitor Well and Test Pit Records in Appendix 8c.

Surface debris and physical hazards at the Camp Road Dump Site were generally found throughout the site. Drawing No. 121410105-EE-08A in Appendix 8a shows the locations of the surface debris encountered. Items encountered on the Camp Road Dump Site consisted of the following:

- 09-SD16 - Partially buried and surface metal debris (i.e., drums, pipe, cans, etc.)

3.7.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 5.65 mbgs in to 6.37 mbgs in the deep groundwater wells at the site during the two (2) groundwater survey events. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed during the excavation of test pits on August 7, 2009 in 09-TP39 to 09-TP41 at depths ranging from 1.4 mbgs in 09-TP39 and 09-TP41 to 2.0 mbgs in 09-TP40. Groundwater seepage was not observed in 09-TP37 and 09-TP38. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the east towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-08A in Appendix 8a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW22 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 8e. Minimal hydraulic response was observed as a result of the bail down test, therefore there was insufficient data to determine the hydraulic conductivity of the underlying stratigraphy at the site.

3.7.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits, monitor wells or surface soil samples during the current investigation. No measurable product was detected on groundwater in monitor wells at the site with the product interface probe.

3.7.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Camp Road Dump Site are provided on the Test Pit Records and Monitor Well Records in Appendix 8c. The soil vapour concentrations measured ranged from 2.4 ppm in soil sample 09-MW23D-SS7 to 48 ppm in soil sample 09-TP38-BS2. Petroleum hydrocarbon odours were not detected in the test pits or monitor wells during excavation.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations did not exceed 50 ppm in any of the soil samples collected at the site.

3.7.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Camp Road Dump Site is presented in Table 3.13 below.

Table 3.13 Laboratory Analysis Schedule (Camp Road Dump Site)

Issues	Sample Locations	Sample Matrix				
		Soil/ Sediment	Ground-water	Veg./ Berries	Small Mammals/ Fish	Benthic
• Surface debris identified during previous investigations – characterization required. • Possible petroleum hydrocarbons, metals, PAHs, PCBs and VOCs in soil and in the sand cover placed over the dump site in 2001. • COC (petroleum hydrocarbons, PAHs, PCBs, VOCs and metals) concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbons, PAHs and metals in shallow groundwater. • Possible petroleum hydrocarbons and metals in surface water in Lake Melville. • Possible petroleum hydrocarbons, PAHs, PCBs and metals in sediment in Lake Melville. Benthic invertebrate and grain size analysis required on near-shore sediments if impacts are detected in sediments. Fish analysis for metals, PCBs and lipids required if there are metals or PCBs impacts in sediment. • Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.	09-TP37 to 09-TP41 09-SS9 to 09-SS14 09-MW21S, 09-MW21D, 09-MW22S, 09-MW22D, 09-MW23S &09-MW23D 09-SWM2 SSM-2-CR 09-VEG12 & 09-VEG13 09-BERRY11 & 09-BERRY12 09-SM9 & 09-SM13 Camp Road-FS1 to Camp Road-FS10 Benthic2	Soil: TPH/ BTEX (6) Metals (7) PAHs (1) PCBs (1) VOCs (3) Sediment: TPH/ BTEX (1) Metals (1)	Ground-water: TPH/ BTEX (3) Metals (3) PAHs (1) General Chemistry (3) Surface Water: TPH/ BTEX (1) Metals (1)	Veg: PCBs (2) Berries: PCBs (2)	SM: PCBs (2) Mercury (1) Fish PCBs (4) Metals (4)	Benthic: Genus (1)

Results of laboratory analysis of soil, groundwater, surface water, sediment, vegetation, berry, small mammal and fish samples obtained from this site are presented in Tables 8.1 to 8.20 in Appendix 8d. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on six (6) soil samples collected from the site including three (3) test pit samples (09-TP39-BS2, 09-TP40-BS2 and 09-TP41-BS2) and three (3) monitor well samples (09-MW21D-SS5, 09-MW22D-SS5 and 09-MW23D-SS7). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 8.1 in Appendix 8d. Modified TPH was detected in one (1) soil sample (09-TP39-BS2). The concentration of modified TPH detected in sample 09-TP39-BS2 (760 mg/kg) exceeded the applicable Tier I RBSL for fuel oil impacts (140 mg/kg). Laboratory analytical results indicated that products impacting soil sample resembled one product in the fuel/lube oil range.

Toluene was detected in sample 09-TP39-BS2 (0.06 mg/kg), but the concentration was below the applicable Tier I RBSL (14 mg/kg). BTEX parameters were not detected in any of the other soil samples analysed.

Metals in Soil

Available metals analysis was conducted on one (1) monitor well soil sample (09-MW21D-SS5) and five (5) surface soil samples collected from the site (09-SS9 to 09-SS14). Results of the laboratory analysis of soil samples for available metals are presented in Table 8.2 in Appendix 8d. Concentrations of various metals were detected in all soil samples. With the exception of samples 09-SS10 and 09-SS14, none of the detected concentrations of available metals in soil samples exceeded the applicable CCME residential/parkland criteria. The concentrations of lead in samples 09-SS10 (150 mg/kg) and 09-SS14 (33,000 mg/kg) were above the CCME soil quality guideline (2.5 mg/kg) for a residential/parkland site. The concentrations of chromium (5,600 mg/kg), copper (690 mg/kg), molybdenum (10 mg/kg) and zinc (390 mg/kg) in sample 09-SS14 were above the CCME soil quality guidelines (64 mg/kg, 63 mg/kg, 140 mg/kg, 10 mg/kg and 200 mg/kg, respectively) for a residential/parkland site.

PAHs in Soil

PAH analysis was conducted on one (1) surface soil sample collected from the site (09-SS10). Results of the laboratory analysis of these soil samples for PAHs are presented in Table 8.3 in Appendix 8d. Various PAHs were detected in the sample. Detected concentrations of PAH parameters were below the applicable CCME soil quality guidelines for a residential/parkland site, where such guidelines exist.

PCBs in Soil

PCB analysis was conducted on two (2) surface soil samples collected from the site (09-SS9 and 09-SS11). Results of the laboratory analysis of these soil samples for PCBs are presented in Table 8.4 in Appendix 8d. PCBs were not detected in either sample.

VOCs in Soil

VOC analysis was conducted on three (3) monitor well soil samples collected from the site (09-MW21D-SS5, 09-MW22D-SS5 and 09-MW23D-SS7). Results of the laboratory analysis of these soil samples for PAHs are presented in Table 8.5 in Appendix 8d. VOCs were not detected in the samples.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on three (3) groundwater samples collected from the site (09-MW21D to 09-MW23D). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 8.6 in Appendix 8d. Modified TPH was detected in two (2) groundwater samples at concentrations of 0.1 mg/L in 09-MW21D and 0.3 mg/L in 09-MW23D. The TPH concentrations did not exceed the applicable Tier I RBSL for fuel oil impacts (i.e., 20 mg/L) in either sample. Laboratory analytical results indicated that the products impacting groundwater sample 09-MW21D did not resemble petroleum hydrocarbons and the products impacting sample 09-MW23D resembled a mixture of weathered fuel oil and lube oil. BTEX parameters were not detected in the samples.

Metals in Groundwater

Dissolved metals analysis was conducted on three (3) groundwater samples collected from the site (09-MW21D to 09-MW23D). Results of the laboratory analysis of the groundwater samples are presented in Table 8.7 in Appendix 8d. Concentrations of various metals were detected in the groundwater samples. The concentration of mercury in sample 09-MW23 (0.8 µg/L) exceeded the applicable MOE guideline (0.29 µg/L). None of the other detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

PAHs in Groundwater

PAHs analysis was conducted on one (1) groundwater sample collected from the site (09-MW23D). Results of the laboratory analysis of the groundwater sample are presented in Table 8.8 in Appendix 8d. Concentrations of almost all PAH parameters were detected in the groundwater sample. The detected concentrations of the following PAH parameters in the groundwater sample 09-MW23D exceeded guidelines:

- Benzo[a]pyrene (3.0 µg/L) exceeded the MOE guideline (0.81 µg/L);
- Benzo[b]fluoranthene (2.4 µg/L) exceeded the MOE guideline (0.75 µg/L);
- Benzo[ghi]perylene (1.7 µg/L) exceeded the MOE guideline (0.2 µg/L);
- Benzo[k]fluoranthene (2.4 µg/L) exceeded the MOE guideline (0.4 µg/L);
- Chrysene (3.5 µg/L) exceeded the MOE guideline (1 µg/L);

- Indeno[1,2,3-cd]pyrene (1.9 µg/L) exceeded the MOE guideline (0.2 µg/L); and

In addition, the concentrations of benzo[a]anthracene (4.8 µg/L) and dibenz[a,h]anthracene (0.57 µg/L) in 09-MW23D Lab-Dup exceeded the MOE guidelines of 4.7 µg/L and 0.52 µg/L, respectively.

General Chemistry in Groundwater

General chemistry analysis was conducted on three (3) groundwater samples collected from the site (09-MW21D to 09-MW23D). Results of the laboratory analysis of the groundwater samples are presented in Table 8.9 in Appendix 8d. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Surface Water

Petroleum hydrocarbon analysis was conducted on one (1) surface water sample collected from Lake Melville near the site (09-SWM2). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 8.10 in Appendix 8d. Modified TPH and BTEX parameters were not detected in the sediment sample.

Dissolved Metals in Surface Water

Dissolved metals analysis was conducted on one (1) surface water sample (09-SWM2) collected from Lake Melville, near the site. Results of the laboratory analysis of this surface water sample are presented in Table 8.11 in Appendix 8d. Elevated laboratory detection limits were used for various parameters due to the matrix interface. The concentrations of aluminum, arsenic, cadmium, chromium, copper, iron, molybdenum, nickel, selenium, silver, strontium and zinc were not detected above the reportable detection limits (RDLs), therefore it is not possible to determine if the actual concentrations of these parameters exceeded the applicable CCME guidelines.

General Chemistry in Surface Water

General chemistry analysis was conducted on one (1) surface water sample (09-SWM2) collected from Lake Melville, near the site. Results of the laboratory analysis of this surface water sample are presented in Table 8.12 in Appendix 8d. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) sediment sample collected from Lake Melville near the site (SSM-2 CR). Results of the laboratory analysis of the sediment sample for petroleum hydrocarbons are presented in Table 8.13 in Appendix 8d. Modified TPH and BTEX parameters were not detected in the sediment sample.

Metals in Sediment

Available metals analysis was conducted on one (1) sediment sample collected from Lake Melville, near the site (SSM-2 CR). Results of the laboratory analysis of the sediment sample for available metals are presented in Table 8.14 in Appendix 8d. Concentrations of various metals were detected in the sediment sample, but none of the detected concentrations of available metals in sediment exceeded the applicable CCME ISQGs or PELs for freshwater sediment.

PCBs in Vegetation

PCB analysis was conducted on two (2) vegetation samples collected from the site (09-VEG12 and 09-VEG13) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these vegetation samples for PCBs are presented in Table 8.10 in Appendix 8d. PCBs were not detected in the vegetation samples.

PCBs in Berries

PCB analysis was conducted on two (2) berry samples collected from the site (09-BERRY11 and 09-BERRY12) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these berry samples for available metals are presented in Table 8.11 in Appendix 8d. PCBs were not detected in the berry samples.

PCBs in Small Mammals

PCBs analysis was conducted on two (2) small mammals caught at the site (09-SM9 and 09-SM13) in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals for PCBs are presented in Table 8.17 in Appendix 8d. PCBs were not detected in the small mammal samples.

Mercury in Small Mammals

Mercury analysis was conducted on one (1) small mammal caught at the site (09-SM9) in support of the human health and ecological risk assessments. The results of the laboratory analysis of the small mammal for mercury are presented in Table 8.18 in Appendix 8d. Mercury was not detected in the small mammal sample.

PCBs in Fish

PCBs analysis was conducted on four (4) fish samples collected from Lake Melville near the site (CAMP ROAD-FS1, CAMP ROAD-FS3, CAMP ROAD-FS6 and CAMP ROAD-FS9) in support of the human health and ecological risk assessments. The results of the laboratory analysis of fish samples for PCBs are presented in Table 8.19 in Appendix 8d. PCBs were not detected in the fish samples.

Metals in Fish

Metals analysis was conducted on four (4) fish samples collected from Lake Melville near the site (CAMP ROAD-FS1, CAMP ROAD-FS3, CAMP ROAD-FS6 and CAMP ROAD-FS9) in support of the human health and ecological risk assessments. The results of the laboratory analysis of fish samples for Metals are presented in Table 8.20 in Appendix 8d. Concentrations of aluminum, arsenic, copper, iron, manganese, selenium, strontium and zinc were detected in the samples. There are presently no provincial or federal criteria for available metal levels in whole fish.

3.7.9 Discussions and Conclusions

A Phase III ESA was completed at the Camp Road Dump Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of the assessment are summarised below.

1. The observed stratigraphy was variable, and generally consisted of mixtures of rootmat, grey silt (ML), brown sand (SP) and clay (CL), with occasional organics and cobbles. Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. The site was used to bury non-recyclable, non-hazardous waste recovered from the overall site in 2001, therefore buried debris was expected. Buried metal debris was encountered in test pits and monitor wells in the centre of the site and consisted of a car chassis, cable, a creosote utility pole, sheet metal, wood, glass, steel drums, cans and bottles. Surface debris and physical hazards were observed throughout the site and consisted of a partially buried and surface metal debris (i.e., drums, pipe, cans, etc.).
3. Groundwater was encountered at depths ranging from 1.4 mbgs to 2.0 mbgs in three (3) of the five (5) test pits at this site and at depths ranging from from 5.65 mbgs to 6.37 mbgs in deep monitor wells at this site. Based on local topography and site observations the direction of groundwater flow is inferred to be to the east towards Lake Melville.
4. Results of the hydraulic (bail-down) test were inconclusive.
5. There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits, monitor wells or surface soil samples during the current investigation. No measurable product was detected on groundwater in monitor wells at the site with the product interface probe.
6. Petroleum hydrocarbon odours were not detected in the test pits, monitor wells or surface soil samples during excavation.
7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.14 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.14 Summary of Exceedances (Camp Road Dump Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	09-TP39-BS2	760 mg/kg	140 mg/kg (Tier I RBSL, 2003)
	Chromium	09-SS14	5,600 mg/kg	54 mg/kg (CCME SQG, 2007)
	Copper	09-SS14	690 mg/kg	63 mg/kg (CCME SQG, 2007)
	Lead	09-SS10 09-SS14	150 mg/kg 33,000 mg/kg	140 mg/kg (CCME SQG, 2007)
	Molybdenum	09-SS14	58 mg/kg	10 mg/kg (CCME SQG, 2007)
	Zinc	09-SS14	390 mg/kg	200 mg/kg (CCME SQG, 2007)
Groundwater	Mercury	09-MW23	0.8 µg/L	0.12 µg/L (MOE, 2009)
	Benzo(a)pyrene	09-MW23D	3.0 µg/L	0.81 µg/L (MOE, 2009)
	Benzo(b)fluoranthene	09-MW23D	2.4 µg/L	0.75 µg/L (MOE, 2009)
	Benzo(g,h,i)perylene	09-MW23D	1.7 µg/L	0.2 µg/L (MOE, 2009)
	Benzo(k)fluoranthene	09-MW23D	2.4 µg/L	0.4 µg/L (MOE, 2009)
	Chrysene	09-MW23D	3.5 µg/L	1 µg/L (MOE, 2009)
	Ideno(1,2,3-cd)pyrene	09-MW23D	1.9 µg/L	0.2 µg/L (MOE, 2009)

Note: Details of Referenced Guidelines are provided in Section 1.5.2

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pits 09-TP39 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-8B in Appendix 8a shows the estimated extent of the petroleum hydrocarbon-impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 195 m^2 has TPH levels in soil above 140 mg/kg.
   - **Metals** remediation of site soil would be required in the vicinity of samples 09-SS10 and 09-SS14 and metals remediation of site groundwater would be required in the vicinity of monitor well 09-MW23 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-8C in Appendix 8a shows the estimated extent metals impacted soil and groundwater at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 528 m^2 has metals (i.e., chromium, copper, lead, molybdenum or zinc) levels in soil above the applicable CCME guidelines and approximately 242 m^2 has mercury levels in groundwater above the applicable MOE guideline.
   - **PAH** remediation of site groundwater would be required in the vicinity of monitor well 09-MW23D in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-8D in Appendix 8a shows the estimated extent PAH impacted groundwater at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field

data, an estimated area of approximately 173 m^2 has PAH levels in groundwater above the applicable MOE guidelines.

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH and metals impacts on soil, and metals and PAHs impacts groundwater above the generic guidelines.

3.8 Camp Road Drum Storage Site

3.8.1 Site Description

The Camp Road Drum Storage Site is a former drum storage area located on the south side of Camp Road just west of the East Generator Site. The site is accessible from Camp Road via a narrow foot path. Photos taken of the site during the current investigation are presented in Appendix 9b.

The ground is covered with alternating patches of bare sand and low alder bushes. At the centre of the site, modest surface staining was visible over an area of 10 m^2 during previous investigations. The terrain is relatively level with no standing water and slopes very gently towards Lake Melville. The perimeter of the site is heavily treed with large fir and spruce trees.

Modest hydrocarbon odours were noticed downwind of the site during previous investigations. Previous subsurface investigations revealed significant impacts to subsurface soil (0.5 mbgs) as evidenced by staining and strong hydrocarbon odours from the surface to subsurface. Chromatograms for soil samples with elevated concentrations of TPH resembled heavy oil and diesel.

3.8.2 Field Work

Field work at this site comprised the excavation of four (4) test pits, the installation of one (1) monitor well, and the collection of five (5) surface soil samples, one (1) vegetation sample, one (1) berry sample and one (1) rabbit sample. A site plan (Drawing No. 121410105-EE-09A) showing the location of these as well as general site features is provided in Appendix 9a. Coordinates of each sample location are provided in Appendix 9c.

3.8.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Record in Appendix 9d. Loose to compact brown sand (SP) with minor gravel was encountered at the surface in test pits and the monitor well and extended to depths ranging from 0.6 mbgs in 09-TP46, 09-TP48 and 09-MW24 to 1.3 mbgs in 09-TP45. This layer was generally underlain by a layer of compact grey silt and sand (ML) that extended to a maximum depth of >2.6 mbgs in 09-TP47. In 09-MW24, the layer sand (SP) was underlain by thin layers of grey clay (CL) and grey silt (ML).

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.8.4 Debris and Physical Hazards

No debris was encountered in test pits or monitor wells at the site. Surface debris and physical hazards were identified to the southwest of the Camp Road Drum Storage Site. Drawing No. 121410105-EE-09A in Appendix 9a shows the location of the surface debris encountered. Items encountered on the Camp Road Drum Storage Site consisted of the following:

- 09-SD17 - 7 m of 200 m diameter open steel pipe and 0.9 m of a 200 mm diameter open steel pipe protruding from the ground

3.8.5 Groundwater Conditions

Groundwater levels were measured in the monitor well at the site on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 3.20 mbgs to 3.51 mbgs in 09-MW24 during the two (2) groundwater survey events. Groundwater levels at this monitor well are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed during the excavation of test pits on August 7, 2009 in 09-TP45 to 09-TP47, at depths ranging from 0.6 mbgs in 09-TP46 to 2.2 mbgs in 09-TP45 and 09-TP47. Groundwater seepage was not observed in 09-TP48. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the east towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-09A in Appendix 9a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW24 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 9f. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 9f. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW24 with a value of 2×10^{-6} m/s determined using the Bouwer & Rice method and 5×10^{-6} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 3×10^{-6} m/s is determined for the underlying stratigraphy at the site.

3.8.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits, the monitor well or surface soil samples during the current investigation. No measurable product was detected on groundwater in monitor well at the site with the product interface probe.

3.8.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Camp Road Drum Storage Site are provided on the Test Pit Records and the Monitor Well Record in Appendix 9d. The soil vapour concentrations measured ranged from 0.5 ppm in soil samples 09-TP45-BS1 to 10.3 ppm in soil sample 09-MW24-SS5. A slight petroleum hydrocarbon odour was detected in test pit 09-TP45 during excavation.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. The soil vapour concentrations did not exceed 50 ppm in any of the soil samples collected from the site.

3.8.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Camp Road Drum Storage Site is presented in Table 3.15 below.

Table 3.15 Laboratory Analysis Schedule (Camp Road Drum Storage Site)

Issues	Sample Locations	Sample Matrix			
		Soil	Groundwater	Veg./ Berries	Rabbits
• Possible Free Product on groundwater. • Petroleum hydrocarbon impacts in soil – delineation required. • Possible PAHs, PCBs and metals in soil. • COC (petroleum hydrocarbons, PAHs, PCBs and metals) concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbon and metals impacts in shallow groundwater. • Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.	09-TP45 & 09-TP48 09-SS4 to 09-SS8 09-MW24 09-VEG11 09-BERRY10 09-SM33	TPH/ BTEX (4) Metals (5) PAHs (2) PCBs (2)	-	Veg: Metals (1) Berries: Metals (1)	PCBs (1) Mercury (1)

Results of laboratory analysis of soil, berry and rabbit samples obtained from this site are presented in Tables 9.1 to 9.8 in Appendix 9e. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on four (4) soil samples collected from the site including three (3) test pit samples (09-TP45-BS2, 09-TP46-BS2 and 09-TP48-BS2) and one (1) monitor well sample (09-MW24-SS4). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 9.1 in Appendix 9e. Modified TPH and BTEX were not detected in any of the four (4) soil samples.

Metals in Soil

Available metals analysis was conducted on five (5) surface soil samples collected from the site (09-SS4 to 09-SS8). Results of the laboratory analysis of soil samples for available metals are presented in Table 9.2 in Appendix 9e. Concentrations of various metals were detected in all soil samples. None of the detected concentrations of available metals exceeded the applicable CCME residential/parkland criteria.

PAHs in Soil

PAH analysis was conducted on two (2) surface soil samples collected from the site (09-SS4 and 09-SS6). Results of the laboratory analysis of these soil sample for PAHs are presented in Table 9.3 in Appendix 9e. PAHs were not detected in sample 09-SS6. Low concentrations of fluoranthene (0.009 mg/kg), phenanthrene (0.006 mg/kg) and pyrene (0.008 mg/kg) were detected in sample 09-SS4. Detectable concentrations of these PAH parameters were below the applicable CCME soil quality guidelines for a residential/parkland site, where such guidelines exist.

PCBs in Soil

PCB analysis was conducted on two (2) surface soil samples collected from the site (09-SS6 and 09-SS8). Results of the laboratory analysis of these soil samples for PCBs are presented in Table 9.4 in Appendix 9e. PCBs were not detected in both samples.

PCBs in Vegetation

PCBs analysis was conducted on one (1) vegetation sample collected from the site (09-VEG11) in support of the human health and ecological risk assessments. Results of the laboratory analysis of this vegetation sample for PCBs are presented in Table 9.5 in Appendix 9e. PCBs were not detected in the vegetation sample.

PCBs in Berries

PCBs analysis was conducted on one (1) berry sample collected from the site (09-BERRY11) in support of the human health and ecological risk assessments. Results of the laboratory analysis of this berry samples for available metals are presented in Table 9.6 in Appendix 9e. PCBs were not detected in the berry sample.

PCBs in Rabbits

PCBs analysis was conducted on one (1) rabbit (09-SM33) caught near the site in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals and rabbits for PCBs are presented in Table 9.7 in Appendix 9e. PCBs were not detected in the rabbit sample.

Mercury Rabbits

Mercury analysis was conducted on one (1) rabbit caught at the site (09-SM33) in support of the human health and ecological risk assessments. The results of the laboratory analysis of rabbit for mercury are presented in Table 9.8 in Appendix 3e. Mercury was not detected in the rabbit sample.

3.8.9 Discussions and Conclusions

A Phase III ESA was completed at the Camp Road Drum Storage Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of the assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of brown sand (SP) with varying percentages of gravel underlain by grey silt (ML) and grey clay (CL). Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. Surface debris and physical hazards were identified to the southwest of the Camp Road Drum Storage Site and consisted of sections of 200 mm diameter open steel pipe.
3. Groundwater was encountered at depths ranging from 0.30 mbgs to 3.51 mbgs in test pits and the shallow monitor well completed at this site. Based on local topography and site observations the direction of groundwater flow is inferred to be to the east towards Lake Melville.
4. A hydraulic conductivity of 3 x 10^{-6} m/s was determined for the underlying stratigraphy at the site, which is within the range expected for silty sands (i.e., 10^{-3} m/s to 10^{-7} m/s).
5. In 1999, groundwater was not encountered in the test pit excavated at the site; however, soil staining and mild to strong petroleum odours were detected from the surface to the base of the test pit. During the current investigation, there was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits, the monitor well or surface soil samples. No measurable product was detected on groundwater in the monitor well at the site with the product interface probe.
6. Petroleum hydrocarbon odours were not detected in the test pits, the monitor well or surface soil samples during excavation.
7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.16 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.16 Summary of Exceedances (Camp Road Drum Storage Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	CDS-TP1 (1999)	21,902 mg/kg	140 mg/kg (Tier I RBSL, 2003)

Note: Details of Referenced Guidelines are provided in Section 1.5.2

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pit CDS-TP1 (1999) in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-9B in Appendix 9a shows the estimated extent of the petroleum hydrocarbon-impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 86 m^2 has TPH levels in soil above 140 mg/kg.

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH impacts on soil above the generic guidelines.

3.9 Service Site

3.9.1 Site Description

The Service Site is located southwest of the intersection of Site Access Road and Crossover Road as shown on Drawing No. 121410105-EE-10A in Appendix 10a Based on information collected to date, the site contained two single storey buildings containing garage, workshop, kitchen and dining areas. Other infrastructure reportedly present included a boiler, seawater desalination unit and a large garbage freezer. At least one AST is reported to have been on site, possibly serving as a daytank for the boiler and desalination units. Photos taken of the site during the current investigation are presented in Appendix 10b.

The terrain at the site is level and no preferred direction of surface runoff route could be identified. The westerly portion of the site has several hummocky features or mounds. Two large foundation ruins and some surface debris were identified at the site. The site is heavily overgrown with alders.

Previous subsurface investigations revealed significant impacts to soil at modest depths as evidenced by staining and strong hydrocarbon odours from subsurface. Building demolition debris is buried at the site.

3.9.2 Field Work

Field work at this site comprised the excavation of six (6) test pits, the installation of three (3) monitor wells, and the collection of three (3) groundwater samples, two (2) vegetation samples, three (3) berry samples and one (1) small mammal sample. A site plan (Drawing No. 121410105-EE-10A) showing the location of these as well as general site features is provided in Appendix 10a. Coordinates of each sample location are provided in Appendix 10c.

3.9.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 10d. Brown to grey sand (SP) with varying percentages of silt was encountered at or near the surface and extended to the bottom of the test pits at a maximum depth of 2.6 mbgs in 09-TP07. The stratigraphy observed in monitor wells was variable and consisted of layers of brown to grey sand (SP), grey silt (ML) and/or gray clay (CL).

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.9.4 Debris and Physical Hazards

Buried debris was encountered in test pits 09-TP07, 09-TP49 and 09-TP50 and consisted of pipe, a culvert, metal, concrete and wood, as identified in Table 2.2 and documented on the Test Pit Records in Appendix 10c. Buried debris was not encountered in the other three (3) test pits.

Surface debris and physical hazards at the Service Site were generally found between the two foundation ruins. Drawing No. 121410105-EE-10A in Appendix 10a shows the location of the surface debris encountered. Items encountered on the Service Site consisted of the following:

- 09-SD32 – 10 m long 50 mm diameter steel pipe, 10 m long 25 mm diameter conduit (partially buried)

3.9.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 0.75 mbgs to 1.88 mbgs in shallow groundwater wells at the site during the two (2) groundwater survey events. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed in all of the test pits at the site (09-TP7, 09-TP8, 09-TP9, 09-TP10, 09-TP49 and 09-TP50) during excavation on August 5 and 7, 2009. Groundwater was observed at depths ranging from 1.1 mbgs in 09-TP49 to 1.8 mbgs in 09-TP7. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the northeast towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-10A in Appendix 10a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW4 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 10f. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 10f. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW4 with a value of 4×10^{-7} m/s determined using the Bouwer & Rice method and 6×10^{-7} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 5×10^{-7} m/s is determined for the underlying stratigraphy at the site.

3.9.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil in test pits, monitor wells or surface soil samples during the current investigation. Measurable product was not detected on groundwater in monitor wells 09-MW5 or 09-MW6 at the site.

A sheen was observed on groundwater extracted from monitor well 09-MW4 during purging on August 27, 2009; however no measurable free product was detected on groundwater in the well with the interface probe at that time. During the free product survey conducted on October 18, 2009, 4 mm of product was detected on groundwater in 09-MW4 with the product interface probe.

3.9.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Service Site are provided on the Test Pit Records and Monitor Well Records in Appendix 10d. The soil vapour concentrations measured ranged from 0.0 ppm in soil sample 09-MW5-SS2 to 500 ppm in soil sample 09-MW4-SS2. Slight to moderate petroleum hydrocarbon odours were detected in test pits 09-TP7, 09-TP10, and 09-TP49 during excavation, and in monitor well 09-MW4 during drilling.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations exceeded 50 ppm in five (5) soil samples collected at the site (09-TP49-BS2, 09-MW4-SS2, 09-MW4-SS3, 09-MW4-SS4 and 09-MW4-SS5). Soil vapour concentrations, along with field observations, site usage and site history were used to select samples for petroleum hydrocarbon analysis.

3.9.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Service Site is presented in Table 3.17 below.

Table 3.17 Laboratory Analysis Schedule (Service Site)

Issues	Sample Locations	Sample Matrix			
		Soil	Groundwater	Veg./ Berries	Small Mammals
• Surface debris identified during previous investigations – characterization required. • Petroleum hydrocarbon impacts in soil – delineation required. • Possible metals impacts in soil around the former garage, workshops and earthen mound (buried demolition rubble). • Possible glycol impacts in soil in vicinity of garbage freezer. • Metals and glycol concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbon, metals and glycol impacts in shallow groundwater. • Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.	09-TP7 to 09-TP10, 09-TP49 & 09-TP50 09-SS54 to 09-SS57 09-MW4 to 09-MW6 09-VEG2 & 09-VEG3 09-BERRY1 to 09-BERRY3 09-SM20	TPH/ BTEX (6) Metals (10)	TPH/ BTEX (3) Metals (3) General Chemistry (3) Glycol (1)	Veg: PCBs (2) Berries: PCBs (3)	PCBs (1)

Results of laboratory analysis of soil, groundwater, vegetation, berry and small mammal samples obtained from this site are presented in Tables 10.1 to 10.10 in Appendix 10e. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on six (6) soil samples collected from the site including three (3) test pit samples (09-TP7-BS2, 09-TP9-BS2 and 09-TP10-BS2) and three (3) monitor well samples (09-MW4-SS4, 09-MW5-SS3 and 09-MW6-SS4). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 10.1 in Appendix 10e.

Modified TPH was not detected in soil samples 09-TP9-BS2, 09-MW4-SS4 and 09-MW5-SS3. Modified TPH was detected in three (3) soil samples (09-TP7-BS2, 09-TP10-BS2 and 09-MW6-SS4) at concentrations of 8,100 mg/kg, 8,700 mg/kg and 20 mg/kg, respectively. Concentrations of modified TPH exceeded the applicable Tier I RBSL (140 mg/kg) in two (2) soil samples (09-TP7-BS2 and 09-TP10-BS2). Laboratory analytical results indicated that products impacting soil samples on this site resembled the weathered fuel oil fraction or possible fuel oil.

BTEX was not detected in any of the soil samples analysed, except for 09-TP7-BS2. Ethylbenzene (0.28 mg/kg) and xylenes (8.9 mg/kg) were detected in sample 09-TP7-BS2, but the concentrations were below the applicable Tier I RBSLs (58 mg/kg and 17 mg/kg, respectively).

Metals in Soil

Available metals analysis was conducted on five (5) test pit soil samples (09-TP7-BS1, 09-TP8-BS1, 09-TP9-BS1, 09-TP10-BS1 and 09-TP49-BS2), one (1) monitor well soil sample (09-MW4-SS1) and four (4) surface soil samples collected from the site (09-SS54 to 09-SS57). Results of the laboratory analysis of soil samples for available metals are presented in Table 10.2 in Appendix 10e. Concentrations of various metals were detected in all soil samples. With the exception of sample 09-SS55, none of the detected concentrations of available metals in soil samples exceeded the applicable CCME residential/parkland criteria. The concentration of lead in sample 09-SS55 (210 mg/kg) was above the CCME soil quality guideline (2.5 mg/kg) for a residential/parkland site.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on three (3) groundwater samples collected from the site (09-MW4 to 09-MW6). Fractionation analysis was carried out on the sample from 09-MW4. Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 10.3 and Table 10.4 in Appendix 10e. Modified TPH was detected in all groundwater samples at concentrations of 540 mg/L in 09-MW4, 4.9 mg/L in 09-MW5 and 0.1 mg/L in 09-MW6. TPH concentrations in 09-MW4 (540 mg/L) exceeded the applicable Tier I RBSL for fuel oil impacts (i.e., 20 mg/L). Laboratory analytical results indicated that the products impacting the groundwater samples resembled weathered fuel oil. BTEX was not detected in sample 09-MW6. The detected concentration of ethylbenzene (0.07 mg/L) in sample 09-MW4 and xylenes (0.58 mg/L and 0.005 mg/L) in samples 09-MW4 and 09-MW5 were below the applicable Tier I RBSL (20 mg/L).

Metals in Groundwater

Dissolved metals analysis was conducted on three (3) groundwater samples collected from the site (09-MW4 to 09-MW6). Results of the laboratory analysis of the groundwater samples are presented in Table 10.5 in Appendix 10e. Concentrations of various metals were detected in the groundwater samples. None of the detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

General Chemistry in Groundwater

General chemistry analysis was conducted on three (3) groundwater samples collected from the site (09-MW4 to 09-MW6). Results of the laboratory analysis of the groundwater samples are presented in Table 10.6 in Appendix 10e. The concentration of nitrate in sample 09-MW6 (3.1 mg/L as N) and the pH value in sample 09-MW4 (6.41) exceeded the applicable CCME freshwater aquatic life guidelines (2.9 mg/L as N and 6.5 to 9.0, respectively). None of the remaining general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Glycol in Groundwater

Glycol analysis was conducted on one (1) groundwater sample collected from the site (09-MW4). Results of the laboratory analysis of this groundwater sample for glycol parameters are presented in Table 10.7 in Appendix 10e. Glycol parameters were not detected in the groundwater sample.

PCBs in Vegetation

PCBs analysis was conducted on two (2) vegetation samples collected from the site (09-VEG2 and 09-VEG3) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these vegetation samples for PCBs are presented in Table 10.8 in Appendix 10e. PCBs were not detected in the vegetation samples.

PCBs in Berries

PCBs analysis was conducted on three (3) berry samples collected from the site (09-BERRY1, 09-BERRY2 and 09-BERRY3) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these berry samples for available metals are presented in Table 10.9 in Appendix 10e. PCBs were not detected in the berry samples.

PCBs in Small Mammals

PCBs analysis was conducted on one (1) small mammal caught at the site (09-SM20) in support of the human health and ecological risk assessments. The results of the laboratory analysis of this small mammal for PCBs are presented in Table 10.10 in Appendix 10e. PCBs were not detected in the small mammal sample.

3.9.9 Discussions and Conclusions

A Phase III ESA was completed at the Service Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of this assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of a layer of brown to grey sand (SP) with varying percentages of silt overlying grey silt (ML) and/or gray clay (CL). Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. Various buried debris was observed within the overburden layer in test pits 09-TP07, 09-TP49 and 09-TP50 and consisted of pipe, a culvert, metal, concrete and wood. Surface debris and physical hazards at the Service Site were found between the two foundation ruins and consisted of steel pipe and a conduit.
3. Groundwater was encountered at depths ranging from 0.75 mbgs to 1.88 mbgs in test pits and shallow monitor wells completed at this site. Based on local topography and site

observations, the direction of groundwater flow at the site is inferred to be to the northeast towards Melville Lake.

4. A hydraulic conductivity of 5 x 10^{-7} m/s was determined for the underlying stratigraphy at the site, which is within the range expected for silty sands (i.e., 10^{-3} m/s to 10^{-7} m/s) or silt (i.e., 10^{-5} m/s to 10^{-9} m/s).

5. In 1999, groundwater was not encountered in test pits; however, soil staining and strong petroleum odours were detected in two test pits between approximately 1.5 and 2.1 mbgs. On August 27, 2009, no measurable free product was detected on groundwater in 09-MW4; however a sheen was observed on the groundwater extracted from the well. During the free product survey conducted on October 18, 2009, 4 mm of product was detected on groundwater in monitor well 09-MW4. There was no visual evidence of free phase petroleum hydrocarbons on soil in test pits, the monitor well or surface soil samples during the current investigation.

6. Slight to moderate petroleum hydrocarbon odours were detected on soil in the test pits and monitor well surrounding the northern foundation ruin (09-TP7, 09-TP10, 09-TP49 and 09-MW4).

7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.18 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.18 Summary of Exceedances (Service Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	SS-TP1 (1999) WG-TP6 (1999) 09-TP7-BS2 09-TP10-BS2	10,940 mg/kg 16,739 mg/kg 8,100 mg/kg 8,700 mg/kg	140 mg/kg (Tier I RBSL, 2003)
	Lead	09-SS55	210 mg/kg	140 mg/kg (CCME SQG, 2007)
Groundwater	TPH	09-MW4	540 mg/kg	20 mg/kg (Tier I RBSL, 2003)
	Nitrate	09-MW6	3.1 mg/L as N	2.9 mg/L as N (CCME FWAL, 2007)
	pH	09-MW4	6.41	6.5 to 9.0 (CCME FWAL, 2007)

Note: Details of Referenced Guidelines are provided in Section 1.5.2

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Free product** recovery would be required in the vicinity of monitor well 09-MW4. Given that there was no evidence of free product in test pits or monitor wells surrounding monitor well 09-MW4, it appears that the free product is localized to the area surrounding the well. Based on an estimated area of approximately 100 m^2 and a product thickness of 4 mm, there is an estimated 400 L of free product present on groundwater in the vicinity of monitor well 09-MW4.

- **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pits SS-TP1 (1999), WG-TP6 (1999), 09-TP7 and 09-TP10 and petroleum hydrocarbon remediation of shallow groundwater would be required in the vicinity of monitor well 09-MW4 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-10B in Appendix 10a shows the estimated extent of the petroleum hydrocarbon-impacted soil and groundwater at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 528 m2 has TPH levels in soil above 140 mg/kg and an estimated area of approximately 86 m2 has petroleum hydrocarbon levels in groundwater above 20 mg/L.
- Metals remediation of site soil would be required in the vicinity of sample 09-SS55 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-10C in Appendix 10a shows the estimated extent metals impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 87 m^2 has lead levels in soil above the 210 mg/kg.

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH and metals (i.e., lead) impacts on soil and TPH, metals (i.e., copper) and general chemistry impacts in groundwater above the generic guidelines.

3.10 Oil Shed Site

3.10.1 Site Description

The Oil Shed Site is located across from the Service Site, approximately 10 m north of the Main Access Road as shown on Drawing No. 121410105-EE-11A in Appendix 11a. Based on information collected to date, the site contained a small wooden shed which was used to store oils and lubricants.

The ground is covered with heavy alder growth. At the centre of the site, modest surface staining was visible over an area of approximately 10 m^2 during previous investigations. The terrain is relatively level with no standing water. No preferred direction of surface water drainage could be identified.

Previous subsurface investigations revealed impacts to soil as evidenced by staining and modest hydrocarbon odours from the surface downwards.

3.10.2 Field Work

Field work at this site comprised the excavation of three (3) test pits, the installation of one (1) monitor well, and the collection of three (3) surface soil samples, one (1) groundwater sample and one (1) vegetation sample. A site plan (Drawing No. 121410105-EE-11A) showing the location of these as well as general site features is provided in Appendix 11a. Coordinates of each sample location are provided in Appendix 11b.

3.10.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 11c. Loose to compact brown sand with gravel (SP) was encountered at the surface of all the test pits and extended to depths ranging from 1.1 mbgs in 09-TP51 to 1.6 mbgs in 09-TP52 and 09-TP53. This layer was generally underlain by compact to dense grey silt with sand (ML) and trace clay. In monitor well 09-MW25, layers of brown sand (SP) with cobbles were interbedded with layers of grey silt (ML).

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.10.4 Debris and Physical Hazards

Buried debris was not encountered in any of the test pits at the site. Surface debris and physical hazards were not observed at the site.

3.10.5 Groundwater Conditions

Groundwater levels in 09-MW25 were measured August 26, 2009 and October 18, 2009. Groundwater levels ranged from 0.69 mbgs to 1.40 mbgs in the shallow groundwater well during the two (2) groundwater survey events. Groundwater levels at this monitor well are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed in all of the test pits at the site (09-TP51, 09-TP52 and 09-TP53) during excavation on August 7, 2009. Groundwater seepage was observed at depths ranging from 1.8 mbgs in 09-TP51 to 2.6 mbgs in 09-TP52. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the northeast towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-11A in Appendix 11a.

Hydraulic response (bail down) testing was conducted on August 26, 2009 on monitoring well 09-MW25 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 11e. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 11e. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW25 with a value of 4×10^{-7} m/s determined using the Bouwer & Rice method and 5×10^{-7} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 4×10^{-7} m/s is determined for the underlying stratigraphy at the site.

3.10.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits, the monitor well or surface soil samples during the current investigation. Measurable product was not detected on groundwater in the monitor well at the site with the product interface probe.

3.10.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Oil Shed Site are provided on the test pit and monitor well records in Appendix 11c. The soil vapour concentrations measured ranged from 0.0 ppm in soil sample 09-TP53-BS2 and in soil samples collected from monitor well 09-MW25 to 29 ppm in soil sample 09-TP53-BS1. Petroleum hydrocarbon odours were not detected in any of the test pits, the monitor well or surface soil samples at the site during excavation.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations did not exceed 50 ppm in any of the soil samples collected at the site.

3.10.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Oil Shed Site is presented in Table 3.19 below.

Table 3.19 Laboratory Analysis Schedule (Oil Shed Site)

Issues	Sample Locations	Sample Matrix			
		Soil	Groundwater	Veg./ Berries	Small Mammals
• Possible Free Product on groundwater. • Possible petroleum hydrocarbons, metals, PCBs and PAHs in soil. • COC (petroleum hydrocarbons, PAHs, PCBs and metals) concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbons and metals in shallow groundwater. • Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.	09-TP51 to 09-TP53 09-SS44 to 09-SS46 09-MW25 09-VEG1	TPH/ BTEX (4) Metals (4) PAHs (1) PCBs (1)	TPH/ BTEX (1) Metals (1) General Chemistry (1)	Veg: PCBs (1)	-

Results of laboratory analysis of soil, groundwater and vegetation samples obtained from this site are presented in Tables 11.1 to 11.8 in Appendix 11d. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on four (4) soil samples collected from the site including three (3) test pit samples (09-TP51-BS2, 09-TP52-BS2 and 09-TP53-BS2) and one (1) monitor well sample (09-MW25-SS3). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 11.1 in Appendix 11d.

Modified TPH was not detected in soil samples 09-TP51-BS2, 09-TP52-BS2 and 09-TP53-BS2. Modified TPH was detected in one (1) soil sample (09-MW25-SS3) with a concentration of 250 mg/kg, which did not exceed the applicable Tier I RBSL for lube oil (690 mg/kg). Laboratory analytical results indicated that products impacting soil sample on this site resembled the lube oil fraction. BTEX parameters were not detected in any of the soil samples analysed.

Metals in Soil

Available metals analysis was conducted on one (1) monitor well soil sample (09-MW25-SS3) and three (3) surface soil samples collected from the site (09-SS44 to 09-SS46). Results of the laboratory analysis of soil samples for available metals are presented in Table 11.2 in Appendix 11d. None of the detected concentrations of available metals exceeded the applicable CCME residential/parkland criteria.

PAHs in Soil

PAH analysis was conducted on one (1) surface soil sample collected from the site (09-SS46). Results of the laboratory analysis of this soil sample for PAHs are presented in Table 11.3 in Appendix 11d. Low concentrations of PAHs were detected in sample 09-SS46. Detectable concentrations of these PAH parameters were below the applicable CCME soil quality guidelines for a residential/parkland site, where such guidelines exist.

PCBs in Soil

PCB analysis was conducted on one (1) surface soil sample collected from the site (09-SS46). Results of the laboratory analysis of this soil sample for PCBs are presented in Table 11.4 in Appendix 11d. PCBs were not detected in the sample.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on one (1) groundwater sample collected from the site (09-MW25). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 11.5 in Appendix 11d. Modified TPH and BTEX parameters were not detected in the groundwater sample.

Metals in Groundwater

Dissolved metals analysis was conducted on one (1) groundwater sample collected from the site (09-MW25). Results of the laboratory analysis of the groundwater sample are presented in Table 11.6 in Appendix 11d. Concentrations of various metals were detected in the groundwater sample. The detected concentration of silver in the groundwater sample (52.3 µg/L) exceeded the MOE guideline (1.5 µg/L). None of the other detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

General Chemistry in Groundwater

General chemistry analysis was conducted on one (1) groundwater sample collected from the site (09-MW25). Results of the laboratory analysis of the groundwater sample are presented in Table 11.7 in Appendix 11d. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

PCBs in Vegetation

PCBs analysis was conducted on one (1) vegetation sample collected from the site (09-VEG1). Results of the laboratory analysis of this vegetation sample for PCBs are presented in Table 11.8 in Appendix 11d. PCBs were not detected in the vegetation sample.

3.10.9 Discussions and Conclusions

A Phase III ESA was completed at the Oil Shed Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of this assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of a layer of brown sand with gravel (SP) and occasional cobbles overlying grey silt with sand (ML) and trace clay. Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. Buried debris was not encountered in test pits dug at the site and surface debris and physical hazards were not observed at the site.
3. Groundwater was encountered at depths ranging from 0.69 mbgs to 2.6 mbgs in test pits and the shallow monitor well completed at this site. Based on local topography and site observations, the direction of groundwater flow at the site is inferred to be to the northeast towards Melville Lake.
4. A hydraulic conductivity of 4×10^{-7} m/s was determined for the underlying stratigraphy at the site, which is within the range expected for silty sands (i.e., 10^{-3} m/s to 10^{-7} m/s) or silt (i.e., 10^{-5} m/s to 10^{-9} m/s).
5. In 1999, groundwater was not encountered in the test pit excavated at the site; however, soil staining and mild to strong petroleum odours were detected from the surface to the base of the test pit. During the current investigation, there was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits, the monitor well or surface soil samples. No measurable product was detected on groundwater in the monitor well at the site.
6. Petroleum hydrocarbon odours were not detected in the test pits, the monitor well or surface soil samples during excavation.

7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.20 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.20 Summary of Exceedances (Oil Shed Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	O-TP1 (1999)	3,800 mg/kg	690 mg/kg (Tier I RBSL, 2003)
Groundwater	Silver	09-MW25	52.3 µg/L	1.5 µg/L (MOE, 2009)
Note: Details of Referenced Guidelines are provided in Section 1.5.2				

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pit O-TP1 (1999) in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-11B in Appendix 11a shows the estimated extent of the petroleum hydrocarbon-impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 86 m^2 has TPH levels in soil above 140 mg/kg.
   - **Metals** remediation of site groundwater would be required in the vicinity of monitor well 09-MW25 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-11C in Appendix 11a shows the estimated extent of metals impacted groundwater at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 87 m^2 has silver levels in groundwater above 1.2 µg/L.

9. The extent of petroleum hydrocarbon impacts on soil have been delineated horizontally.

10. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of metals (i.e., silver) impacts in groundwater above the generic guidelines.

3.11 Lake Melville Dump Site

3.11.1 Site Description

The Lake Melville Dump Site was one of two dump sites identified in previous ESAs. The site is located near the shore of Lake Melville in the first cove to the southwest of the dock as indicated by Drawing No. 121410105-EE-12A in Appendix 12a. The site has modest tree and alder bush cover. The land slopes modestly towards Lake Melville, with boggy areas at lower elevations. The site is accessible both from the shore of Lake Melville and from Dock Road via a rough trail made by an excavator. Photos taken of the site during the current investigation are presented in Appendix 12b.

In 2001, all exposed rubble was flattened and levelled. Rubble that was identified in the lower boggy area and throughout the large growth trees was removed, compressed and buried on site. A 300 mm layer of site sand and topsoil was then redistributed and spread over the majority of the site to act as a cover.

Previous subsurface investigations revealed significant quantities of leachate and groundwater entering test pits at shallow to modest depths. TPH impacts were identified in subsurface soil (1.5 mbgs). Chromatograms for the soil sample with an elevated concentration of TPH resembled motor oil. An area of standing is present at the site, down-gradient of an area of surface debris. A sheen was observed of the surface of the standing water during the current sampling program.

3.11.2 Field Work

Field work at this site comprised the excavation of eight (8) test pits, the installation of four (4) monitor wells, and the collection of six (6) surface soil samples, four (4) groundwater samples, two (2) surface water samples, two (2) sediment samples, two (2) vegetation samples, two (2) berry samples, three (3) small mammal samples, one (1) rabbit sample and ten (10) fish samples. A site plan (Drawing No. 121410105-EE-12A) showing the location of these as well as general site features is provided in Appendix 12a. Coordinates of each sample location are provided in Appendix 12c.

3.11.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 12d. Loose to compact brown sand (SP) with varying percentages of organics, gravel and cobbles was encountered at the surface of test pits and monitor wells and extended to depths ranging from 0.6 mbgs in 09-TP61 to 2.43 mbgs in 09-MW29. This layer was generally underlain by stiff grey marine clay (CL) with some silt.

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.11.4 Debris and Physical Hazards

Buried debris was encountered in test pits 09-TP62 and 09-TP65 and consisted of drums, metal, cans, bottles, plastic, wood, asphalt, shingles and glass, as identified in Table 2.2 and documented on the Test Pit Records in Appendix 12d. Buried debris was not encountered in the other six (6) test pits.

Surface debris and physical hazards at the Lake Melville Dump Site were generally found in the northwest portion of the site, near Lake Melville. Drawing No. 121410105-EE-12A in Appendix

12a shows the location of the surface debris encountered. Items encountered on the site consisted of the following:

- 09-SD15 – Five (5) 200 L drums, small amounts of surface and partially buried debris (metal, batteries, etc.)

3.11.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 1.46 mbgs to 5.66 mbgs in the "shallow" groundwater wells at the site and from 3.03 mbgs to 3.94 mbgs in the deep groundwater well drilled at the site during the two (2) groundwater survey events. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed in all of the test pits at the site (09-TP42, 09-TP43, 09-TP61, 09-TP62, 09-TP63, 09-TP63, 09-TP64, 09-TP65 and 09-TP66) during excavation on August 7 and August 8, 2009. Groundwater seepage was observed at depths ranging from 0.60 mbgs in 09-TP63 and 09-TP64 to 3.20 mbgs in 09-TP43. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the northwest towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-12A in Appendix 12a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW27D to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 12f. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 12f. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW27D with a value of 3×10^{-8} m/s determined using the Bouwer & Rice method and 3×10^{-8} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 3×10^{-8} m/s is determined for the underlying stratigraphy at the site.

3.11.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits, the monitor well or surface soil samples during the current investigation; however, a sheen was observed on surface water in the area of standing water (Refer to photo 2 in Appendix 12b). Measurable product was not detected on groundwater in the monitor well at the site with the product interface probe.

3.11.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Lake Melville Dump Site are provided on the Test Pit Records and Monitor Well Records in Appendix 11c. The soil vapour concentrations measured ranged from 0.0 ppm in various soil samples (09-TP61-BS1 & BS2, 09-TP63-BS1, 09-TP64-BS1 & BS2, 09-TP65-BS2 and all soil samples collected from 09-MW27S, 09-MW27D, 09-MW28 and 09-MW29) to 4.9 ppm in 09-TP42-BS2. Slight petroleum hydrocarbon odours were detected in monitor wells 09-MW27S and 09-MW27D during excavation.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations did not exceed 50 ppm in any of the soil samples collected from the site.

3.11.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Lake Melville Dump Site is presented in Table 3.21 below.

Table 3.21 Laboratory Analysis Schedule (Lake Melville Dump Site)

Issues	Sample Locations	Sample Matrix				
		Soil/ Sediment	Ground-water/ Surface water	Veg./ Berries	Small Mammals/ Rabbits/ Fish	Benthic
• Surface debris identified during previous investigations – characterization required. • Possible Free Product on groundwater. • Petroleum hydrocarbon, PAH and metals impacts in soil – delineation required. • Possible PCBs in soil. • Possible COC impacts in the sand cap placed over the dump site in 2001. • COC (petroleum hydrocarbons, PAHs, PCBs and metals) concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbons, metals and PAHs in shallow groundwater.	09-TP42, 09-TP43, 09-TP61 to 09-TP66 09-SS30 to 09-SS35 09-MW27S, 09-MW27D, 09-MW28 & 09-MW29 09-SW6 & 09-SWM3 09-SED6 & SSM-3-DS 09-VEG18 & 09-VEG19 09-BERRY14 & 09-BERRY15 09-SM11, 09-SM16 & 09-SM29 09-SM32 Dump Site-FS01 to Dump Site-FS10	Soil: TPH/ BTEX (8) Metals (11) PAHs (7) PCBs (2) Sediment: TPH/BTEX (2) Metals (2)	Ground-water: TPH/ BTEX (4) Metals (4) General Chemistry (4) Surface Water: TPH/ BTEX (2) Metals (2) General Chemistry (2)	Veg: PCBs (2) Berries: PCBs (2)	SM: PCBs (3) Rabbits: PCBs (1) Mercury (1) Fish: PCBs (4) Metals (4)	Benthic: Genus (1)

Issues	Sample Locations	Sample Matrix				
		Soil/ Sediment	Ground-water/ Surface water	Veg./ Berries	Small Mammals/ Rabbits/ Fish	Benthic
• Possible petroleum hydrocarbons and metals in surface water in Lake Melville. • Possible petroleum hydrocarbons, PAHs, PCBs and metals in sediment in Lake Melville. Benthic invertebrate and grain size analysis required on near-shore sediments if impacts are detected in sediments. Fish analysis for metals, PCBs and lipids required if there are metals or PCBs impacts in sediment.	Benthic4					

Results of laboratory analysis of soil, groundwater, surface water, sediment, vegetation, berry, small mammal, rabbit and fish samples obtained from this site are presented in Tables 12.1 to 12.18 in Appendix 12e. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on eight (8) soil samples collected from the site including five (5) test pit samples (09-TP42-BS2, 09-TP43-BS2, 09-TP64-BS2, 09-TP65-BS2 and 09-TP66-BS2) and three (3) monitor well samples (09-MW27D-SS3, 09-MW28D-SS6 and 09-MW29-SS3). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 12.1 in Appendix 12e. Modified TPH was detected in two (2) soil samples (09-MW27D-SS3 and 09-MW29-SS3) with concentrations of 1,500 mg/kg and 65 mg/kg, respectively. Concentrations of modified TPH exceeded the applicable Tier I RBSL (140 mg/kg) in one (1) soil sample (09-MW27D-SS3). Laboratory analytical results indicated that products impacting soil samples on this site resembled a mixture of fuel oil and lube oil fractions. BTEX was not detected in any of the soil samples analysed.

Metals in Soil

Available metals analysis was conducted on two (2) test pit samples (09-TP63-BS1 and 09-TP66-BS1), three (3) monitor well soil samples (09-MW27D-SS3, 09-MW28D-SS6 and 09-MW29-SS3) and six (6) surface soil samples collected from the site (09-SS30 to 09-SS35). Results of the laboratory analysis of soil samples for available metals are presented in Table 12.2 in Appendix 12e. Concentrations of various metals were detected in all soil samples, but none of the detected concentrations of available metals in soils exceeded the applicable CCME residential/parkland criteria.

PAHs in Soil

PAH analysis was conducted on one (1) monitor well soil sample (09-MW27D-SS1) and six (6) surface soil samples collected from the site (09-SS30 to 09-SS35). Results of the laboratory analysis of these soil samples for PAHs are presented in Table 12.3 in Appendix 12e. Various PAHs were detected in all three (3) samples. Detectable concentrations of PAH parameters were below the applicable CCME soil quality guidelines for a residential/parkland site in samples 09-SS30, 09-SS31 and 09-SS33 to 09-SS35, where such guidelines exist. The concentrations of anthracene (6.3 mg/kg), fluoranthene (230 mg/kg), benzo(a)pyrene (81 mg/kg) and the benzo(a)pyrene TPE (120.9) in sample 09-MW27D-SS1 were above the CCME soil quality guidelines (2.5 mg/kg, 50 mg/kg, 20 mg/kg and 5.3 mg/kg, respectively) for a residential/parkland site. The concentrations of anthracene (9.4 mg/kg) and benzo(a)pyrene TPE (17.8 mg/kg) in sample 09-SS32 were above the CCME soil quality guidelines (2.5 mg/kg and 5.3 mg/kg, respectively) for a residential/parkland site.

PCBs in Soil

PCB analysis was conducted on two (2) surface soil samples collected from the site (09-SS30 and 09-SS33). Results of the laboratory analysis of these soil samples for PCBs are presented in Table 12.4 in Appendix 12e. PCBs were not detected in sample 09-SS30. The concentration of PCBs (3.1 mg/kg) in sample 09-SS33 was above the CCME soil quality guidelines (1.3 mg/kg) for a residential/parkland site.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on four (4) groundwater samples collected from the site (09-MW27S, 09-MW27D, 09-MW28 and 09-MW29). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 12.5 in Appendix 12e. Low concentrations of modified TPH were detected in three (3) groundwater samples with concentrations of 0.2 mg/L in 09-MW27S, 0.07 mg/L in 09-MW27D and 0.05 mg/L in 09-MW29. The TPH concentrations did not exceed the applicable Tier I RBSL for fuel oil impacts (20 mg/L). Laboratory analytical results indicated that the products impacting the groundwater samples did not resemble petroleum hydrocarbons. BTEX was not detected in the samples.

Metals in Groundwater

Dissolved metals analysis was conducted on four (4) groundwater samples collected from the site (09-MW27S, 09-MW27D, 09-MW28 and 09-MW29). Results of the laboratory analysis of the groundwater samples are presented in Table 12.6 in Appendix 12e. Concentrations of various metals were detected in the groundwater samples. The detected concentration of mercury in groundwater samples 09-MW28 (i.e., 1.1 µg/L) exceeded the MOE guideline (i.e., 0.29 µg/L). None of the other detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

General Chemistry in Groundwater

General chemistry analysis was conducted on four (4) groundwater samples collected from the site (09-MW27S, 09-MW27D, 09-MW28 and 09-MW29). Results of the laboratory analysis of the groundwater samples are presented in Table 12.7 in Appendix 12e. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Surface Water

Petroleum hydrocarbon analysis was conducted on one (1) surface water sample collected from the site (09-SW6) and one (1) surface water sample collected from Lake Melville near the site (09-SWM3). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Tables 12.8 in Appendix 12e. A low concentration of modified TPH was detected in the surface water sample (0.05 mg/L) collected from the area of standing water (09-SW6); however, there are no applicable guidelines for TPH in surface water. Concentrations of BTEX parameters were not detected in the surface water samples.

Dissolved Metals in Surface Water

Dissolved metals analysis was conducted one (1) surface water sample collected from the site (09-SW6) and one (1) surface water sample collected from Lake Melville near the site (09-SWM3). Results of the laboratory analysis of these surface water samples are presented in Table 12.9 in Appendix 12e. The detected concentrations of aluminum, cadmium, chromium, copper, iron and lead (i.e., 398 µg/L, 0.071 µg/L, 10.2 µg/L, 4.8 µg/L and 3,090 µg/L, respectively) in sample 09-SW6 exceeded the CCME guidelines for the protection of freshwater aquatic life (100 µg/L, 0.017 µg/L, 8.9 µg/L, 2 µg/L, 300 µg/L and 1 µg/L respectively). Similar concentrations of aluminum and copper were detected in the background surface water samples (i.e., 98 to 442 µg/L and <1 to 5 µg/L), as indicated in Section 3.17.3, which may suggest that aluminum, copper and iron concentrations are naturally elevated in surface water in the area. Elevated laboratory detection limits were used for various parameters in sample 09-SWM3 due to the matrix interface. The concentrations of aluminum, arsenic, cadmium, chromium, copper, iron, molybdenum, nickel, selenium, silver, thallium and zinc were not detected above the RDLs, therefore it is not possible to determine if the actual concentrations of these parameters exceeded the applicable CCME guidelines in sample 09-SWM3.

General Chemistry in Surface Water

General chemistry analysis was conducted on one (1) surface water sample collected from the site (09-SW6) and one (1) surface water sample collected from Lake Melville near the site (09-SWM3). Results of the laboratory analysis of these surface water samples are presented in Table 12.10 in Appendix 12e. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) sediment sample collected from the site (09-SED6) and one (1) sediment sample collected from Lake Melville near the site (SSM-3-DS). Results of the laboratory analysis of the sediment samples for petroleum hydrocarbons are presented in Table 12.11 in Appendix 12e. Modified TPH was detected in sediment sample 09-SED6, at a concentration of 690 mg/kg. The concentration of modified TPH did not exceed the applicable MOE guideline for oil and grease in sediment (1,500 mg/kg). Laboratory analytical results indicated that products impacting the sediment sample resembled a product in the lube oil range. BTEX parameters were not detected in the sediment samples analysed.

Metals in Sediment

Available metals analysis was conducted on one (1) sediment sample collected from the site (09-SED6) and one (1) sediment sample collected from Lake Melville near the site (SSM-3-DS). Results of the laboratory analysis of these sediment samples for available metals are presented in Table 12.12 in Appendix 12b. Concentrations of various metals were detected in the sediment samples, but only one (1) detected concentration of an available metal exceeded the applicable CCME guidelines for freshwater sediment. The concentration of lead (430 mg/kg) in sediment sample 09-SED6 exceeded both the CCME ISQG (35 mg/kg) and the CCME PEL (91.3 mg/kg) for freshwater sediment.

PCBs in Vegetation

PCBs analysis was conducted on two (2) vegetation samples collected from the site (09-VEG18 and 09-VEG19) in support of the human health and ecological risk assessments. Results of the laboratory analysis of this vegetation sample for PCBs are presented in Table 12.13 in Appendix 12e. PCBs were not detected in the vegetation samples.

PCBs in Berries

PCBs analysis was conducted on two (2) berry samples collected from the site (09-BERRY14 and 09-BERRY15) in support of the human health and ecological risk assessments. Results of the laboratory analysis of this berry sample for available metals are presented in Table 12.14 in Appendix 12e. PCBs were not detected in the berry samples.

PCBs in Small Mammals and Rabbits

PCBs analysis was conducted on three (3) small mammals (09-SM11, 09-SM16 and 09-SM29) and one (1) rabbit (09-SM32) caught at the site in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals for PCBs are presented in Table 12.15 in Appendix 12e. PCBs were not detected in the small mammal samples.

Mercury in Rabbits

Mercury analysis was conducted on one (1) rabbit caught at the site (09-SM32) in support of the human health and ecological risk assessments. The results of the laboratory analysis of the rabbit for mercury are presented in Table 12.16 in Appendix 12e. Mercury was not detected in the rabbit sample.

PCBs in Fish

PCBs analysis was conducted on four (4) fish samples collected from Lake Melville near the site (DUMP SITE-FS01, DUMP SITE-FS03, DUMP SITE-FS05 and DUMP SITE-FS09) in support of the human health and ecological risk assessments. The results of the laboratory analysis of fish samples for PCBs are presented in Table 12.17 in Appendix 12e. PCBs were not detected in the fish samples.

Metals in Fish

Metals analysis was conducted on four (4) fish samples collected from Lake Melville near the site (DUMP SITE-FS01, DUMP SITE-FS03, DUMP SITE-FS05 and DUMP SITE-FS09) in support of the human health and ecological risk assessments. The results of the laboratory analysis of fish samples for metals are presented in Table 12.18 in Appendix 12e. Concentrations of aluminum, arsenic, copper, iron, manganese, strontium and zinc were detected in the samples. There are presently no provincial or federal criteria for available metal levels in whole fish.

3.11.9 Discussion and Conclusions

A Phase III ESA was completed at the Lake Melville Dump Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of this assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of brown sand (SP) with varying percentages of organics, gravel and cobbles overlying stiff grey marine clay (CL) with some silt. Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. Various buried debris was observed within the overburden layer in test pits 09-TP62 and 09-TP65 and consisted of drums, metal, cans, bottles, plastic, wood, asphalt, shingles and glass. Surface debris and physical hazards at the Lake Melville Dump Site were found in the northwest portion of the site, near Lake Melville, and consisted of 200 L drums, metal debris and batteries.
3. Groundwater was encountered at depths ranging from 0.6 mbgs to 5.66 mbgs in test pits and monitor wells completed at this site. Based on local topography and site observations, the direction of groundwater flow at the site is inferred to be to the northwest towards Melville Lake.
4. A hydraulic conductivity of 3×10^{-8} m/s was determined for the underlying stratigraphy at the site, which is within the range expected for silt (i.e., 10^{-5} m/s to 10^{-9} m/s).
5. There was no visual evidence of free phase petroleum hydrocarbons on soil in test pits, the monitor well or surface soil samples during the current investigation. No measurable product was detected on groundwater in the monitor well at the site.
6. Slight petroleum hydrocarbon odours were detected on soil in monitor wells 09-MW27S and 09-MW27D, located at the centre of the site.

7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.22 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.22 Summary of Exceedances (Lake Melville Dump Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	LD-TP1 (1999) 09-MW27-SS3	29,500 mg/kg 1,500 mg/kg	140 mg/kg (Tier I RBSL)
	Anthracene	09-MW27-SS1 09-SS32	57 mg/kg 9.4 mg/kg	2.5 mg/kg (CCME SQG, 2007)
	Fluoranthene	09-MW27-SS1	230 mg/kg	50 mg/kg (CCME SQG, 2007)
	Benzo(a)pyrene	09-MW27-SS1	81 mg/kg	20 mg/kg (CCME SQG, 2007)
	Benzo(a)pyreneTPE	09-MW27-SS1 09-SS32	120.9 mg/kg 17.8 mg/kg	5.3 mg/kg (CCME SQG, 2007)
	PCBs	09-SS33	3.1 ug/g	1.3 ug/g (CCME SQG, 2007)
Groundwater	Mercury	09-MW28	1.1 µg/L	0.29 µg/L (MOE, 2009)
Surface Water	Aluminum*	09-SW6	398 µg/L	100 µg/L (CCME FWAL, 2007)
	Cadmium	09-SW6	0.071 µg/L	0.017 µg/L (CCME FWAL, 2007)
	Chromium	09-SW6	10.2 µg/L	8.9 µg/L (CCME FWAL, 2007)
	Copper*	09-SW6	4.8 µg/L	2 µg/L (CCME FWAL, 2007)
	Iron	09-SW6	3,090 µg/L	300 µg/L (CCME FWAL, 2007)
	Lead	09-SW6	2.97 µg/L	1 µg/L (CCME FWAL, 2007)
Sediment	Lead	09-SED6	430 mg/kg	35 mg/kg (CCME ISQG, 2007) 91.3 mg/kg (CCME ISQG, 2007)

Note: Details of Referenced Guidelines are provided in Section 1.5.2
*Aluminum and copper concentrations are naturally elevated in surface water in the area based on the results of background sampling conducted in 2001 (SW-C1 to SW-C3)

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pits LD-TP1 (1999) and 09-MW27 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-12B in Appendix 12a shows the estimated extent of the petroleum hydrocarbon-impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 105 m^2 has TPH levels in soil above 140 mg/kg.
   - **Metals** remediation of site groundwater would be required in the vicinity of monitor well 09-MW28 and metals remediation of site surface water and sediment would be required in the area of standing water in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-12C in Appendix 12a shows the estimated extent of metals (i.e., mercury) impacted

groundwater, surface water and sediment at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 146 m^2 has mercury levels in groundwater above 0.12 µg/L and an estimated area of approximately 45 m^2 (i.e., the approximate area of the area of standing water) has cadmium, chromium, iron and lead levels in surface water and lead in sediment above the applicable CCME guidelines.

- **PAH** remediation of site soil would be required in the vicinity of monitor well 09-MW27 and soil sample 09-SS32 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-12D in Appendix 12a shows the estimated extent of PAH impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 70 m^2 has PAH levels in soil above the applicable CCME guidelines.
- **PCB** remediation of site soil would be required in the vicinity of soil sample 09-SS33 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-12E in Appendix 12a shows the estimated extent of PCB impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 64 m^2 has PCB levels in soil above 1.3 mg/kg.

9. The extent of petroleum hydrocarbon impacts on soil has been delineated horizontally.
10. The extent of impacted surface water and sediment is expected to be limited to the boundaries of the area of standing water
11. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of PAH and PCB impacts in soil and metals impacts in groundwater above the generic guidelines.

3.12 Underground Pipeline System

3.12.1 Site Description

Six (6) distinct runs of underground fuel pipelines have been identified at the facility. Potential pipeline locations were located previously by conducting an EM-31 survey. These locations were then investigated with test pit excavations. Pipelines located were then traced using a Metrotech 810 instrument.

A 170 mm OD fuel supply line begins at an exposed end on the Lake Melville shoreline at the end of Dock Road. A flexible segment is attached to the pipe end, likely for ease of connection to a tanker. This line travels along the west side of Dock Road to a location approximately 450 m from the East Bulk Fuel Storage Site where it has been cut and removed from the ground. It is believed that the portion of the line that has been removed from the ground would have then continued on in a southerly direction to the East Bulk Fuel Storage Site.

A similar 170 mm OD line runs north from the East Bulk Fuel Storage Site to the North Bulk Fuel Storage Site crossing the Main Access Road and then the VOR Road. These large diameter lines are believed to have served as the AST fill lines for each of the three fuel storage sites.

Two smaller lines (50 mm OD) run south from the pump block at the East Bulk Fuel Storage Site towards the East Generator Site. One of these lines ends near a surface riser pipe near previous test pit P-TP37. The other crosses Dock Road and takes a right turn to the East Generator Site, ending near the tank cribs. A third line runs west from the same pump block towards the Transmitter Building and West Generator Sites. The end of this line at the Transmitter Building and West Generator Sites has not been established. A fourth line runs from the pump block at the North Bulk Fuel Storage Site in a southerly direction towards the Transmitter Building and West Generator Sites. The end of this line at the Transmitter Building and West Generator Sites has not been established. No smaller diameter line was found to be associated with the South Bulk Fuel Storage Site. It is believed that these smaller diameter fuel lines supplied fuel to various day tanks and other demands throughout the facility. It is possible that the South Bulk Fuel Storage Site was used as a reservoir to fill the ASTs at the East and North Bulk Fuel Storage Sites via the larger diameter line.

At all locations, the larger diameter pipelines were coated with a black fibre tar material (rust-proofing). Laboratory analysis of a sample of the coating reported an asbestos content (chrysotile) content of 15%.

The sections of the underground pipeline assessed as part of the current investigation consisted of the area where the pipeline begins, on the Lake Melville shoreline at the end of Dock Road and the area near intersection of Main Access Road and Dock Road. These areas are shown on Drawing 121410105-EE-13A in Appendix 13a. A drainage ditch is present along Dock Road east of the underground pipeline. The drainage ditch was dry at the time of surface water and sediment sampling carried out as part of the current investigation.

3.12.2 Field Work

Field work at this site comprised the excavation of two (2) test pits, and the collection of one (1) surface soil sample, one (1) sediment sample and one (1) standing water sample collected from the exposed end of the pipeline. A site plan (Drawing No. 121410105-EE-013A) showing the location of these as well as general site features is provided in Appendix 13a. Coordinates of each sample location are provided in Appendix 13b.

3.12.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records in Appendix 13c. Compact brown sand (SP) with gravel was encountered at the surface in test pits and extended to depths of 1.1 mbgs. This layer was underlain by a layer of compact grey sand with silt (SP-SM) that extended to the base of the test pits at 2.5 mbgs in 09-TP54 and 2.7 mbgs in 09-TP55.

Bedrock was not encountered in any of the test pits at the site.

3.12.4 Debris and Physical Hazards

No debris was encountered in test pits at the site. Surface debris and physical hazards at the Underground Pipeline System site were generally found near Lake Melville and between Dock

Road and the Helicopter Pad Site. Drawing No. 121410105-EE-13A in Appendix 13a shows the locations of the surface debris encountered. Items encountered on the site consisted of the following:

- 09-SD1 – 1 m^3 concrete block and steel cable
- 09-SD2 – 1.5 m^3 concrete anchor block
- 09-SD3 – 6 m long 200 mm diameter steel pipe and valve
- 09-SD4 – 4 m of pipe protruding from ground
- 09-SD5 - 10 m of steel cable

3.12.5 Groundwater Conditions

Very slow groundwater seepage was observed during the excavation of test pits on August 7, 2009 in 09-TP54 and 09-TP55 at depths of 2.2 mbgs and 2.1 mbgs, respectively. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the northwest towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-13A in Appendix 13a.

3.12.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in the test pits or in the surface soil sample collected during the current investigation.

3.12.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Underground Pipeline Site are provided on the Test Pit Records in Appendix 13c. The soil vapour concentrations measured ranged from 0.0 ppm in soil samples 09-TP55-BS1 & BS2 to 0.6 ppm in soil sample 09-TP54-BS1. Hydrocarbon odours were not detected on soil in either of the test pits or in the surface soil sample during excavation.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. The soil vapour concentrations did not exceed 50 ppm in any of the soil samples collected from the site.

3.12.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Underground Pipeline System is presented in Table 3.23 below.

Table 3.23 Laboratory Analysis Schedule (Underground Pipeline System)

Issues	Sample Locations	Sample Matrix			
		Soil/ Sediment	Water	Veg./ Berries	Small Mammals
Liquid was identified in the pipelines during previous investigations – product identification required.	09-TP54 & 09-TP55 09-SS22 09-PIPE2 09-SED4	Soil: TPH/ BTEX (3) Metals (1) Sediment: TPH (1) Metals (1)	Standing Water: TPH/ BTEX (1)	-	-

Results of laboratory analysis of soil, sediment and standing water samples obtained from this site are presented in Tables 13.1 to 13.7 in Appendix 13d. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on two (2) test pit soil samples (09-TP54-BS2 and 09-TP55-BS2) and one (1) surface soil sample collected from the site (09-SS22). Results of the laboratory analysis of the soil sample for petroleum hydrocarbons are presented in Table 13.1 in Appendix 13d. Modified TPH was detected in the soil sample (09-SS22) at a concentration of 210 mg/kg. The concentration of modified TPH did not exceed the applicable Tier I RBSL (i.e., 140 mg/kg). Laboratory analytical results indicated that products impacting the soil sample on this site resembled a mixture of weathered fuel oil and lube oil fractions. Modified TPH parameters were not detected in soil samples 09-TP54-BS2 or 09-TP55-BS2. BTEX was not detected in any of the soil samples analysed.

Metals in Soil

Available metals analysis was conducted on one (1) surface soil sample collected from the site (09-SS22). Results of the laboratory analysis of the soil sample for available metals are presented in Table 13.2 in Appendix 13d. Concentrations of various metals were detected in the soil sample, but none of the detected concentrations of available metals in soils exceeded the applicable CCME residential/parkland criteria.

Product Identification

Free product identification was conducted on one (1) standing water sample collected from the open end of a pipeline (09-PIPE2). Results of the laboratory identification of the standing water sample are presented in Table 13.3 in Appendix 13d. Laboratory analytical results indicated that the sample contained one product in the fuel oil range resembling stove oil.

Petroleum Hydrocarbons in Standing Water (Contents of a pipeline)

Petroleum hydrocarbon analysis was conducted on one (1) water sample collected from the open end of a pipeline (09-PIPE2). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 13.5 in Appendix 13d. A concentration of modified TPH (1,100 mg/L) was detected in the standing water sample. Laboratory analytical results indicated that the products impacting the groundwater samples resembled weathered fuel oil. A concentration of benzene (0.007 mg/L) was detected in the water sample and a concentration of toluene (0.008 mg/L) was detected in the surface water sample.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) sediment sample collected from the site (09-SED4). Results of the laboratory analysis of the sediment sample for petroleum hydrocarbons are presented in Table 13.6 in Appendix 13d. Modified TPH was detected in the sediment sample, at a concentration of 90 mg/kg. The concentration of modified TPH did not exceed the applicable MOE guideline for oil and grease in sediment (i.e., 1,500 mg/kg). Laboratory analytical results indicated that products impacting the sediment sample on this site did not resemble petroleum hydrocarbons.

Metals in Sediment

Available metals analysis was conducted on one (1) sediment sample collected from the site (09-SED4). Results of the laboratory analysis of the sediment sample for available metals are presented in Table 13.7 in Appendix 13d. Concentrations of various metals were detected in the sediment sample, but none of the detected concentrations of available metals in sediment exceeded the applicable CCME ISQGs or PELs for freshwater sediment.

3.12.9 Discussions and Conclusions

A Phase III ESA was completed at the Underground Pipeline Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of this assessment are summarised below.

1. Surface debris and physical hazards at the Underground Pipeline Site were found along the Lake Melville shoreline, and consisted of concrete anchor blocks, steel cable, steel pipes and a valve.
2. Based on local topography and site observations, the direction of groundwater flow at the site is inferred to be to the northwest towards Melville Lake.
3. There was no visual evidence of free phase petroleum hydrocarbons in the surface soil samples during the current investigation.
4. Petroleum hydrocarbon odours were not detected on the surface soil sample collected from the site.
5. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.24 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations. Note that impacted locations recorded during previous investigations are shown on the site plans for the North Bulk Fuel Storage Site (P-TP22),

South Bulk Fuel Storage Site (P-TP14 and P-TP31), East Bulk Fuel Storage Site (P-TP34, P-TP35 and P-TP37); areas for these impacted locations are also included in the areas calculated for other sites.

Table 3.24 Summary of Exceedances (Underground Pipeline Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	P-TP14 (1999)[1] P-TP16 Cable Wrap (1999) P-TP22 (1999)[2] P-TP31 (1999)[1] P-TP35 (1999)[3] P-TP35 Replicate (1999)[3] P-TP37 (1999)[4] 09-SS22	2,695 mg/kg 6,804 mg/kg 15,969 mg/kg 1,494 mg/kg 22,263 mg/kg 11,632 mg/kg 9,498 mg/kg 210 mg/kg	140 mg/kg (Tier I RBSL, 2003)
	Benzene	P-TP14 (1999)[1] P-TP31 (1999)[1]	4.1 mg/kg 5 mg/kg	2.5 mg/kg (Tier I RBSL, 2003)
	Xylenes	P-TP31 (1999)[1] P-TP31 (1999)[1]	49.3 mg/kg 38.7 mg/kg	0.75 mg/kg (Tier I RBSL, 2003)

Note: Details of Referenced Guidelines are provided in Section 1.5.2
1. Shown on site plans and included in impacted area calculated for the South Bulk Fuel Storage Site
2. Shown on site plans and included in impacted area calculated for the North Bulk Fuel Storage Site
3. Shown on site plans and included in impacted area calculated for the East Bulk Fuel Storage Site
4. Shown on site plans for East Bulk Fuel Storage Site and included in the area calculated for the East Generator Site

6. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pit P-TP16 Cable Wrap (1999) and surface soil sample 09-SS22 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-13B in Appendix 13a shows the estimated extent of the petroleum hydrocarbon-impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 110 m^2 has TPH levels in soil above 140 mg/kg.

7. The extent of petroleum hydrocarbon impacted soil near test pit P-TP16 has been delineated horizontally.

8. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH impacts in soil above the generic guidelines.

3.13 Sewer System

3.13.1 Site Description

The current understanding of the sewer system suggests it begins with a concrete tank located approximately 5 m north of Main Access Road as shown on Drawing 121410105-EE-14A in Appendix 14a. The tank is likely a settling tank designed to separate liquids and solids. The tank collected upstream liquids via an inlet sewer pipe. The inlet pipe enters the southern end of the tank and is oriented in the direction of the Transmitter Building. Three manholes are located in the vicinity of the settling tank and appear to provide access and clean-outs for the tank, as well as inlet and outlet pipes.

The outlet pipe continues underground in a northerly direction from the tank at a depth of approximately 2.4 m through at least two additional manholes, ending at an outfall structure approximately 50 m from the shore of Lake Melville. Water flows from the end of the pipe down onto a concrete pad and onward overland towards Lake Melville. Photos taken of the site during the current investigation are presented in Appendix 14b.

Diesel product was visible in the tank during previous investigations. Previous subsurface investigations at the location of the structure revealed possible impacts to groundwater as evidenced by a sheen on the groundwater at the test pit locations. Impacts to subsurface soil were noted within the test pits as evidenced by staining and modest to strong hydrocarbon odours.

3.13.2 Field Work

Field work at this site comprised the excavation of four (4) test pits, the installation of three (3) monitor wells, and the collection of four (4) surface soil samples, four (4) groundwater samples, two (2) surface water samples, two (2) sediment samples, one (1) water sample from a manhole, two (2) vegetation samples, two (2) berry samples, three (3) small mammal samples, two (2) rabbit samples, ten (10) fish samples and one (1) benthic invertebrate sample. A site plan (Drawing No. 121410105-EE-14A) showing the location of these as well as general site features is provided in Appendix 14a. Coordinates of each sample location are provided in Appendix 14c.

3.13.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 14c. The stratigraphy encountered in test pits and monitor wells at the site generally consisted of loose to compact brown sand (SP) with some organics and cobbles interbedded with layers of brown to grey silt (ML) or grey clay (CL). A 0.3 m layer of loose organic soil (OL) with peat and rootlets was encountered at the surface of 09-TP70.

Bedrock was not encountered in any of the test pits or monitor wells at the site.

3.13.4 Debris and Physical Hazards

Buried debris was not encountered in any of the test pits at the site. Surface debris and physical hazards at the Sewer System Site were generally found near the settling tank, in the vicinity of Main Access Road. Drawing No. 121410105-EE-14A in Appendix 14a shows the location of the surface debris encountered. Items encountered on the site consisted of the following:

- 09-SD19 – 20 m of steel cable
- 09-SD20 – Sewer manhole and 20 m of steel cable
- 09-SD21 – Sewer manhole
- 09-SD22 – Sewer manhole
- 09-SD28 – Steel drum, partially buried concrete debris

3.13.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 0.42 mbgs to 0.72 mbgs in the shallow groundwater wells at the site during the two (2) groundwater survey events. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed in all of the test pits (09-TP67, 09-TP68, 09-TP69 and 09-TP70) during excavation on August 8, 2009 at depths ranging from 0.50 mbgs in 09-TP67 to 1.60 mbgs in 09-TP69. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the north towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-14A in Appendix 14a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW31 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 14f. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 14f. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW31 with a value of 3×10^{-7} m/s determined using the Bouwer & Rice method and 5×10^{-7} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 4×10^{-7} m/s is determined for the underlying stratigraphy at the site.

3.13.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil in test pits, monitor wells or surface soil samples during the current investigation. A sheen was observed on groundwater extracted from monitor well 09-MW31 during purging on August 27, 2009;

however, measurable product was not detected on groundwater in monitor wells at the site with the product interface probe.

Slight sheens were observed on water in the first and third manholes (09-SD20 and 09-SD22, respectively). In the second manhole (09-SD21), 0.15 m of product was present on the water. A sewer water sample (09-SW9) was collected from the third manhole for TPH/BTEX, metals and general chemistry analysis and a product sample (09-Product1) was collected from the second manhole for product identification.

3.13.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Sewer System site are provided on the Test Pit Records and Monitor Well Records in Appendix 14d. The soil vapour concentrations measured ranged from 0.0 ppm in soil samples 09-TP67-BS2, 09-TP68-BS2, 09-TP69-BS2, 09-TP70-BS1 & BS2 and 09-MW32-SS1 to 99.4 ppm in 09-MW31-SS4. A slight petroleum hydrocarbon odour was detected in monitor well 09-MW30 during drilling.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations exceeded 50 ppm in two (2) soil samples collected at the site (i.e., 09-MW31-SS3 and 09-MW31-SS4). Soil vapour concentrations, along with field observations, site usage and site history were used to select samples for petroleum hydrocarbon analysis.

3.13.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Sewer System is presented in Table 3.25 below.

Table 3.25 Laboratory Analysis Schedule (Sewer System)

Issues	Sample Locations	Sample Matrix				
		Soil/ Sediment	Ground-water/ Sewer water	Veg./ Berries	Small Mammals/ Rabbits/ Fish	Benthic
• Free Product noted in the sewer system settling tank during previous investigations – volume calculation required. • Petroleum hydrocarbon impacts in soil around the sewer system and sewer outfall – delineation required. • Possible PCBs and metals in soil around the sewer system and sewer outfall. • COC (petroleum hydrocarbons, PAHs and metals) concentrations in surface soil (<0.3 m) required for the ecological risk assessment.	09-TP67 to 09-TP70 09-SS36 to 09-SS39 09-MW30 to 09-MW32 09-SWM4 SSM-4-SEWER 09-VEG21 & 09-VEG22 09-BERRY17 & 09-BERRY18	Soil: TPH/ BTEX (5) Metals (5) PCBs (2)	Ground-water: TPH/ BTEX (3) Metals (3) General Chemistry (3)	Veg: PCBs (2)	SM: PCBs (3) Metals (1) Rabbits: PCBs (2) Mercury (1)	Benthic: Genus (1)

Issues	Sample Locations	Sample Matrix				
		Soil/ Sediment	Ground-water/ Sewer water	Veg./ Berries	Small Mammals/ Rabbits/ Fish	Benthic
• Possible petroleum hydrocarbon, PCB or metals impacts in sludge in the sewer system settling tank or sewer lines • Possible petroleum hydrocarbon, PCB or metals impacts in water in the sewer system settling tank or sewer lines • Possible petroleum hydrocarbons and metals in shallow groundwater. • Possible petroleum hydrocarbons and metals in surface water in Lake Melville near the sewer outfall. • Possible petroleum hydrocarbons, PAHs, PCBs and metals in sediment in Lake Melville near the sewer outfall. Benthic invertebrate and grain size analysis required on near-shore sediments if impacts are detected in sediments. Fish analysis for metals, PCBs and lipids required if there are metals or PCBs impacts in sediment.	09-SM3, 09-SM10 & 09-SM14 09-SM34 & 09-SM35 09-SW9 09-Pipe1 Benthic5	Sediment: TPH/ BTEX (1) Metals (1) General Chemistry (1)	Sewer water: TPH/ BTEX (1) Metals (1) General Chemistry (1)	Berries: PCBs (2)	Fish: Metals (1) PCBs (4) Crude Fat (2) Mercury (1)	

Results of laboratory analysis of soil, groundwater, sewer water, surface water, sediment, vegetation, berry, small mammal and fish samples obtained from this site are presented in Tables 14.1 to 14.21 in Appendix 14e. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on five (5) soil samples collected from the site including two (2) test pit samples (09-TP68-BS2 and 09-TP70-BS2), two (2) monitor well samples (09-MW30-SS3 and 09-MW32-SS2) and one (1) surface soil samples (09-SS39). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 14.1 in Appendix 14b. Modified TPH was detected in only one (1) soil sample (09-SS39) with a concentration of 18 mg/kg, which did not exceed the applicable Tier I RBSL (i.e., 140 mg/kg). Laboratory analytical results indicated that products impacting soil samples on this site did not resemble petroleum hydrocarbons. BTEX was not detected in any of the soil samples analysed.

Metals in Soil

Available metals analysis was conducted on one (1) monitor well soil sample (09-MW30-SS3) and four (4) surface soil samples collected from the site (09-SS36 to 09-SS39). Results of the laboratory analysis of soil samples for available metals are presented in Table 14.2 in Appendix

14e. Concentrations of various metals were detected in all soil samples, but none of the detected concentrations of available metals in soils exceeded the applicable CCME residential/parkland criteria.

PCBs in Soil

PCB analysis was conducted on one (1) monitor well soil sample (09-MW30-SS3) and one (1) surface soil sample collected from the site (09-SS39). Results of the laboratory analysis of these soil samples for PCBs are presented in Table 14.3 in Appendix 14e. PCBs were not detected in the soil samples.

Product Identification

Free product identification was conducted on one (1) product sample collected from the sewer line. The sample was collected via the second manhole from the main access road (09-Product1, refer to drawing). Results of the laboratory identification of the product sample are presented in Table 14.4 in Appendix 14e. Laboratory analytical results indicated that the sample contained one product in the fuel oil range resembling weathered diesel.

Petroleum Hydrocarbons in Sewer Water

Petroleum hydrocarbon analysis was conducted on one (1) sewer water sample collected from a manhole at the site (09-SW9). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Tables 14.5 in Appendix 14e. A modified TPH concentration of 13 mg/L was detected in the sample. The detected concentration of TPH was below the Newfoundland and Labrador Environmental Control Water and Sewage Regulations discharge criteria (Schedule A) for oil (ether extract) (15 mg/L in excess of the background level of <0.1 mg/L). BTEX parameters were not detected in the sewer water sample.

Dissolved Metals in Sewer Water

Dissolved metals analysis was conducted on one (1) sewer water sample collected from a manhole at the site (09-SW9). Results of the laboratory analysis of this sewer water sample are presented in Table 14.6 in Appendix 14e. The detected concentrations of metals were below the Newfoundland and Labrador Environmental Control Water and Sewage Regulations discharge criteria (Schedule A).

General Chemistry in Sewer Water

General chemistry analysis was conducted on one (1) sewer water sample collected from a manhole at the site (09-SW9). Results of the laboratory analysis of this surface water sample are presented in Table 14.7 in Appendix 14e. None of the general chemistry parameters analysed exceeded the Newfoundland and Labrador Environmental Control Water and Sewage Regulations discharge criteria (Schedule A).

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on three (3) groundwater samples collected from the site (09-MW30, 09-MW31 and 09-MW32). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 14.8 in Appendix 14e. Low concentrations of modified TPH was detected in two groundwater samples with concentrations of 0.9 mg/L in 09-MW30 and 0.08 mg/L in 09-MW32, which did not exceed the applicable Tier I RBSL for fuel oil impacts (20 mg/L). A modified TPH concentration of 39 mg/L in 09-MW31 exceeded the applicable Tier I RBSL for fuel oil impacts (20 mg/L). Laboratory analytical results indicated that the products impacting the groundwater samples resembled weathered fuel oil. BTEX parameters were not detected in the samples.

Metals in Groundwater

Dissolved metals analysis was conducted on three groundwater samples collected from the site (09-MW30, 09-MW31 and 09-MW32). Results of the laboratory analysis of the groundwater samples are presented in Table 14.9 in Appendix 14e. Concentrations of various metals were detected in the groundwater samples. None of the detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

General Chemistry in Groundwater

General chemistry analysis was conducted on three (3) groundwater samples collected from the site (09-MW30, 09-MW31 and 09-MW32). Results of the laboratory analysis of the groundwater samples are presented in Table 14.10 in Appendix 14e. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Surface Water

Petroleum hydrocarbon analysis was conducted on one (1) surface water sample collected from Lake Melville near the site (09-SWM4). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Tables 14.11 in Appendix 14e. Modified TPH and BTEX parameters were not detected in the surface water sample.

Dissolved Metals in Surface Water

Dissolved metals analysis was conducted one (1) surface water sample collected from Lake Melville near the site (09-SWM4). Results of the laboratory analysis of these surface water samples are presented in Table 14.12 in Appendix 14e. Elevated laboratory detection limits were used for various parameters in sample 09-SWM4 due to the matrix interface. The concentrations of aluminum, arsenic, cadmium, chromium, copper, iron, molybdenum, nickel, selenium, silver, thallium and zinc were not detected above the RDLs, therefore it is not possible to determine if the actual concentrations of these parameters exceeded the applicable CCME guidelines in sample 09-SWM4.

General Chemistry in Surface Water

General chemistry analysis was conducted on one (1) surface water sample collected from Lake Melville near the site (09-SWM4). Results of the laboratory analysis of these surface water samples are presented in Table 14.13 in Appendix 14e. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) sediment sample collected from Lake Melville near the site (SSM-4-SEWER). Results of the laboratory analysis of the sediment samples for petroleum hydrocarbons are presented in Table 14.14 in Appendix 14e. Modified TPH and BTEX parameters were not detected in the sediment sample analysed.

Metals in Sediment

Available metals analysis was conducted on one sediment sample collected from Lake Melville near the site (SSM-4-SEWER). Results of the laboratory analysis of these sediment samples for available metals are presented in Table 14.15 in Appendix 14e. Concentrations of various metals were detected in the sediment sample, however none exceeded the CCME ISQGs or PELs for freshwater sediment, where such guidelines exist.

PCBs in Vegetation

PCBs analysis was conducted on two (2) vegetation samples collected from the site (09-VEG21 and 09-VEG22) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these vegetation samples for PCBs are presented in Table 14.16 in Appendix 14e. PCBs were not detected in the vegetation samples.

PCBs in Berries

PCBs analysis was conducted on two (2) berry samples collected from the site (09-BERRY17 and 09-BERRY18). Results of the laboratory analysis of this berry sample for available metals are presented in Table 14.17 in Appendix 14e. PCBs were not detected in the berry samples.

PCBs in Small Mammals and Rabbits

PCBs analysis was conducted on three (3) small mammals (09-SM3, 09-SM10 and 09-SM14) and two (2) rabbits (09-SM34 and 09-SM35) caught at the site in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals and rabbits for PCBs are presented in Table 14.18 in Appendix 14e. PCBs were not detected in the small mammal or rabbit samples.

Metals in Small Mammals

Available metals analysis was conducted on one (1) small mammal caught at the site (09-SM3) in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals for metals are presented in Table 14.19 in Appendix 14e.

Concentrations of various available metals were detected in the small mammal sample analysed. There are presently no provincial or federal criteria for available metal levels in small mammals.

Mercury in Rabbits

Mercury analysis was conducted on one (1) rabbit caught at the site (09-SM34) in support of the human health and ecological risk assessments. The results of the laboratory analysis of the rabbit for mercury are presented in Table 14.19 in Appendix 14e. Mercury was not detected in the rabbit sample.

PCBs in Fish

PCBs analysis was conducted on four (4) fish samples collected from Lake Melville near the site (SEWER SITE-FS01, SEWER SITE-FS03, SEWER SITE-FS07 and SEWER SITE-FS10) in support of the human health and ecological risk assessments. The results of the laboratory analysis of fish samples for PCBs are presented in Table 14.20 in Appendix 14e. PCBs were not detected in the fish samples.

Metals in Fish

Metals analysis was conducted on four (4) fish samples collected from Lake Melville near the site (SEWER SITE-FS01, SEWER SITE-FS03, SEWER SITE-FS07 and SEWER SITE-FS10) in support of the human health and ecological risk assessments. The results of the laboratory analysis of fish samples for metals are presented in Table 14.21 in Appendix 14e. Concentrations of aluminum, arsenic, copper, iron, manganese, strontium and zinc were detected in the samples. There are presently no provincial or federal criteria for available metal levels in whole fish.

3.13.9 Discussions and Conclusions

A Phase III ESA was completed at the Sewer System Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of this assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted of brown sand (SP) with some organics and cobbles interbedded with layers of brown to grey silt (ML) or grey clay (CL). A 0.3 m layer of loose organic soil (OL) with peat and rootlets was encountered at the surface of 09-TP70. Bedrock was not encountered in any of the test pits or monitor wells at the site.
2. Buried debris was not encountered in any of the test pits at the site. Surface debris and physical hazards at the Sewer System Site were found near the settling tank, in the vicinity of Main Access Road, and consisted of steel cable, three (3) sewer manholes, a steel drum and partially buried concrete debris.
3. Groundwater was encountered at depths ranging from 0.42 mbgs to 1.60 mbgs in test pits and shallow monitor wells completed at this site. Based on local topography and site

observations the direction of groundwater flow is inferred to be to the north towards Lake Melville.

4. A hydraulic conductivity of 4 x 10^{-7} m/s is determined for the underlying stratigraphy at the site, which is within the range expected for silty sands (i.e., 10^{-3} m/s to 10^{-7} m/s) or silt (i.e., 10^{-5} m/s to 10^{-9} m/s).

5. In 1999, diesel product was observed in the concrete settling tank at the beginning of the sewer system and sheens were observed on groundwater in test pits downgradient of the sewer outfall. During the current investigation, there was no visual evidence of free phase petroleum hydrocarbons on soil in test pits, monitor wells or surface soil. A sheen was observed on groundwater extracted from monitor well 09-MW31; however, no measurable product was detected on groundwater in the monitor well at the site. Slight sheens were observed on water in the first and third manholes (09-SD20 and 09-SD22, respectively). In the second manhole (09-SD21), 0.15 m of product was present on the water.

6. A slight petroleum hydrocarbon odour was detected in monitor well 09-MW30 during drilling.

7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.26 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.26 Summary of Exceedances (Sewer System Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	S-TP3 (1999) S-TP7 (1999) S-TP10 (1999) S-TP12 (1999)	15,807 mg/kg 999 mg/kg 22,029 mg/kg 22,013 mg/kg	140 mg/kg (Tier I RBSL, 2003)
Sewer Water	TPH	SEWER 2	16,480 mg/L	15 mg/L above background concentration (NL Reg. 65/03, 2003)
Groundwater	TPH	S-TP2 (1999) S-TP6 (1999) S-TP12 (1999) 09-MW31	177 mg/L 200 mg/L 525 mg/L 39 mg/L	20 mg/L (Tier I RBSL, 2003)

Note: Details of Referenced Guidelines are provided in Section 1.5.2

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

   - **Free Product** recovery would be required within the second manhole. It is recommended that the sewer system, including the settling tank and sewer outfall be properly cleaned and filled with clean sand or dismantled.

- **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pits S-TP3 (1999), S-TP7 (1999), S-TP10 (1999) and S-TP12 (1999) and petroleum hydrocarbon remediation of site groundwater would be required in the vicinity of test pits S-TP2 (1999), S-TP6 (1999) and S-TP12 (1999) and monitor well 09-MW31 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-14B in Appendix 14a shows the estimated extent of the petroleum hydrocarbon-impacted soil and groundwater at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 340 m^2 has TPH levels in soil above 140 mg/kg and an estimated area of approximately 232 m^2 has TPH levels in groundwater above 20 mg/L.

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH, PAH and PCB impacts in soil and metals impacts in groundwater above the generic guidelines.

10. It is recommended that the sewage system be decommissioned.

3.14 Dock Road Drum Storage Site

3.14.1 Site Description

The Dock Road Drum Storage Site is a former drum storage area located on the east side of Dock Road northeast of the Lake Melville Dump Site. Based on information collected to date, the site was used by the US Military for drum storage. The site is accessible from Dock Road via narrow footpaths and an excavator trail. Photos taken of the site during the current investigation are presented in Appendix 15b.

The terrain is relatively level, but slopes very gently downwards towards Lake Melville. Boggy areas with ponded surface water have developed in low lying areas. Heavy alder and willow cover is present throughout the site. A significant quantity of drums and scattered surface debris (i.e., engine bloks, pipe, cable, steel drums, cast iron heaters, car wrecks and lockers) were removed from the site in 2001.

Previous subsurface investigations revealed petroleum hydrocarbon odours and staining that extended from the surface to a depth of 2.0 mbgs (DDS-TP2) and mild hydrocarbon impacts detected in a soil sample collected at 1.5 mbgs (DDS-TP2).

3.14.2 Field Work

Field work at this site comprised the excavation of three (3) test pits, the installation of one (1) monitor well, and the collection of five (5) surface soil samples, one (1) groundwater sample, one (1) surface water sample, one (1) sediment sample, one (1) vegetation sample, one (1) berry sample and three (3) small mammal samples. A site plan (Drawing No. 121410105-EE-15A) showing the location of these as well as general site features is provided in Appendix 15a. Coordinates of each sample location are provided in Appendix 15c.

3.14.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records and Monitor Well Records in Appendix 15d. The stratigraphy encountered in test pits consisted of compact brown sand with gravel (SP) and some cobbles that extended from the surface to 0.8 mbgs in 09-TP60 and 0.9 mbgs in 09-TP58 and 09-TP59, underlain by compact to dense grey sand with silt (SP-SM) that extended to a depth of 3.8 mbgs. The stratigraphy observed in monitor well 09-MWW26 consisted of a layer of brown to grey sand (SP) with some cobbles that extended from the surface to a depth of 4.0 mbgs and was underlain by slity clay (CL-ML).

Bedrock was not encountered in any of the test pits at the site.

3.14.4 Debris and Physical Hazards

Buried debris was not encountered in any of the test pits at the site. Surface debris and physical hazards at the Dock Road Drum Storage Site were found throughout the site. Drawing No. 121410105-EE-12A in Appendix 12a shows the locations of the surface debris encountered. Items encountered on the site consisted of the following:

- 09-SD7 – 2 empty 200 L steel drums
- 09-SD9 – 5 m long 500 mm diameter galvanized steel pipe
- 09-SD10 – 10 by 30 m area of scattered surface and partially buried debris (plate steel, pipe, steel cable, drums, etc.)
- 09-SD11 – 20 m steel cable, 5 m long 50 mm diameter galvanized steel pipe
- 09-SD12 – Partially buried rear end of car
- 09-SD13 – 1 m^2 piece of steel
- 09-SD14 – 2 m by 3 m tail gate

3.14.5 Groundwater Conditions

Groundwater levels were measured in monitor well 09-MW26 on August 27, 2009 and October 18, 2009. On August 27, 2009 the groundwater level was 0.56 mbgs and on October 18, 2009 the well was dry. Groundwater levels at this monitor well are expected to vary seasonally and in response to individual precipitation events.

Groundwater seepage was observed in all of the test pits at the site (09-TP58, 09-TP59 and 09-TP60) during excavation on August 7, 2009 at depths ranging from 3.2 mbgs in 09-TP58 and 09-TP59 to 3.3 mbgs in 09-TP60. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the northwest towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-15A in Appendix 15a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW26 to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 15f. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 15f. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW26 with a value of 7×10^{-8} m/s determined using the Bouwer & Rice method and 8×10^{-8} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 7×10^{-8} m/s is determined for the underlying stratigraphy at the site.

3.14.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil in test pits, the monitor well or surface soil samples during the current investigation. Measurable product was not detected on groundwater in the monitor well at the site with the product interface probe.

3.14.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Dock Road Drum Storage Site are provided on the test pit and monitor well records in Appendix 15c. The soil vapour concentrations measured ranged from 0.0 ppm in soil samples 09-TP58-BS1 & BS2, 09-TP60-BS1 and 09-MW26-SS1 to SS6 to 0.3 ppm in 09-TP59-BS2. Petroleum hydrocarbon odours were not detected in any of the test pits or the monitor well at the site.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations did not exceed 50 ppm in any soil samples collected from the site.

3.14.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Dock Road Drum Storage Site is presented in Table 3.27 below.

Table 3.27 Laboratory Analysis Schedule (Dock Road Drum Storage Site)

Issues	Sample Locations	Sample Matrix			
		Soil/ Sediment	Groundwater/ Surface Water	Veg./ Berries	Small Mammals
• Surface debris identified during previous investigations – characterization required. • Possible Free Product on groundwater. • Possible petroleum hydrocarbons, metals, PCBs and PAHs in soil. • COC (petroleum hydrocarbons, PAHs, PCBs and metals) concentrations in surface soil (<0.3 m) required for the ecological risk assessment. • Possible petroleum hydrocarbons and metals in shallow groundwater. • Vegetation, berry and small mammal analysis for COCs required for use in risk assessments.	09-TP58 to 09-TP60 09-SS25 to 09-SS29 09-MW26 09-SW5 09-SED5 09-VEG17 09-BERRY13 09-SM17, 09-SM22, 09-SM23 & 09-SM24 09-Pipe2	Soil: TPH/ BTEX (4) Metals (5) PAHs (1) PCBs (2) Sediment: TPH/ BTEX (1) Metals (1)	Surface Water: TPH/BTEX (1) Metals (1) General Chemistry (1)	Veg: PCBs (1) Berries: PCBs (1)	SM: PCBs (4)

Results of laboratory analysis of soil, sediment, surface water, vegetation, berry and small mammal samples obtained from this site are presented in Tables 15.1 to 15.12 in Appendix 15e. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on four (4) soil samples collected from the site including three (3) test pit samples (09-TP58-BS2, 09-TP59-BS2 and 09-TP60-BS2) and one (1) monitor well sample (09-MW26-SS2). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 15.1 in Appendix 15e. Modified TPH and BTEX parameters were not detected in the soil samples.

Metals in Soil

Available metals analysis was conducted on five (5) surface soil samples collected from the site (09-SS25 to 09-SS29). Results of the laboratory analysis of soil samples for available metals are presented in Table 15.2 in Appendix 15e. Concentrations of various metals were detected in all soil samples, but none of the detected concentrations of available metals in soils exceeded the applicable CCME residential/parkland criteria.

PAHs in Soil

PAH analysis was conducted on one (1) surface soil sample collected from the site (09-SS29). Results of the laboratory analysis of this soil sample for PAHs are presented in Table 15.3 in

Appendix 15e. Various PAHs were detected in the sample. Detectable concentrations of PAH parameters were below the applicable CCME soil quality guidelines for a residential/parkland site, where such guidelines exist.

PCBs in Soil

PCB analysis was conducted on two (2) surface soil samples collected from the site (09-SS27 and 09-SS29). Results of the laboratory analysis of these soil samples for PCBs are presented in Table 15.4 in Appendix 15e. PCBs were not detected in the soil samples.

Petroleum Hydrocarbons in Surface Water

Petroleum hydrocarbon analysis was conducted on one (1) surface water sample collected from the site (09-SW5). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 15.5 in Appendix 15e. Modified TPH was not detected in the surface water sample. A concentration of toluene (0.005 mg/L) was detected in the surface water sample, which exceeded the CCME guideline for the protection of freshwater aquatic life (i.e., 0.002 mg/L). A low concentration of ethylbenzene (0.003 mg/L) was detected in the surface water sample, which did not exceed the CCME guideline for the protection of freshwater aquatic life (i.e., 0.09 mg/L).

Dissolved Metals in Surface Water

Dissolved metals analysis was conducted on one (1) surface water sample collected from the site (09-SW5). Results of the laboratory analysis of this surface water sample are presented in Table 15.6 in Appendix 15e. The detected concentrations of aluminum, cadmium, copper, iron, lead and zinc (i.e., 612 µg/L, 0.086 µg/L, 6.3 µg/L, 1,020 µg/L, 66.3 µg/L and 32.7 µg/L, respectively) exceeded the CCME guidelines for the protection of freshwater aquatic life (i.e., 5 µg/L, 0.009 µg/L, 2 µg/L, 300 µg/L, 1 µg/L and 30 µg/L, respectively). The concentrations iron in 09-SW5 (1,020 µg/L) was similar to the concentration of iron detected in one of the background samples (1,080 µg/L), suggesting that elevated levels of iron in surface water may occur naturally in the area.

General Chemistry in Surface Water

General chemistry analysis was conducted on one (1) surface water sample collected from the site (09-SW5). Results of the laboratory analysis of this surface water sample are presented in Table 15.7 in Appendix 15e. The pH value recorded in 09-SW5 (5.69) was outside the CCME freshwater aquatic life range (6.5 to 9.0). None of the remaining general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) sediment sample collected from the site (09-SED5). Results of the laboratory analysis of the sediment sample for petroleum hydrocarbons are presented in Table 15.8 in Appendix 15e. Modified TPH was detected in the sediment sample, at a concentration of 1,600 mg/kg. The concentration of modified TPH exceeded the applicable MOE guideline for oil and grease in sediment (i.e., 1,500 mg/kg). Laboratory analytical results indicated that products impacting the sediment sample on this site resembled a mixture of the fuel oil range and the lube oil range. BTEX parameters were not detected in the sediment sample analysed.

Metals in Sediment

Available metals analysis was conducted on one (1) sediment sample collected from the site (09-SED5). Results of the laboratory analysis of the sediment sample for available metals are presented in Table 15.9 in Appendix 15e. Concentrations of various metals were detected in the sediment sample, but only one of the detected concentrations of available metals in sediment exceeded the applicable CCME guidelines for freshwater sediment. The concentration of lead (300 mg/kg) in sediment sample 09-SED5 exceeded both the CCME ISQG (35 mg/kg) and the CCME PEL (91.3 mg/kg) for freshwater sediment.

PCBs in Vegetation

PCBs analysis was conducted on one (1) vegetation sample collected from the site (09-VEG17) in support of the human health and ecological risk assessments. Results of the laboratory analysis of this vegetation sample for PCBs are presented in Table 15.10 in Appendix 15e. PCBs were not detected in the vegetation sample.

PCBs in Berries

PCBs analysis was conducted on one (1) berry sample collected from the site (09-BERRY13) in support of the human health and ecological risk assessments. Results of the laboratory analysis of this berry sample for available metals are presented in Table 15.11 in Appendix 15e. PCBs were not detected in the berry sample.

PCBs in Small Mammals

PCBs analysis was conducted on four (4) small mammals caught at the site (09-SM17, 09-SM22, 09-SM23 and 09-SM24) in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals for PCBs are presented in Table 15.12 in Appendix 15e. PCBs were not detected in the small mammal samples.

3.14.9 Discussions and Conclusions

A Phase III ESA was completed at the Dock Road Drum Storage Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of this assessment are summarised below.

1. The observed stratigraphy was generally similar at all test pit and monitor well locations, and consisted compact brown sand with gravel (SP) and some cobbles underlain by compact to dense grey sand with silt (SP-SM). A 0.3 m layer of loose organic soil (OL) with peat and rootlets was encountered at the surface of 09-TP70. Bedrock was not encountered in any of the test pits or monitor wells at the site.

2. Buried debris was not encountered in any of the test pits at the site. Surface debris and physical hazards were found throughout the site, and consisted of empty 200 L drums, steel pipes, plate steel, steel cables, rear end of a car, a 1 m^2 piece of steel and a tail gate.

3. Groundwater was encountered at a depths ranging from 3.2 mbgs to 3.3 mbgs in test pits completed at this site and at a depth of 0.56 mbgs in the shallow monitor well at the site (the well was dry during the second groundwater survey). Based on local topography and site observations the direction of groundwater flow is inferred to be to the northwest towards Lake Melville.

4. A hydraulic conductivity of 7 x 10^{-8} m/s was determined for the underlying stratigraphy at the site, which is within the range expected for silt (i.e., 10^{-5} m/s to 10^{-9} m/s).

5. In 1999, groundwater was not encountered in the test pits excavated at the site; however, soil staining and strong petroleum odours were detected from the surface to the base of one of the two test pits. During the current investigation, there was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits, monitor wells or surface soil samples. No measurable product was detected on groundwater in the monitor well at the site.

6. Petroleum hydrocarbon odours were not detected in any of the test pits or the monitor well at the site.

7. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.28 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.28 Summary of Exceedances (Dock Road Drum Storage Site)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Soil	TPH	DDS-TP2 (1999)	209 mg/kg	140 mg/kg (Tier I RBSL, 2003)
Surface Water	Toluene	09-SW5	0.005 mg/L	0.002 mg/L (CCME FWAL, 2007)
	Aluminum	09-SW5	612 µg/L	5 µg/L (CCME FWAL, 2007)
	Cadmium	09-SW5	0.086 µg/L	0.009 µg/L (CCME FWAL, 2007)
	Copper	09-SW5	6.3 µg/L	2 µg/L (CCME FWAL, 2007)
	Iron*	09-SW5	1,020 µg/L	300 µg/L (CCME FWAL, 2007)
	Lead	09-SW5	66.3 µg/L	1 µg/L (CCME FWAL, 2007)
	Zinc	09-SW5	32.7 µg/L	30 µg/L (CCME FWAL, 2007)
	pH	09-SW5	5.69	6.5 to 9.0 (CCME FWAL, 2007)
Sediment	TPH	09-SED5	1,600 mg/kg	1,500 mg/kg (MOE)

Note: Details of Referenced Guidelines are provided in Section 1.5.2
*Iron concentrations are naturally elevated in surface water in the area based on the results of background sampling conducted in 2001 (SW-C1 and SW-C2)

8. Based on NLDEC policy directive PPD05-01, remedial activities would be required at the site in the areas where concentrations of parameters exceed the generic guidelines, unless a risk-based remedial approach is followed for the site. Adopting a risk-based remedial

approach, remediation of impacted media would be governed by site-specific target level (SSTL) criteria determined for each contaminant. Based on NLDEC policy directive PPD05-01, remediation would be required in the following areas:

- **Petroleum hydrocarbon** remediation of site soil would be required in the vicinity of test pit DDS-TP2 (1999) and petroleum hydrocarbon remediation of site sediment would be required in the vicinity of sediment sample 09-SED5, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-15B in Appendix 15a shows the estimated extent of the petroleum hydrocarbon-impacted soil and sediment at the site. The actual impacted areas may be smaller or larger than the estimated areas. Based on available analytical and field data, an estimated area of approximately 86 m^2 has TPH levels in soil above 140 mg/kg and an estimated area of approximately 86 m^2 has TPH levels in sediment above 1,500 mg/kg.
- **BTEX** remediation of site surface water would be required in the vicinity of surface water sample 09-SW5 in accordance with provincial regulations, unless a Tier II risk assessment is conducted to determine a risk-based remedial approach for the site. Drawing No. 121410105-EE-15C in Appendix 15a shows the estimated extent of the BTEX-impacted soil at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 86 m^2 has toluene levels in surface water above 0.005 mg/L.
- **Metals** remediation of site surface water would be required in the vicinity of surface soil sample 09-SW5 in accordance with provincial regulations, unless a risk-based remedial approach is followed for the site. Drawing No. 121410105-EE-15D in Appendix 15a shows the estimated extent of metals (i.e., aluminum, cadmium, copper, lead and zinc) impacted surface water at the site. The actual impacted area may be smaller or larger than the estimated area. Based on available analytical and field data, an estimated area of approximately 87 m^2 has metals levels in surface water above the applicable CCME guidelines.

9. If a risk-based remedial approach is not followed for the site, further field sampling and laboratory analysis would be required to more precisely determine the extent of TPH, impacts in soil and sediment and the extent of metals and general chemistry impacts in surface water above the generic guidelines.

3.15 Helicopter Pad

3.15.1 Site Description

The Helicopter Pad is located on Dock Road, west of the dock and north of the Lake Melville Dump Site, as shown on Drawing 121410105-EE-16A. The terrain is relatively level, but slopes very gently downwards towards Lake Melville. No previous investigations have been carried out at this site.

3.15.2 Field Work

Field work at this site comprised the excavation of two (2) test pits and the collection of surface soil samples. A site plan (Drawing No. 121410105-EE-16A) showing the location of these as well as general site features is provided in Appendix 16a. Coordinates of each sample location are provided in Appendix 16b.

3.15.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Test Pit Records Records in Appendix 16c. The stratigraphy encountered in both test pits at the site consisted of compact brown sand with gravel (SP) and some cobbles that extended from the surface to 1.0 mbgs, underlain by compact grey sand with silt (SP-SM) that extended to a depth of 4.0 mbgs.

Bedrock was not encountered in either of the test pits at the site.

3.15.4 Debris and Physical Hazards

Buried debris was not encountered in either of the test pits at the site. Surface debris and physical hazards were found in west of the Helicopter Pad. Drawing No. 121410105-EE-16A in Appendix 16a shows the locations of the surface debris encountered. Items encountered near the site consisted of the following:

- 09-SD6 – One empty 200 L steel drum
- 09-SD8 – Remnants of an old trailer, aluminum, wood debris

3.15.5 Groundwater Conditions

Groundwater seepage was observed in both of the test pits at the site (09-TP5 and 09-TP57) during excavation on August 5, 2009 at 3.8 mbgs. Test pits are not normally left open long enough for groundwater levels to stabilise, therefore groundwater level estimates at these locations have to be considered with caution.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the northwest towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-16A in Appendix 16a.

3.15.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits or surface soil samples during the current investigation.

3.15.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Helicopter Pad site are provided on the Test Pit Records in Appendix 16c. The soil vapour concentrations measured were 0.0 ppm in soil samples collected from both test pits at the site (09-TP56 and 09-TP57). Petroleum hydrocarbon odours were not detected in either of the test pits during excavation.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations did not exceed 50 ppm in any of the soil samples collected from the site.

3.15.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Helicopter Pad site is presented in Table 3.29 below.

Table 3.29 Laboratory Analysis Schedule (Helicopter Pad)

Issues	Sample Locations	Sample Matrix			
		Soil	Groundwater	Veg./ Berries	Small Mammals
• No previous investigation conducted. • Possible petroleum hydrocarbons and pesticides in soil. • COC (petroleum hydrocarbons and pesticides) concentrations in surface soil (<0.3 m) required for the ecological risk assessment.	09-TP56 & 09-TP57 09-SS23 & 09-SS24	TPH/ BTEX (2) PAHs (2) PCBs (2)	-	-	-

Results of laboratory analysis of soil samples obtained from this site are presented in Tables 16.1 to 16.3 in Appendix 16d. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on two (2) soil samples collected from the site including two (2) test pit samples (09-TP56-BS2 and 09-TP57-BS2). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 16.1 in Appendix 16d. Modified TPH and BTEX were not detected in the soil samples.

PAHs in Soil

PAH analysis was conducted on two surface soil samples collected from the site (09-SS23 and 09-SS240). Results of the laboratory analysis of these soil samples for PAHs are presented in Table 16.2 in Appendix 16d. Various PAHs were detected in the samples. Detectable concentrations of PAH parameters were below the applicable CCME soil quality guidelines for a residential/parkland site, where such guidelines exist.

PCBs in Soil

PCB analysis was conducted on two (2) surface soil samples collected from the site (09-SS23 and 09-SS24). Results of the laboratory analysis of these soil samples for PCBs are presented in Table 16.3 in Appendix 16d. PCBs were not detected in the soil samples.

3.15.9 Discussions and Conclusions

A Phase III ESA was completed at the Helicopter Pad Site, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of this assessment are summarised below.

1. The observed stratigraphy was generally similar at both test pit locations, and consisted compact brown sand with gravel (SP) and some cobbles underlain by compact grey sand with silt (SP-SM). Bedrock was not encountered in either of the test pits at the site.
2. Buried debris was not encountered in either of the test pits at the site. Surface debris and physical hazards were found east and west of the Helicopter Pad, and consisted of an empty steel drum, the remnants of an old trailer, aluminum and wood debris.
3. Groundwater was encountered at a depth of 3.8 mbgs in test pits completed at this site. Based on local topography and site observations the direction of groundwater flow is inferred to be to the northwest towards Lake Melville.
4. There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in test pits or surface soil samples during the current investigation.
5. Petroleum hydrocarbon odours were not detected in either of the test pits at the site.
6. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. No exceedances of the applicable generic guidelines were detected in samples analysed from the site during the current investigation.
7. Based on NLDEC policy directive PPD05-01, remedial activities would not be required at the site. However, it is recommended that further sampling be conducted at this site to verify the presence/absence of pesticides in surface soil.

3.16 VOR Site

3.16.1 Site Description

The VOR (i.e., Variable Omni-directional Range) Site is located approximately 1.6 km south of the main facility at the end of VOR Road. The site is accessible via the VOR Road; however, several sections of the road have been overgrown with alders.

Based on information collected to date, the site was used as an aircraft communications centre and contained at least one single-storey building structure. One abandoned underground storage tank (approximately 900 L) was previously identified at the site, immediately adjacent to a concrete foundation pad (approximately 5 m x 10 m). It is likely that this UST was used to store fuel for heating or back-up power generation.

The terrain is relatively level and the site is covered with dense vegetation. No significant hydrocarbon impacts were previously identified at the location of the abandoned UST.

In 2001, the concrete foundation pad was covered with approximately 600 mm of sand and gravel and gently sloped to help blend with the surrounding topography. All surrounding trees were left to assist in the revegetation process.

3.16.2 Field Work

The site was visited during the current assessment to search for possible environmental issues related to the abandoned 900 L UST. Due to the dense vegetation present at the site, a thorough site inspection could not be completed at that time.

3.16.3 Discussions and Conclusions

A site inspection was attempted at the VOR Site, located within the Former U.S. Military Site in Northwest Point, NL, however the inspection was inconclusive due to the dense vegetation. It is recommended that the site be inspected during the late fall during a later site visit to assess for possible environmental issues related to the abandoned 900 L UST.

3.17 Streams

3.17.1 Site Description

Streams, ditches and areas of standing water encountered on the Former U.S. military site were assessed during the current investigation. One (1) stream was encountered at the Site during the current investigation. The stream flows east and discharges into Lake Melville. A site plan (Drawing No. 121410105-EE-17A) showing the location of samples collected from the streams during the current and previous investigations is provided in Appendix 17a.

During the previous sampling events, surface water in streams was sampled at six (6) locations throughout the Site (SW1 to SW6). Three (3) surface water samples were (SWC1, SWC2 and SWC3) were collected outside the known boundaries of the facility, from streams along the Main Access Road at locations well upstream of the road. Results of these samples are expected to be representative of background concentrations of parameters in the area. Site plans showing the 2001 sampling locations (i.e., SWC1, SWC2 and SWC3) were not provided for review, therefore these locations are not shown on the site plans.

Ditches were generally present along roads and did not appear to discharge into Lake Melville. The majority of the ditches did not contain considerable amounts of water during the October 2009 surface water sampling program. Results of the sediment and surface water samples collected from ditches at the Site are described in the previous sections.

3.17.2 Field Work

Field work in streams at the Site comprised collection of one (1) surface water sample and one (1) sediment sample.

Samples 09-SW7 and 09-SED7 were collected from a stream located east of Dock Road. The stream crosses Dock Road and flows east, towards Melville Lake. The samples were collected downstream of sample SW2 collected in 1999. BTEX/TPH parameters were not detected in sample SW2 in 1999. Results of the analysis of samples 09-SW7 and 09-SED7 are discussed below. Coordinates of the sample locations are provided in Appendix 17b.

3.17.3 Laboratory Analysis and Results

A laboratory analysis schedule for the stream on the Site is presented in Table 3.30 below.

Table 3.30 Laboratory Analysis Schedule (Streams)

Issues	Sample Locations	Sample Matrix			
		Surface water	Sediment	Fish	Benthic
• Surface water and sediment analysis for petroleum hydrocarbons, PAHs, PCBs and/or metals (including mercury), depending on the concerns in the area. • Fish analysis for metals, PCBs and lipids required where there are metals or PCBs impacts in sediment.	09-SW7 09-SED7	TPH/BTEX (1) Metals (1) Gen. Chem. (1)	TPH/ BTEX(1) Metals (1)	-	-

Results of laboratory analysis of soil obtained from this site are presented in Tables 17.1 to 17.5 in Appendix 17c. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Surface Water

Petroleum hydrocarbon analysis was conducted on one (1) surface water sample collected from a stream at the Site (09-SW7). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 17.1 in Appendix 17c. Modified TPH and BTEX parameters were not detected in the surface water sample.

Dissolved Metals in Surface Water

Dissolved metals analysis was conducted on one (1) surface water sample collected from a stream at the site (09-SW7). Results of the laboratory analysis of this surface water sample are presented in Table 17.2 in Appendix 17c. In sample 09-SW7, the detected concentrations of aluminum and iron (i.e., 529 µg/L and 1,120 µg/L, respectively) exceeded the CCME guidelines for the protection of freshwater aquatic life (100 µg/L and 300 µg/L, respectively) and the CDWQGs for aluminum and iron (100 µg/L and 300 µg/L, respectively).

General Chemistry in Surface Water

General chemistry analysis was conducted on one (1) surface water samples collected from a stream at the Site (09-SW7). Results of the laboratory analysis of this surface water sample are presented in Table 17.3 in Appendix 17c. The colour and turbidity values recorded in the sample (100 TCU and 2.3 NTU) exceeded the applicable CDWQGs (15 TCU and 1.0 NTU, respectively). The pH value recorded in the sample (6.03) was outside the applicable CCME freshwater aquatic life and the CDWQG ranges (6.5 to 9.0 and 6.5 to 8.5, respectively). None of the remaining general chemistry parameters analysed exceeded applicable CCME or Health Canada guidelines, where guidelines exist.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) sediment sample collected from a stream at the Site (09-SED7). Results of the laboratory analysis of the sediment sample for petroleum hydrocarbons are presented in Table 17.4 in Appendix 17c. Modified TPH was detected in the sediment sample, at a concentration of 610 mg/kg. The concentration of modified TPH did not exceed the applicable MOE guideline for oil and grease in sediment (i.e., 1,500 mg/kg). Laboratory analytical results indicated that products impacting the sediment sample resembled a mixture of the weathered fuel oil fraction and a product in the lube oil range that did not resemble petroleum hydrocarbons. BTEX was not detected in the sediment sample analysed.

Metals in Sediment

Available metals analysis was conducted on one (1) sediment sample collected from a stream at the Site (09-SED7). Results of the laboratory analysis of the sediment sample for available metals are presented in Table 17.5 in Appendix 17c. Concentrations of various metals were detected in the sediment sample, but none of the detected concentrations of available metals in sediment exceeded the applicable CCME ISQGs or PELs for freshwater sediment.

3.17.4 Discussions and Conclusions

A Phase III ESA was completed on the stream, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of this assessment are summarised below.

1. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.31 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current and previous investigations.

Table 3.31 Summary of Exceedances (Streams)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Surface Water	Aluminum	SW1 (1999) SW1 (2001) SW3 (2001) SW6 (2001) 09-SW7 SW-C1 (2001)* SW-C2 (2001)* SW-C3 (2001)*	234 µg/L 358 µg/L 106 µg/L 386 µg/L 529 µg/L 98 µg/L 442 µg/L 110 µg/L	100 µg/L (CCME FWAL, 2007) 100 µg/L (CDWQG, 2008)
	Copper	SW1 (2001) SW-C3 (2001)*	5 µg/L 5 µg/L	2 to 4 µg/L (CCME FWAL, 2007)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Surface Water	Iron	SW1 (1999) SW3 (1999) SW1 (2001) SW2 (2001) SW3 (2001) SW6 (2001) 09-SW7 SW-C1 (2001)* SW-C2 (2001)*	3,040 µg/L 1,930 µg/L 1,450 µg/L 1,940 µg/L 1,060 µg/L 331 µg/L 1,120 µg/L 621 µg/L 1,080 µg/L	300 µg/L (CCME FWAL, 2007) 300 µg/L (CDWQG, 2008)
	Colour	09-SW7	100 TCU	15 TCU (CDWQG, 2008)
	pH	09-SW7	6.03	6.5 to 9.0 (CCME FWAL, 2007) 6.5 to 8.5 (CDWQG, 2008)

Note: Details of Referenced Guidelines are provided in Section 1.5.2
* = Background sample

2. The concentrations of aluminum, copper and iron in select surface water samples collected from steams at the Site exceeded the applicable CCME and Health Canada guidelines, however the concentrations of these parameters are consistent with background concentrations recorded in the area. Elevated concentrations of these metals in surface water at the Site are expected to be associated with background concentrations of metals in surface water in the area.
3. The colour and pH values exceeded applicable guideline(s) in sample 09-SW7. Background concentrations of general chemistry parameters have not been recorded in the area; therefore, it is recommended that general chemistry analysis be conducted on background surface water samples prior to the assessment of remedial options for surface water at the Site.
4. Detectable concentrations of TPH were recorded in surface water samples collected as part of the previous investigations and were believed to be associated with site operations. It was recommended that surface water not be used for drinking.

3.18 Innu Healing Ground

3.18.1 Site Description

An area within the Former U.S. Military Site that was not used as an active site during site operations was selected as a background sampling location. The site is located west of Dock Road, south of the Lake Melville Dump Site. The site is located hydraulically upgradient of the Lake Melville Dump Site.

3.18.2 Field Work

Field work at this site comprised the installation of two (2) monitor wells and the collection of two (2) groundwater samples, one (1) vegetation sample, one (1) berry sample and one (1) benthic sample. A site plan (Drawing No. 121410105-EE-18A) showing the location of these as well as general site features is provided in Appendix 18a. Coordinates of each sample location are provided in Appendix 18b.

3.18.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Monitor Well Records in Appendix 18c. The stratigraphy encountered in monitor wells at the site consisted of brown to grey sand (SP) with some organics at the surface and some cobbles that extended from the surface to 7.6 mbgs in 09-MW33S and 6.8 mbgs in 09-MW33D underlain by grey silty sand (SM) to a depth of 10.7 mbgs in 09-MW33D.

Bedrock was not encountered in either of the monitor wells at the site.

3.18.4 Debris and Physical Hazards

No test pits were dug at this site, therefore a buried debris survey was not conducted. Surface debris was not observed at the site.

3.18.5 Groundwater Conditions

Groundwater levels were measured in the monitor wells on August 27, 2009 and October 18, 2009. Groundwater levels ranged from 5.75 mbgs to 5.81 mbgs in the shallow groundwater well and from 6.09 mbgs to 6.64 mbgs in the deep groundwater well during the two (2) groundwater survey events. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the northwest, towards Lake Melville. The assumed direction of groundwater flow is shown on Drawing No. 121410105-EE-18A in Appendix 18a.

Hydraulic response (bail down) testing was conducted on August 27, 2009 on monitoring well 09-MW33S to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 18e. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 18e. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW33S with a value of 3×10^{-8} m/s determined using the Bouwer & Rice method and 5×10^{-8} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 4×10^{-8} m/s is determined for the underlying stratigraphy at the site.

3.18.6 Free Phase Petroleum Hydrocarbons

There was no visual evidence of free phase petroleum hydrocarbons on the monitor well soil samples during the current investigation. Measurable product was not detected on groundwater in the monitor wells at the site with the product interface probe.

3.18.7 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Innu Healing Ground are provided on the Monitor Well Records in Appendix 18c. The soil vapour concentrations measured ranged from 0.0 ppm in soil samples collected from 09-MW33S and in soil sample 09-MW33D-SS1 to 21.2 ppm in soil sample 09-MW33D-SS3. Slight petroleum hydrocarbon odours were detected in monitor well 09-MW33D.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations did not exceed 50 ppm in any of the soil samples collected from the site.

3.18.8 Laboratory Analysis and Results

A laboratory analysis schedule for the Clean Background Area site is presented in Table 3.32 below.

Table 3.32 Laboratory Analysis Schedule (Innu Healing Ground)

Issues	Sample Locations	Sample Matrix			
		Soil	Groundwater	Veg./ Berries	Benthic
• Background concentrations of COCs in soil, groundwater and small mammals required for use in risk assessments.	09-MW33S & 09-MW33D 09-VEG20 09-Berry16 09-BENTHIC3	TPH/BTEX (2) Metals (1) PCBs (1)	TPH/ BTEX (2) Metals (2) General Chemistry (1)	<u>Veg:</u> PCBs (1) <u>Berries:</u> PCBs (1)	<u>Benthic:</u> Genus (1)

Results of laboratory analysis of soil, groundwater, vegetation and berry samples obtained from this site are presented in Tables 18.1 to 18.8 in Appendix 18d. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

<u>Petroleum Hydrocarbons in Soil</u>

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on two (2) soil samples collected from monitor wells (09-MW33D-SS3 and 09-MW33D-SS7). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 18.1 in Appendix 18d. Modified TPH was detected in one (1) soil sample (09-MW33D-SS7) with a concentration of 60 mg/kg. The concentration of modified TPH was below the applicable Tier I RBSLs (140 mg/kg). Laboratory analytical results indicated that products impacting the soil sample on this site resembled fuel oil. BTEX was not detected in either of the soil samples analysed.

Metals in Soil

Available metals analysis was conducted on one (1) monitor well soil samples (09-MW33D-SS7) collected from the site. Results of the laboratory analysis of the soil sample for available metals are presented in Table 18.2 in Appendix 18d. Concentrations of various metals were detected in the soil sample, but none of the detected concentrations of available metals in soil exceeded the applicable CCME residential/parkland criteria.

PCBs in Soil

PCB analysis was conducted on one (1) monitor well soil samples collected from the site (09-MW33D-SS7). Results of the laboratory analysis of this soil sample for PCBs are presented in Table 18.3 in Appendix 18d. PCBs were not detected in the soil samples.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on two (2) groundwater samples collected from the site (09-MW33S and 09-MW33D). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 18.4 in Appendix 18d. Low concentrations of modified TPH was detected in both groundwater samples with concentrations of 0.2 mg/L in 09-MW33S and 0.4 mg/L in 09-MW33D. The TPH concentrations did not exceed the applicable Tier I RBSL for fuel oil impacts (i.e., 20 mg/L). Laboratory analytical results indicated that the products impacting the groundwater samples resembled weathered fuel oil/ lube oil. BTEX parameters were not detected in the groundwater samples.

Metals in Groundwater

Dissolved metals analysis was conducted on two (2) groundwater samples collected from the site (09-MW33S and 09-MW33D). Results of the laboratory analysis of the groundwater samples are presented in Table 18.5 in Appendix 18d. None of the detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

General Chemistry in Groundwater

General chemistry analysis was conducted on one (1) groundwater sample collected from the site (09-MW33D). Results of the laboratory analysis of the groundwater sample are presented in Table 18.6 in Appendix 18d. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

PCBs in Vegetation

PCBs analysis was conducted on one (1) vegetation sample collected from the site (09-VEG20) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these vegetation samples for PCBs are presented in Table 18.7 in Appendix 18d. PCBs were not detected in the vegetation sample.

PCBs in Berries

PCBs analysis was conducted on one (1) berry sample collected from the site (09-BERRY16) in support of the human health and ecological risk assessments. Results of the laboratory analysis of this berry sample for PCBs are presented in Table 18.8 in Appendix 18d. PCBs were not detected in the berry sample.

3.18.9 Discussions and Conclusions

Background information was gathered as part of the Phase III ESA from the Innu Healing Ground, located within the Former U.S. Military Site in Northwest Point, NL. The conclusions of this assessment are summarised below.

1. The stratigraphy encountered in the monitor wells at the site consisted of brown to grey sand (SP) with some organics and cobbles underlain by grey silty sand (SM). Bedrock was not encountered in either of the monitor wells at the site.
2. Surface debris and physical hazards were not observed at the site.
3. Groundwater was encountered at depths ranging from 5.75 mbgs to 5.81 mbgs in 09-MW33S and from 6.09 mbgs to 6.64 mbgs in 09-MW33D during the groundwater level surveys. Based on local topography and site observations the direction of groundwater flow is inferred to the northwest, towards Lake Melville.
4. There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in the monitor wells during the current investigation.
5. Slight petroleum hydrocarbon odours were detected in monitor well 09-MW33D.
6. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. No exceedances of the applicable generic guidelines were detected in samples analysed from the site during the current investigation.
7. Based on NLDEC policy directive PPD05-01, remedial activities would not be required at the site.

3.19 Clean Background Area

3.19.1 Site Description

An area of native/virgin ground with similar regional geological soil conditions as the Former U.S. Military Site, located approximately 50 m west of the Service Site, was selected as the background sampling area. Based on local topography maps, the clean background area is located hydraulically upgradient of the Former U.S. military sites assessed as part of this investigation. Three (3) areas in Lake Melville, located at least 400 m from site surface water discharge points, were also selected for background sampling.

3.19.2 Field Work

Field work at this site comprised the installation of two (2) monitor wells and the collection of two (2) vegetation samples, one (1) berry sample, three (3) small mammal samples and two (2) rabbit samples. A site plan (Drawing No. 121410105-EE-19A) showing the location of these as well as general site features is provided in Appendix 19a. Coordinates of each sample location are provided in Appendix 19b.

3.19.3 Stratigraphy

The stratigraphic information recorded during the Phase III ESA investigation is presented on the Monitor Well Records in Appendix 19c. The stratigraphy encountered in monitor wells 09-MW35S and 09-MW35D consisted of a layer of brown sand (SP) with some cobbles that extended from the surface to 0.60 mbgs and was underlain by interbedded layers of grey sand (SP) and grey silt (SM).

Bedrock was not encountered in any of the monitor wells at the site.

3.19.4 Debris and Physical Hazards

No test pits were dug at this site, therefore a buried debris survey was not conducted. Surface debris was not observed at the site.

3.19.5 Groundwater Conditions

Groundwater levels were measured on August 26, 2009 and October 18, 2009. Groundwater levels ranged from 7.54 mbgs to 8.83 mbgs in the deep groundwater well at the site during the two (2) groundwater survey events. The shallow groundwater well was dry on August 26, 2009 and October 18, 2009. Groundwater levels at these monitor wells are expected to vary seasonally and in response to individual precipitation events.

Based on local topography and site observations the direction of groundwater flow is inferred to be to the north towards Lake Melville.

Hydraulic response (bail down) testing was conducted on August 26, 2009 on monitoring well 09-MW35D to determine the permeability of the underlying stratigraphy at the site. Data collected during the bail down test is provided in Appendix 19d. Analysis of the bail down test data for each test well was performed using the Bouwer & Rice and Hvorslev analysis methods. Analysis was conducted with the aid of the computer program AquiferTest, version 3.5 (Waterloo Hydrogeologic Inc.). The test results are graphically displayed in Appendix 19d. Analysis of test data using the Bouwer & Rice and Hvorslev methods provided similar hydraulic conductivity values for monitoring well 09-MW35D with a value of 5×10^{-8} m/s determined using the Bouwer & Rice method and 6×10^{-8} m/s determined using the Hvorslev method. Based on the results of the bail down tests, an average combined hydraulic conductivity of 5×10^{-8} m/s is determined for the underlying stratigraphy at the site.

3.19.6 Soil Vapour Concentrations

The soil vapour concentrations measured in soil samples from the Clean Background Area are provided on the monitor well records in Appendix 19c. The soil vapour concentrations measured were 0.0 ppm in all soil samples collected from 09-MW35S and 09-MW35D. Petroleum hydrocarbon odours were not detected in any of the monitor wells drilled at the site.

Soil vapour concentrations vary with both fuel type and age, and it should be noted that the readings are intended to provide only a qualitative indication of volatile hydrocarbon levels and are not directly equivalent to soil analytical results. Soil vapour concentrations that exceed 50 ppm may indicate the presence of hydrocarbon or VOC impacts in soil. Soil vapour concentrations did not exceed 50 ppm in any of the soil samples collected from the site.

3.19.7 Laboratory Analysis and Results

A laboratory analysis schedule for the Clean Background Area site is presented in Table 3.33 below.

Table 3.33 Laboratory Analysis Schedule (Clean Background Area)

Issues	Sample Locations	Sample Matrix				
		Soil/ Sediment	Ground-water/ Surface Water	Veg./ Berries	Small Mammals/ Rabbits/ Fish	Benthic
• Background concentrations of metals in soil, groundwater, surface water (stream and Lake Melville), sediment (stream and Lake Melville), vegetation, berries, small mammals and rabbits required for use in risk assessments. • Background concentrations of metals, PCBs and lipids in fish (stream and Lake Melville) required for use in risk assessments.	09-MW35S & 09-MW35D 09-SWM1, 09-SWM5 & 09-SWM6 SSM-1-SE, SSM-5-SE & SSM-6-SCB 09-VEG23 & 09-VEG24 09-BERRY19 09-SM1, 09-SM4 & 09-SM12 09-SM30 & 09-SM31 BACKGROUND 1-FS01 to BACKGROUND 1-FS10 Benthic1, Benthic5 & Benthic6	Soil: TPH/BTEX (1) Sediment: TPH/BTEX (1) Metals (1)	Ground-water: TPH/BTEX (1) Metals (1) General Chemistry (1) Surface Water: TPH/BTEX (1) Metals (1) General Chemistry (1)	Veg: PCBs (3) Berries: PCBs (1)	SM: PCBs (3) Metals (1) Mercury (1) Rabbits: PCBs (1) Mercury (1) Fish: PCBs (3) Metals (3)	Benthic: Genus (1)

Results of laboratory analysis of soil, groundwater, vegetation, berry, small mammal and rabbit samples obtained from this site are presented in Tables 19.1 to 19.14 in Appendix 19d. Corresponding analytical reports from Maxxam Analytics are presented in Appendix 21. Results of the current sampling program are described below.

Petroleum Hydrocarbons in Soil

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on one (1) soil sample collected from a monitor well (09-MW35D-SS8). Results of the laboratory analysis of soil samples for petroleum hydrocarbons are presented in Table 19.1 in Appendix 19d. Modified TPH and BTEX parameters were not detected in the soil sample analysed.

Petroleum Hydrocarbons in Groundwater

Petroleum hydrocarbon analysis was conducted on one (1) groundwater sample collected from the site (09-MW35D). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) are presented in Table 19.2 in Appendix 19d. A low concentration of modified TPH was detected in the groundwater sample at a concentration of 0.8 mg/L. The TPH concentration did not exceed the applicable Tier I RBSL for fuel oil impacts (i.e., 20 mg/L). Laboratory analytical results indicated that the products impacting the groundwater sample resembled lube oil. BTEX parameters were not detected in sample 09-MW35D.

Metals in Groundwater

Dissolved metals analysis was conducted on one (1) groundwater sample collected from the site (09-MW35D). Results of the laboratory analysis of the groundwater samples are presented in Table 19.3 in Appendix 19d. Concentrations of various metals were detected in the groundwater sample. None of the detected concentrations of metals exceeded the applicable MOE guidelines, where such guidelines exist.

General Chemistry in Groundwater

General chemistry analysis was conducted on one (1) groundwater sample collected from the site (09-MW35D). Results of the laboratory analysis of the groundwater sample are presented in Table 19.4 in Appendix 19d. None of the general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Surface Water

Petroleum hydrocarbon analysis was conducted on three (3) surface water samples collected from clean background areas in Lake Melville (09-SWM1, 09-SWM5 and 09-SWM6). Results of the laboratory analysis for petroleum hydrocarbon indicator compounds (TPH and BTEX) in these samples are presented in Table 19.5 in Appendix 19d. Modified TPH and BTEX parameters were not detected in the surface water samples.

Dissolved Metals in Surface Water

Dissolved metals analysis was conducted on three (3) surface water samples collected from clean background areas in Lake Melville (09-SWM1, 09-SWM5 and 09-SWM6). Results of the laboratory analysis of these surface water samples are presented in Table 19.6 in Appendix 19d. The detected concentrations of aluminum, cadmium, chromium, and iron in sample 09-SWM6 (312 µg/L, 0.017 µg/L, 23.6 µg/L and 523 µg/L, respectively) exceeded the applicable CCME guidelines for the protection of freshwater aquatic life (5 µg/L, 0.002 µg/L, 8.9 µg/L and

300 µg/L, respectively). The detected concentration of iron in sample 09-SWM1 (1,150 µg/L) also exceeded the applicable CCME guideline for the protection of freshwater aquatic life (300 µg/L). Elevated laboratory detection limits were used for various parameters in samples 09-SWM1 and 09-SWM5 due to the matrix interface. The concentrations of arsenic, cadmium, chromium, copper, selenium, silver, thallium and zinc in sample 09-SWM1 and the concentrations of aluminum, arsenic, cadmium, chromium, copper, iron, molybdenum, nickel, selenium, silver, thallium and zinc in sample 09-SWM5 were not detected above the RDLs, however it is not possible to determine if the actual concentrations of these parameters exceeded the applicable CCME guidelines because the RDLs were greater than the applicable guidelines.

General Chemistry in Surface Water

General chemistry analysis was conducted on three (3) surface water samples collected from clean background areas in Lake Melville (09-SWM1, 09-SWM5 and 09-SWM6). Results of the laboratory analysis of these surface water samples are presented in Table 19.7 in Appendix 19d. The pH value recorded in sample 09-SWM6 (4.55) was outside the CCME freshwater aquatic life range (6.5 to 9.0). None of the remaining general chemistry parameters analysed exceeded applicable CCME guidelines, where guidelines exist.

Petroleum Hydrocarbons in Sediment

Petroleum hydrocarbon analysis (TPH/BTEX) was conducted on three (3) sediment samples collected from clean background areas in Lake Melville (SSM-1-SE, SSM-5-WB, SSM-6-SCB). Results of the laboratory analysis of the sediment sample for petroleum hydrocarbons are presented in Table 19.8 in Appendix 19d. Modified TPH and BTEX parameters were not detected in the sediment samples.

Metals in Sediment

Available metals analysis was conducted on three (3) sediment samples collected from clean background areas in Lake Melville (SSM-1-SE, SSM-5-WB, SSM-6-SCB). Results of the laboratory analysis of the sediment samples for available metals are presented in Table 19.9 in Appendix 19d. Concentrations of various metals were detected in the sediment samples; however, none of the detected concentrations of available metals exceeded the applicable CCME guidelines for freshwater sediment.

PCBs in Vegetation

PCBs analysis was conducted on two (2) vegetation samples collected from the site (09-VEG22 and 09-VEG24) in support of the human health and ecological risk assessments. Results of the laboratory analysis of these vegetation samples for PCBs are presented in Table 19.10 in Appendix 19d. PCBs were not detected in the vegetation samples.

PCBs in Small Mammals and Rabbits

PCBs analysis was conducted on three (3) small mammals (09-SM1, 09-SM4 and 09-SM12) and two (2) rabbits (09-SM30 and 09-SM31) caught at the site in support of the human health and ecological risk assessments. The results of the laboratory analysis of small mammals and rabbits for PCBs are presented in Table 19.11 in Appendix 19d. PCBs were not detected in the small mammal or rabbit samples.

Metals in Small Mammals

Metals analysis was conducted on one (1) small mammal caught at the site (09-SM1) in support of the human health and ecological risk assessments. The results of the laboratory analysis of the small mammal for metals are presented in Table 19.12 in Appendix 19d. Various metals were detected in the sample. There are presently no provincial or federal criteria for metal levels in small mammals.

Mercury in Small Mammals and Rabbits

Mercury analysis was conducted on one (1) small mammal (09-SM4) and one (1) rabbit (09-SM30) caught at the site in support of the human health and ecological risk assessments. The results of the laboratory analysis of the small mammal and rabbit samples for mercury are presented in Table 19.12 in Appendix 19d. Mercury was not detected in the small mammal or rabbit samples.

PCBs in Fish

PCBs analysis was conducted on three (3) fish samples collected from background areas in Lake Melville (BACKGROUND-1-FS1, BACKGROUND-1-FS5 and BACKGROUND-1-FS9) in support of the human health and ecological risk assessments. The results of the laboratory analysis of fish samples for PCBs are presented in Table 19.13 in Appendix 19d. PCBs were not detected in the fish samples.

Metals in Fish

Metals analysis was conducted on three (3) fish samples collected from background areas in Lake Melville (BACKGROUND-1-FS1, BACKGROUND-1-FS5 and BACKGROUND-1-FS9) in support of the human health and ecological risk assessments. The results of the laboratory analysis of fish samples for Metals are presented in Table 19.14 in Appendix 19d. Concentrations of aluminum, arsenic, barium, copper, iron, lead, manganese, strontium and zinc were detected in the samples. There are presently no provincial or federal criteria for available metal levels in whole fish.

3.19.8 Discussions and Conclusions

Background information was gathered as part of the Phase III ESA from the clean background areas, located near the Former U.S. Military Site in Northwest Point, NL. The conclusions of this assessment are summarised below.

1. The stratigraphy encountered in the monitor wells at the site consisted of a layer of brown sand (SP) with some cobbles that underlain by interbedded layers of grey sand (SP) and grey silt (SM). Bedrock was not encountered in either of the monitor wells in the clean background area.

2. Surface debris and physical hazards were not observed at the site.
3. Groundwater was encountered at depths ranging from 7.54 mbgs to 8.83 mbgs in monitor well 09-MW35D. Shallow groundwater well 09-MW35S was dry on August 26, 2009. Based on local topography and site observations the direction of groundwater flow is inferred to be to the north towards Lake Melville.
4. A soil permeability of 5 x 10^{-8} m/s was determined for overburden materials at the site.
5. There was no visual evidence of free phase petroleum hydrocarbons on soil or groundwater in the monitor wells during the current investigation.
6. Petroleum hydrocarbon odours were not detected in either of the monitor wells drilled at the site.
9. This site was considered to have a residential/parkland site designation with non-potable groundwater and coarse-grained soil. Table 3.34 presents a summary of exceedances of the applicable generic guidelines detected in samples analysed from the site during the current investigation.

Table 3.34 Summary of Exceedances (Clean Background Area)

Sample Matrix	Parameter	Sample No.	Concentration	Referenced Guideline(s)
Surface Water	Aluminum	09-SWM6	312 µg/L	5 µg/L (CCME FWAL, 2007)
	Iron	09-SWM1 09-SWM6	1,150 µg/L 523 µg/L	300 µg/L (CCME FWAL, 2007)
	pH	09-SWM6	4.55	6.5 to 9.0 (CCME FWAL, 2007)

Note: Details of Referenced Guidelines are provided in Section 1.5.2

3.20 Surface Debris and Physical Hazards

Surface debris and physical hazards were encountered at various locations throughout the Former U.S. Military Site. Items were encountered within or in close proximity to the boundaries of the following sites:

- North Bulk Fuel Storage Site
- West Generator Site
- Transmitter Building Site
- Service Site
- Camp Road Dump Site
- Camp Road Drum Storage Site
- Service Site
- Lake Melville Dump Site
- Underground Pipeline Site (i.e., Lake Melville shoreline)
- Sewer System Site
- Dock Road Drum Storage Site
- Helicopter Pad Site

Drawing No. 121410105-EE-20A in Appendix 20a shows the locations of all surface debris and physical hazards encountered at the Site. A log of surface debris and physical hazards encountered at the Former U.S. Military Site, including photos and GPS coordinates, is provided in Appendix 20b.

4.0 HUMAN HEALTH RISK ASSESSMENT APPROACH

4.1 Methodology

The approach for the human health risk assessment is consistent with guidance issued by Health Canada (2009a) and CCME (2006), and involves the following components:

- Hazard Identification - Identification of the environmental hazards that may pose a health risk (*e.g.*, chemicals).
- Receptor Identification - Identification of the human organisms that may be exposed to the above hazard(s).
- Exposure Assessment - Qualitative or quantitative evaluation of the likelihood or degree to which the receptors will be exposed to the hazard.
- Risk Characterization - Qualitative or quantitative assessment of the potential health risk of each hazard to each receptor, based on the degree of exposure.
- Target Level Determination - The determination of site-specific concentrations or Site-Specific Target Levels (SSTLs) at the Site below which no adverse effects would be expected.
- Uncertainty Assessment - A qualitative or quantitative assessment of the uncertainty associated with the risk estimation.
- Recommendations – A list of recommendations required to further understand the potential risk posed by hazards at the Site.

4.1.1 Data Sources

The data for soil, groundwater, surface water, sediment and biota selected for use in the human health risk assessment was compiled from the Phase III Environmental Site Assessment completed herein as well as the following:

- Environmental Assessment, Northwest Point Military Facility, Northwest Point, Labrador, AMEC Earth and Environmental, 2001; and
- 2001 Site Remediation and Assessment Program, Former US Military Facility, Northwest Point, Labrador, AMEC Earth and Environmental, May 2002.

4.2 Screening Framework

An initial generic assessment of the potential for adverse effects associated with site-originated chemicals was conducted within the Phase III ESA (Section 3.0). This assessment compared the detected concentrations from each environmental medium in each area to established generic environmental guidelines (*i.e.*, "screening values") that are designed for the protection of human and ecological receptors. Generic guidelines have been developed by various jurisdictions (including CCME) as conservative benchmarks for screening purposes. If soil concentrations are below these guidelines then the potential for adverse human health and ecological effects is negligible.

For the human health risk assessment, a second screening was completed using human health based guidelines (discussed below) to determine the contaminants of concern (COCs) specifically for human health. Groundwater is not used as a source of potable water at the Former U.S. Military Site in Northwest Point; therefore, guidelines for non-potable groundwater conditions were used for screening purposes. Because no buildings exist in the vicinity of the contaminated portions of the Site, and there are no plans to construct buildings in the contaminated portions in the foreseeable future, guidelines based on vapour intrusion to indoor air were excluded for screening purposes. As a result, the screening guidelines used for soil are based on surface soil ingestion/dermal contact.

According to AMEC (2001), recreational site users may obtain drinking water from the areas of surface water samples SW1 and SW6 collected by AMEC (2001). A PVC pipe had been placed in the vicinity of surface water sample SW6 to facilitate the collection of surface water for drinking purposes. Therefore, surface water samples from the stream will be compared to the applicable drinking water quality guidelines for the purpose of the human health risk assessment.

4.2.1 Summary of Chemicals of Concern – Surface Water

Concentrations of metals in surface water from the stream (SW1 to SW6 from AMEC (2000/2001), and 09-SW7 from Stantec (2009)) were compared to the Canadian Drinking Water Quality Guidelines. Concentrations of aluminum (ranging from less than 5 µg/L to 529 µg/L) and iron (ranging from 331 µg/L to 3040 µg/L) in several surface water samples exceeded the CDWQGs for aluminum (100 µg/L) and iron (300 µg/L). However, concentrations of aluminum and iron from the stream are comparable to the concentrations of aluminum and iron in water samples from the background stream (samples SW-C1 to SW-C3 collected by AMEC, 2001) where aluminum concentrations ranged from 98 µg/L to 442 µg/L and iron concentrations ranged from 281 µg/L to 1080 µg/L. The concentration of copper in one surface water sample (5 µg/L in SW1) exceeded the CDWQG; however, the concentration was also comparable to the concentration in background surface water sample SW-C3 (5 µg/L). In addition, the iron and copper guidelines for drinking water quality are aesthetic objectives and are not health based.

The concentrations of benzene, toluene, ethylbenzene, xylene in surface water were also compared to the CDWQG. Concentrations of BTEX parameters were not detected in surface water samples from the stream and hence, did not exceed the CDWQG.

The concentration of TPH in surface water was compared to the Atlantic PIRI Tier I Risk-Based Screening Levels for groundwater at a residential site with potable groundwater and coarse-grained soil type. The maximum concentration of TPH in surface water (1.1. mg/L) did not exceed the most conservative RBSL (*i.e.*, 3.2 mg/L for fuel oil).

Observed concentrations of metals, BTEX and TPH in surface water from the stream do not pose a concern for recreational visitors at the Site. However, this assessment is based primarily on surface water samples collected by AMEC (2000/2001). Only one surface water sample was collected from the stream during the 2009 field program. No surface water samples were collected within the vicinity of surface water samples SW1 and SW6 (AMEC, 2001), where it was reported that recreational site users had historically collected drinking water. In addition, the sampling program during 2000/2001 and 2009 did not include analysis of PAHs, which were carried forward in soil for the human health risk assessment. Recommendations for additional surface water sampling will be provided in the Recommendations in Section 7.

4.2.2 Soil

For the human health risk assessment, the following guidelines (in order of preference) were used for the screening of chemicals in soil for inclusion in the human health risk assessment (HHRA).

- Atlantic RBCA Tier I Risk Based Screening Levels (RBSLs) and Pathway Specific Screening Levels (PSSLs) for a residential site with non-potable groundwater and coarse-grained soil (2003).
- Canadian Council of Ministers of the Environment (CCME) Canadian Soil Quality Guidelines for Residential/Parkland land use for protection of human health (1999, and subsequent updates). Pathway-specific information from the individual fact sheets was reviewed to confirm human health guidelines.
- Alberta Environment (AENV) Tier I and II Soil Remediation Guidelines for Residential/Parkland land use (2009).
- Ontario Ministry of Environment (OMOE) soil components for Table 3, Residential/Parkland land use, full depth, coarse-grained, non-potable water scenario (2009).
- United States Environmental Protection Agency (US EPA) (Oak Ridge National Laboratory) Regional Screening Levels for Chemical Contaminants at Superfund Sites (May 2010) for soil at residential sites. As per current Health Canada guidance, screening level concentrations for non-carcinogens have been multiplied by 0.2.

In order to conduct the human health risk assessment, a framework was developed. The following steps were taken to identify the COCs in soil at the sites.

1. ***Is the maximum concentration greater than the applicable guideline?***

   Maximum concentrations were compared to selected guidelines. If the concentration of a chemical exceeds the guideline, then it is carried forward in the risk assessment. Where an applicable guideline did not exist and a substance was detected in measurable concentrations, the substance was carried forward to the next step in the screening framework.

2. ***Is the substance a major mineral forming element of low inherent toxicity or is the substance a nutrient and of low inherent toxicity?***

   Several elements can be classified as major mineral forming elements of low inherent toxicity or essential nutrients of low inherent toxicity. It is important to determine whether all parameters analysed and/or detected are present as a result of site activities and if they are generally considered hazardous or toxic to humans or wildlife. The following elements are generally ubiquitous in the environment and are generally not considered hazardous to humans or wildlife, although they are commonly analysed within standard analytical chemistry or trace metal packages:

- Aluminum, iron, calcium, magnesium, sodium, potassium, chloride, phosphorus, silica, and sulfate.

The following elements, for which limited toxicity information exits, are typically associated with seawater spray and could be expected to be present at the Site due to its proximity to the ocean, and not as a result of historical site activities:

- Boron, bismuth, lithium, rubidium, and strontium.

Therefore, the above-mentioned elements of low inherent toxicity, even if detected, were not carried forward in the human health risk assessment.

3. ***Is the exposure point concentration greater than the applicable screening guideline?***

The exposure point concentration (EPC) is an estimate of a reasonable upper limit value for the average chemical concentration in the medium, determined for each exposure unit (USEPA, 1989). Details of how EPCs were determined are provided in Section 5.1.1. If the exposure point concentration did not exceed the applicable screening guideline the chemical was not carried forward in the risk assessment. Where an applicable guideline did not exist and a substance was detected in measurable concentrations, the substance was carried forward to the next step in the screening framework.

4. ***Conduct quantitative risk assessment.***

COCs whose concentrations exceed the applicable guidelines, are considered higher than the naturally occurring background concentrations, and are not considered a major mineral forming element of low inherent toxicity or a nutrient of low inherent toxicity, were carried forward into the risk assessment process.

4.2.3 Groundwater, Sediment, and Biota

No Newfoundland and Labrador guidelines exist for human health that would be directly applicable to metals and PAHs in groundwater at the Site (*i.e.*, non-potable). Further, no CCME human health guidelines exist for these chemicals in groundwater. Since groundwater is not being used as a potable water supply, and will not be developed as a water supply in the foreseeable future. The only pathway for human health exposure to chemicals in groundwater is through the inhalation of volatiles from groundwater (*i.e.*, petroleum hydrocarbons). No exposure pathway exists for human exposure to metals in groundwater as they are not considered volatile. PAHs are also relatively non-volatile with the exception of some lighter compounds that volatize from water or soil (CCME, 2008). Of the PAHs considered in this assessment, the lighter PAHs are the non-carcinogenic PAHs (*e.g.*, naphthalene, phenanthrene). Based on information provided in Atlantic RBCA Reference Documentation for Petroleum Impacted Sites, the TPH mixture consists of thirteen fractions and PAHs are found in many petroleum mixtures. The hydrocarbon fractions address the non-carcinogenic compounds in the TPH mixture. As such, the non-carcinogenic PAHs are addressed for inhalation exposure pathways with the TPH fractions in this assessment. Therefore, metals and PAHs in groundwater were not carried forward in the human health risk assessment.

No known guidelines exist for human health that would be directly applicable to sediment at the Site. Because of the lack of guidelines, if a chemical was carried forward in soil, it was also carried forward for sediment.

Analytical data exists for various biota from the Site including berries, vegetation, fish, small mammals, and Arctic hare. No known guidelines exist for chemicals in biota for human health screening. Therefore, for the human health risk assessment, if a chemical was carried forward in soil, it was also carried forward in biota.

5.0 QUALITATIVE HUMAN HEALTH RISK ASSESSMENT

5.1 Hazard Identification

5.1.1 EPC Calculations

The ESA process results in positively biased data, because the majority of samples are collected at locations where contamination is expected, or to delineate known areas of contamination. As a result, relatively few samples are usually taken from areas of the Site where human impacts have been minor or negligible, and the data will tend to overstate or over-represent the true presence and concentration of COCs in soil and other media. In addition to this inherent source of conservatism, an additional layer of conservatism is introduced through statistical analysis of the data. The primary purpose of the statistical analysis is to determine representative EPCs for estimating potential risks associated with COCs in the various media. The EPC is an estimate of a reasonable upper limit value for the average chemical concentration in the medium, determined for each exposure unit (USEPA, 1989). The appropriate upper confidence limit (UCL) provides reasonable confidence that the true site average will not be underestimated (USEPA, 1992).

In order not to underestimate exposure, where the number of samples was less than 10, the maximum value would be selected as the EPC. Where the number of samples exceeded ten, Pro UCL, Version 4.0 (USEPA, 2007) was used to determine representative exposure point concentrations (EPCs). ProUCL calculates the appropriate upper confidence limit (UCL) given the specific distribution of the Site specific analytical results data.

In the case of laboratory and field duplicate samples, the sample with the highest concentration was used in the calculation of the EPC. This prevents the potential for one soil sample to unduly skew the EPC. The ProUCL output is presented in Appendix 23.

5.1.2 Summary of Chemicals of Concern - Soil

As mentioned previously, no applicable human health guidelines exist for chemicals in sediment and biota. Therefore, if a chemical were carried forward in soil, it was also carried forward in sediment and biota. As a result, screening of chemicals for human health was essentially based on concentrations in soil. Screening of chemicals in soil for the human health risk assessment is presented in Table 23-1, Appendix 23. Based on the screening process outlined in Section 4.2, the following substances were identified as being of potential concern in soil at the Former U.S. Military Site in Northwest Point:

- TPH; and,
- Carcinogenic PAHs (assessed as benzo(a)pyrene TPE).

All other substances analysed in soil were either not of toxicological concern, or were non-detectable in all samples, or in the event that they were detected, the maximum value or EPC was below the selected guideline or benchmark value.

Concentrations of several metals including chromium, copper, lead, and zinc were elevated in one soil sample (09-SS14) from the Camp Road Dump Site but were not elevated in any other samples. Metal debris was noted to be present in this area. This test pit is considered an anomaly for several metals. Therefore, the analytical results from this test pit were not included in the calculations and the risk assessment. Instead, recommendations will be made later in this report to remove the soil and associated debris from this area. This soil sample is not included further in the human health risk assessment.

Concentrations of TPH at the Former U.S. Military Site in Northwest Point mainly resembled a mixture of fuel oil and lube oil. As per guidance provided by Atlantic PIRI (2003), impacts will be assessed for the more restrictive product type (*i.e*., fuel oil).

5.2 Receptor Identification

Existing and intended land use is an important factor in evaluating the potential exposures and estimating risk. The exposure assessment has been performed considering that there will be no significant development at the Site that would increase exposure times, the Former U.S. Military Site in Northwest Point will continue to be used on an occasional basis only and that groundwater from the area will not be used as a drinking water source.

Evaluation of the potential for exposure of human receptors to COCs identified at the Site requires an understanding of the receptors' characteristics and sensitivities, the method of exposure, and the duration over which the exposure is likely to occur. The potential human receptors, or people who may be most affected by the COCs were selected based on site-specific assumptions for the area.

The Former U.S. Military Site in Northwest Point is no longer used as a commercial property. Local residents would likely use the property for walking, ski-dooing, fishing, hunting, and other recreational purposes and there are several cabins located in the area. It is therefore possible that a toddler may be present at the Site on an occasional basis. Therefore, in evaluating non-carcinogenic risks, the most sensitive receptor is considered to be a toddler (*i.e.*, toddler occasionally visiting the Site for recreational purposes).

In evaluating the carcinogenic risk, a composite receptor was selected in order to assess long term exposure to chemicals in soil. The composite receptor includes the infant, toddler, child, teen and adult life stages with total exposure duration of 80 years (Health Canada, 2009a). The receptors are characterized as having no extreme sensitivities.

In summary, the following receptor categories have been considered in this assessment:

- Former U.S. Military Site in Northwest Point: recreational site user (toddler for non-carcinogenic compounds and composite receptor for all life stages for carcinogenic compounds).

5.3 Exposure Pathway Assessment

The exposure assessment evaluated the likelihood that potential hazards may come into contact with potential human receptors. The likelihood of exposure is determined through consideration of the properties of individual hazards that control chemical mobility, and the various pathways through which the hazard could move to contact the receptor, or through which the receptor could move to contact the hazard. The exposure analysis also considers the possible mechanisms through which a hazard can be introduced to a human receptor (*i.e.*, ingestion, dermal contact, and inhalation).

5.3.1 Fate and Transport Properties of Identified Hazards

The relative mobility of a hazard is typically determined through review of the physical properties of the hazard. The fate and transport properties of the identified hazards are summarized in Table 5.1.

Table 5.1 Summary of Fate and Transport Properties of Identified Hazards

Potential Hazards	Solubility	Volatility	Sorption Potential	Reactivity/ Biodegradability	Conditions for Persistence	Fate Assessment
TPH	moderate to high	low to moderate	moderate to high	low to moderate	anaerobic	Low to moderate mobility,
PAHs	low to moderate	low to moderate	high	low	variable	immobile, persistent

5.3.2 Potential Transport Pathways

The principal pathways through which environmental hazards can typically contact a receptor include:

- direct contact (with soil, sediment, dust, liquid phase product, or water);
- transport of liquid phase product;
- transport in groundwater;
- transport in surface water;

- air borne transport (as dust); and,
- transport as a vapour.

5.3.3 Potential Exposure Mechanisms

The mechanisms by which receptors typically become exposed to hazards include:

- inhalation;
- ingestion;
- dermal contact; and,
- uptake by plants.

5.3.4 Identification of Operable Exposure Pathways and Development of Conceptual Site Model

Exposure pathways are used to describe how a substance could move from the impacted media (soil, water, etc.) to a point where it can come in contact with the body. Only those pathways for which there is a reasonable potential for exposure were considered quantitatively in this risk assessment. The likelihood of exposure includes consideration of the duration and frequency of exposure to chemicals of potential concern. The exposure scenarios that have been considered for human receptors at the Site include:

- ingestion/dermal contact with soil or sediments;
- inhalation/ingestion/dermal contact with dust;
- ingestion of vegetation or garden produce grown in impacted soil or irrigated with impacted groundwater;
- ingestion of wild game;
- ingestion of fish;
- ingestion/dermal contact with surface water;
- ingestion/dermal contact with groundwater; and,
- inhalation of vapours.

The likelihood that the on-site receptors may be exposed to the identified hazards through the various exposure scenarios was identified by using a qualitative method. The likelihood of exposure is considered and evaluated in terms of the series of definitions presented in Table 5.2.

Table 5.2 Exposure Definitions

Likelihood of Exposure	Definition
Very Unlikely	Level of exposure that could result in adverse effects is not expected.
Unlikely	Level of exposure that could result in adverse effects would probably not occur.
Possible	Level of exposure that could result in adverse effects might be expected.
Likely	Level of exposure that could result in adverse effects is expected. Exceedance of this exposure level might be expected.

The relevant exposure pathways for the Former U.S. Military Site in Northwest Point are summarized in Table 5.3, which includes the qualitative evaluation of each pathway and summarizes the justification for the likelihood of exposure assigned. Additional details follow Table 5.6. The likelihood of exposure includes consideration of the duration and frequency of exposure to each potential hazard and to the relative concentrations to which the receptor is likely to be exposed. Those hazard-exposure-receptor combinations considered to have the highest likelihood to contribute a health risk are carried forward for further quantitative analysis.

Table 5.3 Potential Exposure Scenarios – Human Receptors

Exposure Pathway Description	Likelihood of Exposure	Carried Forward for Quantitative Analysis?	Justification
Ingestion of soil Dermal contact with soil Ingestion of dust Dermal contact with dust	Possible	Yes	Human receptors may be exposed to impacted soil through the soil ingestion/dermal contact/dust inhalation exposure pathways.
Ingestion of sediment Dermal contact with sediment	Possible	Yes	Human receptors may be exposed to impacted sediment in Lake Melville or the stream through the sediment ingestion/dermal contact exposure pathways.
Ingestion of vegetation/garden produce grown in impacted soil	Unlikely	No	PCBs were not detected in the vegetation at the Site, metals analysis was not conducted on vegetation at the Site as no impacts were expected, and the COPCs being carried forward (TPH, PAHs) are not considered bioaccumulative.
Ingestion of wild game Ingestion of fish	Unlikely	No	PCBs were not detected in the small mammals or fish collected from the site, metals were detected at low concentrations or were not detected in small mammals or fish at the Site, and the COPCs being carried forward (TPH, PAHs) are not considered bioaccumulative.
Dermal Contact with surface water Ingestion of surface water	Unlikely	No	AMEC (2001) reported that surface water in the vicinity of SW1 and SW6 is used for drinking water purposes. However, concentrations of metals and petroleum hydrocarbons in surface water samples meet applicable drinking water guidelines.
Ingestion of groundwater Dermal contact with groundwater	Unlikely	No	Groundwater at the Site is not used for any purpose by human receptors.
Inhalation of vapours (outdoors)	Very Unlikely	No	Volatiles in the soil may volatilize to the outdoor air; however, there is a high potential for dilution in the outdoors.
Inhalation of vapours (indoors)	Very Unlikely	No	There are no buildings within close proximity to the contaminated/disturbed portions of the Site.

The ingestion of wild game and berries from the Site as well as fish from Lake Melville was identified as potential exposure pathways for the Site. Concentrations of PCBs were not detected in fish, small mammals or berries from the Site. In addition, no chemicals considered to be bioaccumulative (*e.g.*, PCBs, metals) were carried forward as a concern in the human health risk assessment. Therefore, ingestion of wild game and berries from the Site and fish from Lake Melville is not considered to be a concern for human health. These exposure pathways were not considered further in the human health risk assessment.

While outdoor air inhalation was identified as an exposure pathway in the conceptual model, the pathway was not assessed further in the human health risk assessment. The only chemicals that are of concern for the outdoor air inhalation exposure pathway are petroleum hydrocarbons. Outdoor air pathway specific criteria are not calculated because the criteria (Atlantic PIRI, 2003) are greater than the residual saturation limit of TPH in soil (*i.e.*, ">Res") and greater than the solubility in groundwater (*i.e.*, ">Sol") thus requiring only free product remediation. This means that in the absence of free phase petroleum hydrocarbons at the Site, TPH concentrations in soil would be below the Tier II PSSL for this exposure pathway. Therefore, the outdoor air exposure pathway is not considered further in this human health risk assessment.

According to AMEC (2001), recreational site users may obtain drinking water from the areas of surface water samples SW1 and SW6 collected by AMEC (2001). A PVC pipe had been placed in the vicinity of surface water sample SW6 to facilitate the collection of surface water for drinking purposes. Therefore, concentrations of metals and petroleum hydrocarbons in surface water samples from the stream were compared to applicable drinking water quality guidelines (refer to Section 4.2.1). Concentrations were not considered to be a concern. This exposure pathway is not considered further in the human health risk assessment.

Therefore, the following exposure pathways were carried forward for quantitative analysis:

- Recreational site users may be exposed to the TPH and carcinogenic PAHs in soil through ingestion, dermal contact, and dust inhalation at the Site.
- Recreational site users may be exposed to TPH and carcinogenic PAHs in sediment through ingestion and dermal contact at the Site.

5.3.5 Receptor Characteristics and Exposure Time

It is assumed that a recreational site user could potentially be on the Former Radar Site for 24 hours per day, 3 days/week, for 52 weeks/year. It should be noted that for the soil ingestion/dermal contact/inhalation exposure pathway, an exposure time of 26 weeks per year with no snow cover was assumed based on Environment Canada climate data for nearby areas. It is assumed that receptors would not be exposed to the surface soil impacts while the soil is snow covered or frozen. For the dermal contact and ingestion exposure pathway, it is assumed that the receptors will receive their entire daily exposure during the hours that they are outside (*i.e.*, event driven exposure).

It is assumed that a Recreational site user would potentially be exposed to impacts in sediment in the stream or Lake Melville 24 hours per day, 3 days a week, for 13 weeks of the year (*i.e.*, weeks with warm temperatures).

Receptor characteristics, exposure frequencies and ingestion/inhalation rates are presented in Tables 5.4 and 5.5.

Table 5.4 Summary of Receptor Characteristics

Characteristic		Toddler	Source
Averaging Times and Constant Values			
Atn	Averaging time, non-cancer (days)	1,643	Equal to exposure duration
ED	Exposure duration (years)	4.5	Health Canada, 2009a
EF	Exposure frequency (days/year)	Soil Exposure – 78	Estimates based on meteorological data and site use
		Sediment Exposure - 39	
ET ing	Exposure Time, ingestion (hrs/day)	24	Assumes ingestion is event driven
ET inh	Exposure Time, inhalation (hrs/day)	24	Estimate of daily exposure on site.
BW	Body Weight (kg)	16.5	Health Canada, 2009a
Ingestion of Surface Soil/Sediment			
IR s	Incidental ingestion rate (mg/day)	80	Health Canada, 2009a
Dermal Contact with Surface Soil/Sediment			
SA	Exposed surface area – Hands (cm^2)	430	Health Canada, 2009a
	Exposed surface area – Rest of Body (cm^2)	2,580	Health Canada, 2009a
AF	Soil adherence factor - Hands (mg/cm^2)	0.1	Health Canada, 2009a
	Soil adherence factor – Rest of Body (mg/cm^2)	0.01	Health Canada, 2009a
Inhalation of Dust/Vapours			
IR air	Inhalation rate (m^3/day)	8.3	Health Canada, 2009a

Table 5.5 Age-Specific Receptor Characteristics: Carcinogens Only

Parameter		Age Group				
		0 – 0.5 yrs	>0.5 – 4 yrs	5-11 yrs	12-19 yrs	20-80 yrs
ED	Exposure Duration (y)	0.5	4.5	7	8	60
BW	Body Weight (kg)	8.2	16.5	32.9	59.7	70.7
IRs	Soil Ingestion Rate (mg/d)	20	80	20	20	20
IRa	Inhalation Rate (m^3/d)	2.2	8.3	14.5	15.6	16.6
AF	Adherance Factor - Hands	0.1	0.1	0.1	0.1	0.1
	Adherence Factor – Rest of Body	0.01	0.01	0.01	0.01	0.01
SA	Skin Surface Area (cm^2) - Hands	320	430	590	800	890
	Skin Surface Area (cm^2) – Rest of Body	1,460	2,580	4,550	2,230	2,500
Sources : Health Canada (2009a)						

The important characteristics of the receptors (including body weight, exposure duration, etc.) considered in the risk analysis are also presented in the input and output tables in Appendix 23.

5.4 Exposure Point Concentrations

The EPCs used in this human health risk assessment are summarized in Table 5.6.

Table 5.6 EPCs used in the Human Health Risk Assessment

Chemical	Soil (mg/kg)
TPH	7751
Benzo(a)pyrene TPE	35

6.0 QUANTITATIVE HUMAN HEALTH RISK ASSESSMENT

6.1 Modelling Tools

6.1.1 Petroleum Hydrocarbons

The quantitative risk assessment and the derivation of SSTLs for petroleum hydrocarbons (TPH, BTEX) as described above was made with the aid of Groundwater Services, Inc. (GSI) RBCA Toolkit for Atlantic Canada, Version 2.1. The spreadsheet model is based on the exposure and mass transport equations presented in the appendix of the ASTM PS-104 “Standard Provisional Guide for Risk-Based Corrective Action” (ASTM 2002). Under the RBCA process, using these standard equations for derivation of site-specific risks and clean-up targets, is considered a “Tier II” assessment. See Appendix 23 for detailed equations and source information.

The Atlantic RBCA Spreadsheet model, Version 2.1, has incorporated a methodology for assessing total petroleum hydrocarbons as thirteen separate fractions. This approach was developed by the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG, 1997a; 1997b; 1998).

The RBCA model was used for the modeling of two exposure pathways: 1) dermal contact/ingestion of soil, and 2) dermal contact/ingestion of sediment. The quantitative analysis of these pathways uses conservative assumptions and relatively simple exposure models and is considered likely to overestimate exposure risks as compared to using detailed models based upon more site-specific data and less conservative assumptions. The input parameters used for the risk calculations are provided in Appendix 23. The Tier II risk assessment for the Site was conducted for petroleum hydrocarbons using the exposure point concentration calculated for soil on the Site (refer to Table 5.2). This is a conservative assumption because calculations are performed assuming that this concentration is found throughout the identified area.

The soil exposure pathway of the GSI RBCA Toolkit is a direct pathway that uses equations to evaluate such variables as average daily soil ingestion rate, skin surface area and sorption of contaminants to skin. It is a direct exposure route, therefore, no predictive chemical fate and transport modelling is required. To conservatively evaluate human health risks, it is further assumed that the impacts are located uniformly across the Site and that there is no biodegradation or other loss mechanism.

6.2 Pro-Rating of Results

The RBCA toolkit requires TPH fractionation in order to assess the potential risks to receptors from exposure to TPH. In order to conservatively assess the potential risks, the fractionated TPH results were pro-rated based on the percentage of each fraction identified in the fractionated result with these percentages utilized in deriving "fractioned" results from the EPC. Pro-rating is a method of estimating the individual fractions from a non-fractionated sample (*i.e.*, EPC) based on a comparison to a fractionated sample. The procedure includes calculating the mass fraction of each known fraction as a percentage of the total TPH concentration. Estimated fraction concentrations can then be calculated by pro-rating these to the TPH concentration of the non-fractionated sample (*i.e.*, multiplying the TPH value of the non-fractionated sample (EPC) by the mass fraction of the fractionated sample). The potential risks to human receptors were then determined from these pro-rated fractions

TPH fractionation results were available for two soil samples from the 2009 sampling program by Stantec, these being soil sample TP1BS3 (North Bulk Fuel Site) and soil sample TP14BS2 (West Generator Site). Soil sample TP1BS3 was chosen for pro-rating due to similar TPH fractions as the maximum TPH concentration (TP22-31,000) from the South Bulk Fuel Site. Soil sample TP1BS3 was used for pro-rating of TPH at the Former U.S. Military Site in Northwest Point. Pro-rating tables are presented in Appendix 23.

Although the concentrations of toluene, ethylbenzene and xylenes did not exceed screening guidelines, the concentrations were added into the TPH fractionation results (*i.e.*, total TPH is required) as per Atlantic PIRI (2003). The RBCA model is inherently conservative and using default values will largely over-estimate the risk associated with the remaining concentrations of petroleum hydrocarbons at the Site.

6.2.1 Carcinogenic PAHs

The benzo(a)pyrene total potency equivalent (TPE) approach has been advocated by regulatory agencies such as the US EPA (1993, 1999), California EPA (OEHHA, 1992), Netherlands (RIVM, 2000), the UK (UK Environment Agency, 1992), the Provinces of British Columbia and Ontario, and more recently Health Canada and CCME (2008). The approach involves the use of "toxic equivalency factors" (TEFs) to relate the carcinogenic potential of other PAHs to that of benzo(a)pyrene.

Because no data from studies in humans are available that are suitable for assessing the potency of benzo(a)pyrene in humans, the potency is estimated from the results of animal studies. The second component in this approach is to estimate the potency of the PAH relative to that of benzo(a)pyrene, in order to obtain a benzo(a)pyrene TEF. The estimate is based on the relative potencies of benzo(a)pyrene and other PAHs in experimental animals. The key assumption in this approach is that the relative potency of two PAHs in an animal model is similar to that of the same compounds in humans. The third component is the assumption that the risks from carcinogenic PAHs are additive. This process requires that the risks posed by all carcinogenic PAHs be assessed.

Data on the PAH composition are generated with standard analytical techniques. It is a recognized limitation that environmental mixtures likely contain many more PAHs than are provided by standard quantitative methods. It is also recognized that the literature regarding the toxicity of PAH mixtures is limited. While the TEF approach assumes additivity of the risks posed by the combined PAHs in a mixture, the major uncertainty is the estimation of risk of benzo(a)pyrene being representative of the overall risk of PAHs in the mixture, especially at coal tar sites.

6.3 Toxicity Assessment

The potential hazards associated with exposures to non-carcinogenic (threshold) substances are assessed based on the assumption that there is a dose (or concentration) of the chemical of concern that does not produce any adverse effect. A Tolerable Daily Intake (TDI) is an estimate of a chemical intake that is unlikely to cause an increased incidence of deleterious health effects during a lifetime of exposure. TDIs are specifically developed to be protective for chronic exposure to a chemical.

For contaminants for which the critical effect is assumed to have no threshold (*i.e.*, carcinogens), it is assumed that there is some probability of harm to human health at any level of exposure (CCME, 2006). There is a linear dose-response relationship that converts estimated daily intakes averaged over a lifetime of exposure directly to an incremental risk of an individual developing cancer. For the purposes of deriving site-specific soil quality guidelines, Health Canada considers that a single increased case of cancer in an exposed population of 100,000 merits action (Health Canada, 2004a). As such, a target risk (TR) of one in one hundred thousand or 10^{-5} is used in this risk assessment for carcinogenic effects.

6.3.1 Toxicity Reference Values

An essential part of the risk assessment is the identification of appropriate toxicity values. This is typically done by a literature review of published toxicological assessments. Toxicity values have been established by several agencies including Atlantic PIRI, Health Canada, the United States Environmental Protection Agency (US EPA), and the World Health Organization (WHO). Preference has been given to Health Canada values and where these are not established, values from the US EPA's Integrated Risk Information System (IRIS) have been employed as the best basis upon which to evaluate health risks. Summaries of the toxicity values selected for inclusion in the risk assessment are provided in Tables 6.1 and 6.2.

Table 6.1 Selected Toxicity Values for Non-Carcinogens

Metal		Route of Exposure	Tolerable Daily Intake (mg/kg-day)	Toxicological Basis	Source Agency
TPH	Aliphatics >C_6-C_8	Ingestion	5	Not given	Atlantic PIRI, 2003
	Aliphatics >C_8-C_{10}	Ingestion	0.1		
	Aliphatics >C_{10}-C_{12}	Ingestion	0.1		
	Aliphatics >C_{12}-C_{16}	Ingestion	0.1		
	Aliphatics >C_{16}-C_{21}	Ingestion	2		
	Aliphatics >C_{21}-C_{34}	Ingestion	2		
	Aromatics>C_7-C_8	Ingestion	0.2		
	Aromatics>C_8-C_{10}	Ingestion	0.04		
	Aromatics>C_{10}-C_{12}	Ingestion	0.04		
	Aromatics>C_{12}-C_{16}	Ingestion	0.04		
	Aromatics>C_{16}-C_{21}	Ingestion	0.03		
	Aromatics>C_{21}-C_{35}	Ingestion	0.03		

Table 6.2 Toxicity Values for Carcinogens

Substance	Route of Exposure	Exposure Limit $(mg/kg\text{-}d)^{-1}$	Toxicological Basis	Source Agency
Benzo(a)pyrene	Ingestion	2.3	Gastric tumors	Health Canada (2009b)
	Inhalation	0.137	Respiratory tract tumors	Health Canada (2009b)

As described in Section 6.1.2, carcinogenic PAHs were assessed using the benzo(a)pyrene TPE approach by applying TEFs to relate the toxicity of other PAHs to benzo(a)pyrene. No toxicity refernce value could be found for phenanthrene. Phenanthrene is a weak carcinogen and Health Canada (2009a) gives a TEF of 0.001. Therefore, phenanthrene was assessed as a carcinogen using the TEF relative to benzo(a)pyrene. The TEFs for this assessment are based on guidance from CCME (2010), and are summarized in Table 6.3.

Table 6.3 PAH TEFs

PAH	TEF
benzo(a)pyrene	1.0
dibenz(a,h)anthracene	1.0
benzo(a)anthracene	0.1
benzo(b)fluoranthene	0.1
benzo(k)fluoranthene	0.1
indeno(1,2,3-c,d)pyrene	0.1
chrysene	0.01
benzo(g,h,i)perylene	0.01
phenanthrene	0.001

6.3.2 Bioavailability

Bioavailability refers to “the fraction of the total amount of material in contact with a body portal-of-entry (lung, gut, skin) that enters the blood”. Relative bioavailability is the amount of a substance entering the blood via a particular route of exposure (*e.g.*, gastrointestinal) relative to the study used to derive the TRV. These factors were then applied in the risk assessment to more realistically represent the portion of contaminants held in soil that are available. For instance, a relative bioavailability factor of 0.5 indicates that 50% of the administered (*e.g.*, ingested) metal is absorbed into the bloodstream compared to the absorption in the TRV study. Table 6.4 provides the bioavailability factors used in this assessment.

Table 6.4 Bioavailability Factors

Bioavailability Factor (or Relative Absorption Factor)	Oral	Dermal	Inhalation
TPH (all fractions)	1	0.5[1]	1
Benzo(a)pyrene TPE	1	0.148[2]	1

1. Atlantic PIRI, 2003
2. Health Canada, 2009b

6.4 Risk Characterization

6.4.1 Approach and Methodology – Non Carcinogens

Risk characterization compares the estimated exposures with the identified toxicity values for each substance to determine the potential for an adverse effect.

The potential health effects associated with non-carcinogenic chemicals are assessed differently than those for carcinogenic chemicals. Non-carcinogenic chemicals are generally considered to act through a threshold mechanism where it is assumed that there is a dose (or concentration) that does not produce any adverse effect. As the dose or concentration increases to the point where the body can no longer process or excrete the chemical, an adverse effect may occur. This point is termed the threshold and is different for every chemical.

As per Atlantic PIRI (2007), a target hazard quotient (HQ) of 1.0 was used for petroleum hydrocarbons. If the calculated hazard quotient for a non-carcinogenic chemical exceeds the target HQ of 1.0, then a potential hazard exists and a maximum allowable concentration (i.e., SSTL) is then calculated. The following is a simplified version of the equation used to calculate the soil SSTLs.

$$\text{SSTL} = \frac{\text{TDI x BW x SAF}}{\text{CDI}}$$

Where:
SAF = Soil Allocation Factor = Target Hazard Quotient
BW = Body Weight
TDI = Tolerable Daily Intake
CDI = Chronic Daily Intake (sum of all intake pathways)

Details of the equations and parameter values used in the analysis are provided in the spreadsheets in Appendix 23.

6.4.2 Carcinogens

In determining the incremental increase in lifetime cancer risk associated with exposure to carcinogenic PAHs, the estimated dose is compared to the established cancer slope factors as shown in the simplified equation below:

$$ILCR = LADD \times CSF$$

Where: ILCR = Incremental Lifetime Cancer Risk

LADD = Lifetime Averaged Daily Dose (mg/kg-day) = Daily Intake/Body Weight

CSF = Cancer Slope Factor ($[mg/kg\text{-}day]^{-1}$

The ILCR estimates the incremental probability that a person will develop cancer as a result of a lifetime of exposure to the Site. This incremental lifetime cancer risk is over and above the probability of developing cancer due to ambient exposures. The characterization of potential ILCR was undertaken using a target risk benchmark established by Health Canada of 1 in 100,000 (theoretically one additional cancer per 100,000 population). Calculation of the LADD is based on methods presented by US EPA (1989), CCME (2006), Health Canada (2009a), and OMOE (2009). Details of the equations and parameter values used in the analysis are provided in the spreadsheets in Appendix 23. In the case of carcinogenic PAHs, the ILCR associated with the benzo(a)pyrene TPE was benchmarked against the 1 in 100,000 risk level.

In general, exposure pathways and intake values for carcinogens were consistent with those used for the development of the non-carcinogenic SSTL for human health, but were adjusted over a lifetime of exposure rather than being specific to one age group.

6.5 Human Health Risk Assessment Results – TPH and PAHs

6.5.1 Baseline Risks

The cumulative hazard indices and carcinogenic risks for the exposure scenarios assessed are shown in Table 6.5. The carcinogenic risk value for the soil ingestion, inhalation, and dermal contact pathway for carcinogenic PAHs (assessed as benzo(a)pyrene TPE) at the Former U.S. Military Site in Northwest Point exceeds the target maximum carcinogenic risk value of 1.0E-05. The hazard index values for TPH in soil and sediment were below their targets.

Table 6.5 Cumulative Pathway Hazard Indices and Target Risks – TPH and PAHs

COC	Exposure Pathway	Hazard Index	Target Hazard Index	Total Carcinogenic Risk	Target Risk (Carcinogens)
TPH	Soil Exposure	0.29	1	NA	NA
	Sediment Exposure	0.013	1	NA	NA
Benzo(a)pyrene TPE	Soil Exposure	NA	NA	**1.5E-05**	1.0E-05

Note:
BOLD indicates risk estimate is higher than target.

6.5.2 SSTLs for Remediation

Based on the results of cumulative pathway hazard indices and carcinogenic risks, soil SSTLs were calculated for each of the COCs identified as representing a potential health risk to help direct the remedial actions. An SSTL of 23 mg/kg was calculated for benzo(a)pyrene TPE at the Site based on the soil ingestion/dermal contact/dust inhalation exposure pathways. In order to get an area wide exposure point concentration of less than 23 mg/kg, soil remediation should be carried out at the Lake Melville Dump Site (Drawing No. 121410105-EE-25c, Appendix 25).

7.0 HUMAN HEALTH RISK ESTIMATION UNCERTAINTIES

Risk estimates normally include an element of uncertainty, and generally these uncertainties are addressed by incorporating conservative assumptions in the analysis. As a result, risk assessments tend to overstate the actual risk. Although many factors are considered in preparation of a risk analysis, analysis results are generally only sensitive to very few of these factors. The uncertainty analysis is included to demonstrate that assumptions used are conservative, or that the analysis result is not sensitive to the key assumptions.

A risk assessment containing a high degree of confidence will be based on:

- conditions where the problem is defined with a high level of certainty based on data and physical observations;
- an acceptable and reasonable level of conservatism in assumptions, which will ensure that risks are overstated; or,
- an appreciation of the bounds and limitations of the final solution.

The exposure assessment performed as part of this study was based on:

- available data to describe existing surface soil conditions;
- sound conservative assumptions for certain parameters, as required; and
- well-understood and generally accepted methods for risk prediction.

7.1 Uncertainties in Toxicological Information

There is a very limited amount of toxicological information on the effects associated with human exposures to low levels of chemicals in the environment. What human information is available is generally based on epidemiological studies of occupationally exposed workers. These studies are generally limited in scope and provide results that may not be applicable to chronic or continuous exposures to low levels of chemicals. Because human toxicological information is limited, reference doses and cancer potency estimates for many compounds are based on the results of dose-response assessment studies using animals. The use of experimental animal data to estimate potential biological effects in humans introduces uncertainties into the evaluation of potential human health effects. These estimations require that a number of assumptions be made:

- The toxicological effect reported in animals is relevant and could occur in humans.
- The assumption that extrapolation from high-dose studies to low-dose environmental exposures adequately represents the shape of the dose-response curve in the low-dose exposure range.
- Short-term exposures used in animal studies can be extrapolated to chronic or long-term exposures in humans.
- The uptake of a compound from a test vehicle (drinking water, food, etc) in animals will be the same as the uptake of the chemical from environmental media (soil, sediment, air-borne particulate matter) in humans.
- The pharmacokinetic processes that occur in the test animals also occur in humans.

There are clearly a number of uncertainties associated with extrapolating from experimental animal data to humans. In order to address these weaknesses, regulatory agencies, such as Health Canada and the US EPA incorporate a large number of conservative assumptions to try and account for the uncertainties associated with this process. The uncertainties are accounted for by the use of Uncertainty Factors that are used to lower the reference dose well below the level at which adverse health effects have been reported in the test species. Uncertainty factors are generally applied by factors of 10 and are used to account for the following types of uncertainties:

- Variation within the population (protection of sensitive members of the population).
- Differences between humans and the test species.
- Differences in using short or medium-term studies to estimate the health effects associated with long-term or chronic exposures.
- Limitations in the available toxicological information.

The magnitude of the uncertainty factors applied by the various regulatory agencies provides an indication of the level of confidence that should be placed in the reference value. Uncertainty factors typically range between 100 and 10,000, although some can be lower than 10. The latter values are found for a few chemicals where sound and substantial human toxicological information is available to enable the setting of toxicological end-point solely on the basis of human epidemiological information. The application of uncertainty factors is intended to introduce a high degree of conservatism into the risk assessment process and to ensure, as far as possible, that limited exposures that exceed the reference concentrations will not result in adverse human health effects. Because risk assessments that use these regulatory limits incorporate the conservatism used in the development of the toxicological information, the results can generally be viewed as being extremely conservative.

7.2 Modeling Assumptions

Table 7.1 contains a summary of the assumptions used in the human health risk analysis, providing an evaluation for each assumption and an opinion as to whether the assumption is acceptable.

Table 7.1 Evaluation of Assumptions in the Risk Analysis

Risk Analysis Study Factor/Assumption	Justification	Analysis Likely to Over/Under Estimate Risk?	Acceptable Assumption ?
Hazard Screening/ Identification			
Measured concentrations are representative.	Used maximum concentrations or statistical upper confidence level on the mean of the data for EPC: conservative measure.	Over-Estimate	Yes
Receptor Characteristics			
The most sensitive receptors for the Former U.S. Military Site in Northwest Point were assumed to be a toddler (non-carcinogens) and an age-adjusted lifetime receptor (carcinogens).	Although it is unlikely that a toddler would spend a significant amount of time at the Site, the Site is publicly accessible. Therefore, a toddler and an age-adjusted lifetime receptor were carried forward as the most sensitive receptor as it is reasonable that nearby residents would visit the Site.	Neutral	Yes
For the exposure scenario of soil ingestion/dermal contact and inhalation, an occasional visitor to the Site was assumed to be present on the property 78 days/year for the exposure duration. Recreational visitors are assumed to be in contact with sediment from the stream and Lake Melville 3 days a week for 12 weeks of the year.	The exposure times represent a reasonable estimate of average annual exposure based on current and potential future site use.	Neutral	Yes
Risk Characterization			
Exposure was modelled for soil ingestion/dermal contact and dust inhalation and sediment ingestion/dermal contact.	Other exposures are expected to produce negligible risks.	Neutral	Yes

Note: Over-estimation of risk indicates that the assumption was conservative, and could possibly overestimate the risks at the Site (*i.e*. higher than actual). Underestimating the risk indicates that the assumptions made could slightly underestimate the level of risk at the Site. Based on the assessment conducted on the Site, the assumptions are acceptable.

7.3 Summary of Uncertainty Analysis

As a result of the scientific investigations, literature reviews, and risk assessment guidance that have been undertaken or followed in the preparation of this Human Health Risk Assessment, the risk assessment results are considered to present a reasonable yet conservative evaluation of the risk to human receptors present at the Site. Where uncertainty or lack of knowledge were encountered in the development of the risk estimates, reasonable yet conservative assumptions were made, or data were selected, in order to ensure that risks were not underestimated.

8.0 ECOLOGICAL RISK ASSESSMENT

Ecological Risk Assessment (ERA) is the formal process that has been developed for the purpose of assessing and quantifying risks to ecological receptors from exposure to one or more stressors. The framework within which ERA is performed was largely developed in the

United States, under the US Environmental Protection Agency (US EPA, 1992) and later expanded (US EPA, 1998). In Canada, the Canadian Council of Ministers of the Environment (CCME, 1996a and 1997) has developed a similar protocol, and variants of these protocols are presently in use in several provinces.

Ecological Risk Assessment is defined (US EPA, 1992) as the process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors. In terms of this ERA, ecological effects refer to toxicologically-induced changes in the health of ecological receptors exposed to stressors, specifically chemicals of concern (COC), present at the Site. Ecological Risk Assessment is a process for organizing and analyzing data, information, assumptions, and uncertainties to evaluate the likelihood of adverse ecological effects. Ecological risk assessment provides risk managers with an approach for considering available scientific information along with the other factors (*e.g.*, social, legal, political, economic) when selecting a course of action.

An ERA includes three primary activities: problem formulation, analysis (composed of an exposure and toxicity assessment) and risk characterization. Within problem formulation, important steps include identifying goals and assessment endpoints, preparing the conceptual model, and developing an analysis plan. The analysis phase involves evaluating exposure to stressors and the relationship between stressor levels and ecological effects. In risk characterization, key elements are estimating risk through integration of exposure and stressor response profiles, describing risk by discussing lines of evidence, and determining ecological adversity.

8.1 Levels of ERA Process

The ERA process is iterative and tiered. A relatively simple process may be all that is required to achieve an adequate foundation for a management decision. Alternatively, remaining uncertainties may require that the process be repeated at increasing levels of detail before decision-making can occur. Initial tiers in an ERA are typically based on conservative assumptions such as maximum exposure or ecological sensitivity. When a lower tier cannot sufficiently define risk to support a management decision, a higher assessment tier that may require either additional data, or applying a more refined analysis technique, may be needed. Higher tiers provide more ecologically realistic assessments while making less conservative assumptions about exposure and effects.

The three tiers of ERA that are typically followed include:

- Screening Level ERA;
- Preliminary Quantitative ERA; and
- Detailed Quantitative ERA.

Each level in this tiered approach to ERA has the same structure and builds upon the data, information, knowledge and decisions from the preceding level. Thus, each level is progressively more complex. At the same time, each level becomes more focused on specific issues or concerns, as the available information is reviewed, and data gaps are addressed. The ERA process does not necessarily involve all three tiers; rather, the process stops at a point when sufficient information has been assembled to support the decision-making or management process (CCME, 1996a). A Screening Level ERA was deemed acceptable to support the decision-making or management process at the Former U.S. Military Site in Northwest Point.

8.2 Objectives and Overview

This ERA has been conducted according to principles laid out in Canadian and U.S. Federal and state guidance documents (CCME 1996a, 1997, US EPA 1992, Ohio EPA 2008). The objectives of the ERA are to:

- Qualitatively characterize the potential ecological receptors that have been observed or could be present in terrestrial or aquatic habitats on or adjacent to the Site;
- Assess potential exposures of ecological receptors to COCs in various environmental media within terrestrial or aquatic habitat under current conditions;
- Characterize the risks associated with exposures of ecological receptors to COCs in various environmental media under current conditions; and
- If unacceptable risk is identified, determine acceptable concentrations of COCs (site-specific target levels, or SSTLs) that would allow re-establishment of the habitat and would not pose on-going risks.

This ERA uses a general framework similar in concept to the approach used for the human health risk assessment, but is distinctive in its emphasis in three areas:

- The ecological risk assessment generally considers effects at the population level rather than at the individual level, with the notable exception being species protected under federal or provincial legislation (*e.g.*, *Species at Risk Act*)
- There is no single set of ecological values or resources to be protected that can be generally applied to every site; and
- If appropriate, the ecological risk assessment can consider non-chemical, as well as chemical, stressors, however, only chemical stressors have been evaluated herein.

8.3 Approach and Methodology

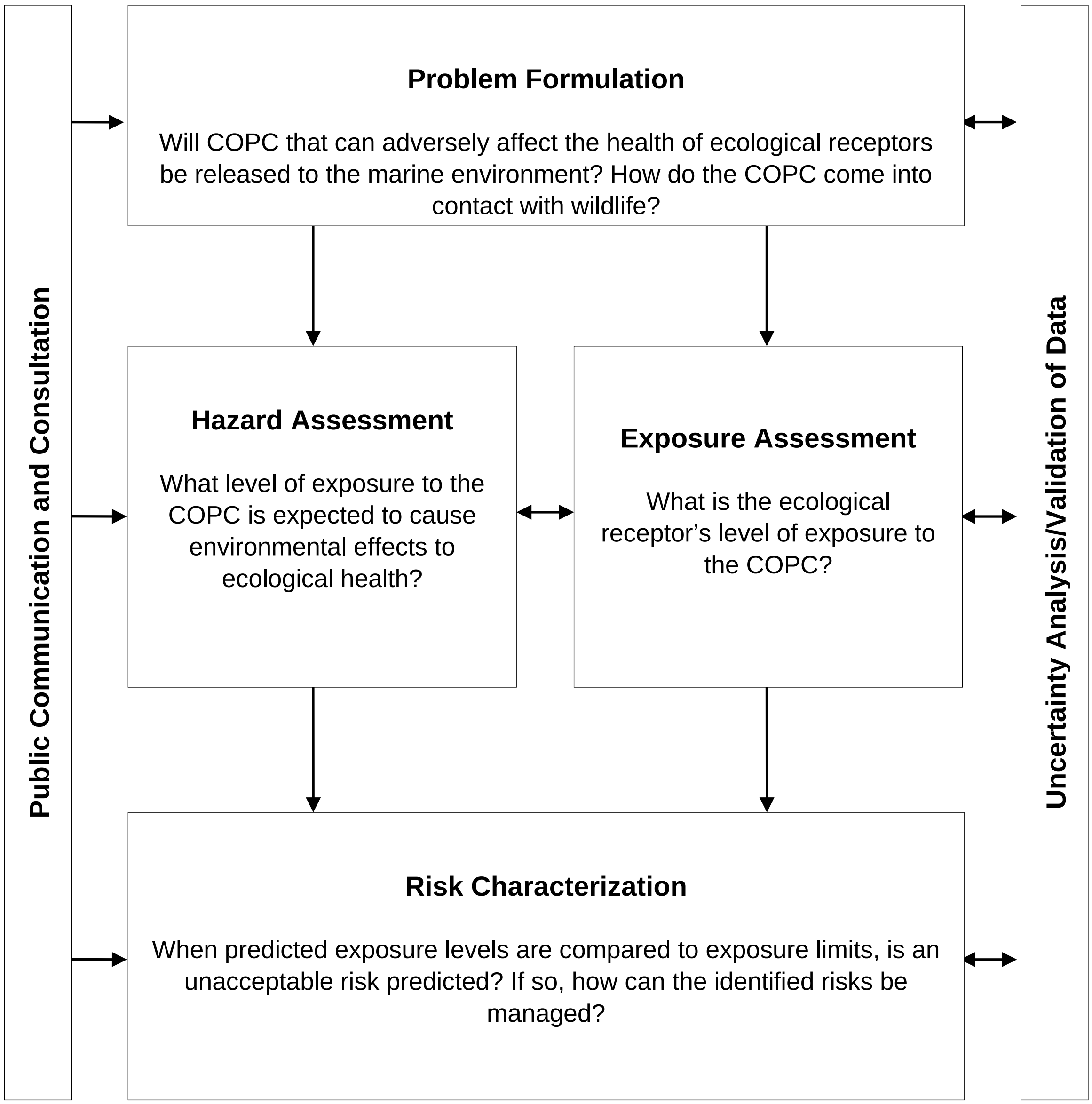
The ecological risk assessment consists of three main steps:

1. **Problem Formulation** - This is a review of available physical, chemical and biological data for the Site and receptor habitats that may be affected by releases of chemicals to environmental media. This step i) identifies potential ecological receptors (*i.e.,* biological communities, populations, individuals, or habitats potentially at risk); ii) identifies chemicals of concern and other stressors for ecological receptors; iii) identifies potential exposure pathways; and iv) identifies appropriate assessment and measurement endpoints for the ecological risk assessment. Each of these elements is integrated into a conceptual model.
2. **Analysis (Exposure and Toxicity Assessments)** - This step involves estimation of the level of exposure of the ecological receptors to the COC, and identification of the biological exposure-response standards based on the concentrations of these chemicals in various environmental media.

3. **Risk Characterization** - This is a description of the nature and magnitude of potential environmental risks, derived by comparing exposure estimates for various media, exposure-response standards for the ecological receptors, and results of the site-specific surveys and bioassays. This step also includes a discussion of the uncertainties in the analysis, an evaluation of the necessity for remedial action, and estimates of maximum chemical concentrations consistent with an acceptable level of risk (*i.e.*, SSTLs).

Following this, a discussion of the uncertainties inherent to ERA, and conclusions and recommendations stemming from the assessment are discussed. The ERA framework is conceptually illustrated in Figure 8.1.

Figure 8.1 ERA Framework



The organization of this document is consistent with these elements of an ERA.

8.4 Site Description

The Site, which covers an area of 450 hectares, is located in central Labrador, west of Lake Melville, and north of Happy Valley-Goose Bay (refer to Drawing No. 121410105-EE-01, Appendix 1). The Site is located 6 km west of the Innu Community of Sheshatshiu and is accessed via a gravel road from Sheshatshiu. The Site is fairly level, with gently sloping land. The land is covered by thick woods, mainly aspen and poplar with alder and willow in grown-in disturbed areas. Overburden on the Site consists of a mixture of sand and silty clay. Existing reports indicated that pockets of shallow perched groundwater are likely present at some areas of the Site; however, the previous groundwater investigations were not sufficient to define the groundwater depths across the entire site. Boggy areas are present in portions of the Site. Several small streams are present in the site area. The Site is bounded to the north and east, and partly to the west, by Lake Melville and to the south and partly to the west by undeveloped crown land.

The Former U.S. Military Site in Northwest Point would fall within the High Boreal Forest - Lake Melville ecoregion. This ecoregion is located on the perimeter of Lake Melville and is characterized by undulating topography and coastal plain with flat river terraces (Meade, 1985). The mean annual precipitation ranges from 800 mm to 1000 mm. Its forests are dominated by balsam fir (*Abies balsamea)*, black spruce (*Picea mariana*), white birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*). Elevations range from around sea level to about 500 m above sea level. Summers are cool and winters are cold with an average snowfall of 4.0 m.

The area surrounding the Former U.S. Military Site in Northwest Point provides habitat typical of the High Boreal Forest – Lake Melville ecoregion. The forested area would provide suitable habitat for moose (*Alces alces*) and caribou (*Rangifer tarandus caribou*) as well as small mammals such as masked shrew (*Sorex cinereus*) and several vole (*e.g*., meadow vole (*Microtus pennsylvanicus*)) species. Birds that would be expected in the area include Dark-eyed junco (*Junco hyemalis*), spruce grouse (*Falcipennis canadensis),* red-tailed hawk (*Buteo jamaicensis*) and short-eared owl (*Asio flammeus*). The Canada goose (*Branta canadensis)* as well as osprey (*Pandion haliaetus*) and bald eagle (*Haliaeetus leucocephalus*) are characteristic birds of the area that may occasionally use the freshwater habitat at Lake Melville. Aquatic fish species characteristic of the Lake Melville system including stickleback (*Gasterostreus aculeatus*), lake trout (*Salvelinus namaycush*), longnose sucker (*Catostomus catostomus*), and white sucker (*Catostomus commersonii*).

Three potential aquatic habitats exist at the Former U.S. Military Site in Northwest Point. Lake Melville (freshwater and slightly brackish) borders portions of the Lake Melville Dump Site and the Sewer Discharge site. A small freshwater stream runs through several areas of the Site and eventually drains into Lake Melville. In addition, an area of standing fresh water exists at the Lake Melville Dump Site where tadpoles were observed during the 2009 field program by Stantec.

8.5 Receptor Identification

Potential receptor habitats and receptors were identified from observations made during site visits and through a desktop review of the Site and similar sites. In addition, photography from the Site was studied to further delineate the habitat present, both in terms of the types present, and the quantities present, in the vicinity of the potentially affected areas. This information was used to identify suitable ecological receptors, referred to as valued ecosystem components (VECs), for the ERA that are likely to be exposed to stressors present at the Site.

Terrestrial habitats present at the Former U.S. Military Site in Northwest Point include disturbed areas near former building locations, roads, treed areas and cleared areas with cabins. As mentioned previously, freshwater habitats include small stream channels, an area of standing water where several tadpoles were observed, as well as the shoreline and Lake Melville.

A broad range of ecological receptors, including freshwater aquatic receptors (fish and benthic invertebrates), terrestrial mammals and birds that have been identified as potentially present at the Site have been assessed in this ERA.

Freshwater fish and benthic invertebrates were assessed as a community rather than as individual species. Toxicity benchmarks for these organisms are commonly derived based on COC media concentrations and the adverse effects thresholds for organisms that reside/rely on those media. Additionally, these benchmarks are typically generated using toxicity data for not one, but several species that rely on that medium, and are intended to represent a COC concentration that will be protective of most, if not all species associated with that medium.

It should be noted that many ditches were observed at the Site. Surface water and sediment samples considered in the aquatic ecological risk assessment included only those collected from the stream, Lake Melville and the area of standing water at the Lake Melville Dump Site where tadpoles were observed (*i.e.*, samples collected from ditches and manholes were disregarded). Samples considered in the ERA include sediment sample 09-SED7 and surface water sample 09-SW7 which were collected from the stream by Stantec in 2009 as well as surface water samples SW1 to SW6 collected from streams on the Site by AMEC in 2000/2001. Sediment sample 09-SED6 and surface water sample 09-SW6 which were collected from the standing water at Lake Melville Dump Site were also considered in the ERA. Sediment samples SSM-1 to SSM-6 and surface water samples SWM-1 to SWM-6 which were collected from Lake Melville by Stantec in 2009, were also considered.

The following terrestrial mammalian species were identified as ecological receptors for quantitative risk evaluation in the ERA:

- masked shrew (*Sorex cinereus*);
- meadow vole (*Microtus pennsylvanicus*);
- Arctic hare (*Lepus arcticus*); and
- red fox (*Vulpes vulpes*).

Large wildlife receptors, such as caribou, were also considered but not included as VECs. These animals, although they may occasionally wander onto the Site, have very large home ranges, and would have very little overall exposure to COCs on site, in comparison with other herbivore VECs (such as the Arctic hare and meadow vole) that have been modelled. Therefore, the present study is designed to provide an accurate picture of current conditions and potential risks, and considers a broad range of ecological habitats and potential receptors.

The following avian species were identified as ecological receptors for quantitative risk evaluation in the ERA and are considered representative of other species potentially present at the Site:

- American robin (*Turdus migratorius*);
- Short-eared owl (*Asio flammeus*); and

- Osprey (*Pandion haliaetus*).

The Canada Goose and Bald Eagle have larger home ranges than the abovementioned avian species, and would have lower exposure to COCs; therefore, they are not considered in the ERA.

For terrestrial receptors that include surface water ingestion as an operable exposure pathway, all accessible surface water supplies including ditches were considered in the ecological risk assessment.

For the assessment of semi-aquatic birds (*i.e*., osprey), only surface water and sediment from Lake Melville were considered because osprey would spend a majority of their time in the vicinity of Lake Melville.

8.5.1 Rare, Threatened, or Endangered Species and Species of Special Concern

The Short-eared owl (*Asio flammeus*) in Newfoundland and Labrador has been reported in tundra, coastal barren, sand dune, field and bog habitats. This species is designated as a "Vulnerable" species in Newfoundland and Labrador under the provincial *Endangered Species Act* (NL ESA E-10.1, 2001). It was also assessed as a species of "Special Concern" in Canada (Committee on the Status of Endangered Wildlife in Canada (COSEWIC), April 1994), and is listed as a species of "Special Concern" under the federal *Species at Risk Act* (*SARA*, Schedule 3). The Short-eared owl is not protected under the Canada-U.S. Migratory Birds Convention, and is listed as an "Appendix 2" species under the Convention on International Trade of Endangered Species (CITES). There has been a long term decrease in this species in Canada but the population is not small enough to be considered threatened. The populations are still stable in the Atlantic Provinces (Government of Newfoundland and Labrador, 2010). Because the Short-eared owl may make occasional use of the Former U.S. Military Site in Northwest Point, this species was considered a representative bird in this ecological risk assessment and is being treated as a sensitive species (see below on how benchmarks are adjusted for sensitive species).

The Harlequin Duck (*Histrionicus histrionicus*) is a small, subarctic sea duck that is listed as "Special Concern" by COSEWIC, as "Special Concern" under Schedule 1 of *SARA,* and as "Vulnerable" under the *Provincial Endangered Species Act*. Satellite telemetry and banding information have indicated that the migration patterns of Harlequin Ducks are variable but many of them spend the winter on the east and south coasts of Newfoundland, in southeastern Nova Scotia, in southern New Brunswick, in Maine, and at a few locations south of Cape Cod (Government of Canada, 2010). Breeding habitat includes fast flowing rivers that may vary in width across the species range. In Labrador, these ducks may breed in narrow, warmer, less acidic rivers (Rodway, 1998). It is estimated that there are two hundred ducks that winter off the coast of Newfoundland and Labrador. There is no Harlequin duck habitat (*i.e.*, rivers) on the Former U.S. Military Site in Northwest Point. Therefore, it is considered unlikely that this species would spend substantial time on the Site.

The subject site also falls within the range of the Red Wine Mountains herd of woodland caribou (*Rangifer tarandus caribou*) which is reported to contain less than 100 animals. This species is designated as a "Vulnerable" species in Newfoundland and Labrador under the provinces *Endangered Species Act* (NL ESA E-10.1, 2001). The species is listed under Schedule 1 of *SARA* as "Threatened". Caribou were not assessed in this ecological risk assessment. A herbivorous small mammal (*i.e.*, Arctic hare) which has a smaller home range was assessed.

The eastern population of wolverine (*Gulo gulo*) is thought to extend from Northern Quebec into most of Labrador. It is probable that it has been extirpated from most of its historical range in Eastern Canada. This species is designated as an "Endangered" species in Newfoundland and Labrador under the province's *Endangered Species Act* (NL ESA E-10.1, 2001). The species is also listed as "Endangered" by COSEWIC and "Endangered" under Schedule 1 of *SARA*. It is unlikely that wolverine would spend substantial time in the Northwest Point area as wolverines tend to prefer remote areas far away from humans and development (Canadian Wildlife Service, 2010). In addition, wolverines have very large ranges and would therefore have very little overall exposure to COCs on the Site.

8.5.2 Valued Ecosystem Components (VECs)

Valued ecosystem components are defined as resources or environmental features important to human populations that have economic and/or social value, and/or have intrinsic ecological significance. These components also provide a baseline from which the impacts of development can be evaluated, including changes in management or regulatory policies.

Aquatic receptors considered to be VECs in this ecological risk assessment are fish and benthic invertebrate communities. Risks to these VECs will be determined primarily by reference to CCME guidelines or equivalent benchmarks. For the purposes of this ERA, amphibians will be considered to be equivalent to fish.

For the terrestrial ecological risk assessment, the following terrestrial mammals can be regarded as representative species for the Site:

Masked shrew: The masked shrew (*Sorex cinereus*) is the most widely distributed shrew in North America, and is found throughout most of Canada (Lee 2001). It is common in moist environments and inhabits open and closed forests, meadows, riverbanks, lakeshores, and willow thickets (Lee 2001). The masked shrew weighs approximately 0.005 kg (US EPA 1993) and has home ranges varying from 2,000 to 6,000 m^2 in size (Saunders 1988). Masked shrews are preyed upon by many small predators such as weasels, hawks, falcons, owls, domestic cats, foxes, snakes, and short-tailed shrews (Lee 2001). The masked shrew does not hibernate (NWF 2003) and feeds year-round. Its diet includes insect larvae (dormant insects in winter), ants, beetles, crickets, grasshoppers, spiders, harvestmen, centipedes, slugs, snails, and seeds and fungi (NWF 2003; Lee 2001). It consumes approximately 0.003 kg of wet-weight food per day and 0.001 L of water or its equivalent per day. For this ERA, the shrew's diet is modeled as including 2.5% terrestrial plant material and 97.5% terrestrial invertebrates. Based on its consumption of these foods, the masked shrew is estimated to incidentally ingest 4.44E-05 kg/day of dry soil.

Meadow Vole: The meadow vole (*Microtus pennsylvanicus*) is a small rodent (approximately 0.042 kg) which makes its burrows along surface runways in grasses or other herbaceous vegetation (US EPA 1993). It is active year-round and is the most widely distributed small grazing herbivore in North America, inhabiting moist to wet habitats including grassy fields, marshes, and bogs (US EPA 1993). Meadow voles are found throughout Canada, roughly to the limit of the tree line in the north. Home ranges vary considerably, from less than 200 m^2 to greater than 830 m^2 (US EPA 1993). Meadow voles are a major prey item for predators such as hawks and foxes, and they feed primarily on vegetation such as grasses, leaves, sedges, seeds, roots, bark, fruits, and fungi, but will occasionally feed on insects and animal matter (US EPA 1993; Neuburger 1999). Meadow voles consume approximately 0.011 kg of wet-weight food and 0.006 L of water or its equivalent per day. For this ERA, the meadow vole's diet is modelled as including 98% terrestrial plant material and 2% terrestrial invertebrates. Based on its consumption of these foods, the meadow vole is estimated to incidentally ingest 3.15E-04 kg/day of dry soil.

Credit: US Fish and Wildlife Service

Arctic Hare: The Arctic hare (*Lepus arcticus*) is found north of the treeline in Canada to the northernmost point of land on Ellesmere Island, Northwest territories, and also on the rock-strewn plateaus and mountains of eastern Newfoundland and Labrador (Best and Henry, 1994). The home ranges of Arctic hares occupy about 2.5 km^2 (Canadian Museum of Nature, 2010). Woody plants are the basic year-round food of the Arctic hare (Hansen and Flinders, 1969) with their main food being Arctic willow (*Salix arctica*) in both winter and summer and they eat all parts of the plant (Klein and Bay, 1994; Canadian Museum of Nature, 2010). Arctic hare are also known to occasionally eat meat (Johnson, 1953) and have been found eating meat used as bait for traps (Freuchen, 1935) and nibbling on carcasses or foraging in garbage dumps (Canadian Museum of Nature, 2010). Foxes, owls and wolves may prey on Arctic hare. Arctic hare consume approximately 0.7 kg of wet-weight food per day and 0.4 L of water or its equivalent per day. For this ERA, the Arctic hare's diet is modelled as including 95% terrestrial plant material and 5% terrestrial mammals and birds. Based on its consumption of these foods, the Arctic hare is estimated to incidentally ingest 5.0E-03 kg/day of dry soil.

Red Fox: The red fox (*Vulpes vulpes*) weighs approximately 4.5 kg, and is found throughout continental Canada but prefers areas with broken and diverse upland habitats (US EPA 1993). Family territories, consisting of home ranges of individuals from the same family, vary from approximately 0.57 km^2 to over 30 km^2 (US EPA 1993). Foxes are active year-round and prey heavily on small mammals such as voles, mice and rabbits, and will consume birds, insects, fruits, berries, and nuts; they are also noted scavengers (US EPA 1993). Red foxes consume approximately 0.76 kg of wet weight food per day and 0.38 L of water or its equivalent per day. For this ERA, the red fox's diet is modeled as including 10% terrestrial plant material, 5% terrestrial invertebrates, and 85% small mammal and bird prey. Based on its consumption of these foods, the red fox is estimated to incidentally ingest 3.00E-03 kg/day of dry soil.

The following bird species can be regarded as representative species for the Site:

American Robin: The American robin (*Turdus migratorius*) is a medium-sized bird (weighing approximately 0.08 kg; US EPA, 1993) that occurs throughout most of Canada during the breeding season and overwinters in mild areas of Canada (CWS & CWF 2005). Access to fresh water, protected nesting habitat, and foraging areas are important to the American robin. Nesting habitat includes moist forest, swamps, open woodlands, orchards, parks, and lawns (US EPA 1993), and the American robin is well adapted to urban living, as well as having a summer range that extends up to the tundra. The American robin consumes approximately 0.065 kg of wet weight food and 0.01 L of water or its equivalent per day. For this ERA, the American robin's diet is modelled as including 52.3% terrestrial plant material and 47.8% soil invertebrates. Based on its consumption of these foods, the American robin is estimated to incidentally ingest 4.85E-04 kg/day of dry soil.

Short-eared Owl: The Short-eared owl (*Asio flammeus*) is widespread throughout all of North America, and is one of the most widely distributed owls in the world (Doan 1999), although it may be considered a species of special conservation status in some jurisdictions. The Short-eared owl weighs approximately 0.35 kg. Found in open, treeless areas, this species is a daylight and twilight hunter found in marshes and bogs and uses similar habitats during the summer and winter (Doan 1999). Short-eared owls have relatively small home ranges of approximately 0.15 km^2 to 2 km^2 (Lewis 2005) during the breeding season. Short-eared owls nest on the ground on dry sites in open country where small mammal prey is abundant (Doan 1999). In addition to small mammals such as voles and mice, Short-eared owls also prey upon birds and occasionally insects (Lewis 2005). They consume approximately 0.09 kg of wet weight food per day and 0.03 L of water or its equivalent per day. The Short-eared owl's diet is modeled as including 95% small mammals and 5% terrestrial invertebrates. Based on its consumption of these foods, the Short-eared owl is estimated to incidentally ingest 3.63E-04kg/day of dry soil. As noted above, this species is designated as a “Vulnerable” species in Newfoundland and Labrador under the provincial *Endangered Species Act* (NL ESA E-10.1, 2001), is of “Special Concern” in Canada (Committee on the Status of Endangered Wildlife in Canada (COSEWIC), April 1994) and listed as a species of “Special Concern” under the federal *Species at Risk Act* (*SARA*, Schedule 3).

Credit: US Fish and Wildlife Service

Osprey: The Osprey (*Pandion haliaetus*) is one of the most widely distributed bird species in the world and is found on ocean coasts and along the shorelines of large lakes and rivers (Canadian Wildlife Service, 2010). In Canada, ospreys are present from April to October (Jamieson *et al.* 1982). The osprey is a bird of prey that feeds mainly on freshwater species are sucker, pike, and pickerel of moderate size (Canadian Wildlife Service, 2010). They will consume approximately 0.3 kg of wet weight food per day and 0.08 L of water or its equivalent per day. The osprey's diet is modelled to include 99% freshwater fish and 1% terrestrial mammals and birds. Based on its consumption of these foods, the osprey is estimated to incidentally ingest 9.0E-06 kg/day of dry soil.

8.6 Hazard Identification

The ERA is concerned primarily with substances that are present in environmental media that are accessible to wildlife or aquatic biota. Therefore, the available data for the Site were screened to consider data for surface soils (0 to 30 cm depth) as well as freshwater sediments and surface waters. Subsurface soil and groundwater samples were not considered in the ERA, although they were considered in the Human Health Risk Assessment (HHRA). Therefore, although both the HHRA and the ERA draw from the same overall dataset, they are not based on identical subsets from that data.

In addition to sampling water, sediment, and soils, certain biological materials were also collected at the Former U.S. Military Site in Northwest Point and were analysed for selected high-priority COCs in order to reduce overall uncertainty that would otherwise be incorporated into the ERA model. These biological materials and analytes included:

- vegetation (primarily green leaves, grasses, moss analysed for PCBs);
- berries (analysed for metals and PCBs);
- small mammals (analysed for metals and PCBs); and,
- freshwater fish (analysed for metals and PCBs).

Data not included in the ecological assessment consisted of QA/QC samples such as field blanks, trip blanks, and matrix spike samples, and surrogate recovery results. For duplicate samples, the higher reported value from the duplicate pair was incorporated into the data set. As stated previously, sediment and soil samples that were collected from a depth greater than 30 cm were not included in the data set because ecological receptors would not regularly contact soil and sediment at this depth.

8.6.1 Screening of Chemicals of Concern

Chemicals of concern were selected based on their concentration in surface soil, surface water and sediments, and their potential toxicity to ecological receptors (*i.e.*, metals and PCBs measured in plants, mammals and fish). An initial generic assessment of the potential for adverse effect associated with site-originated chemicals was conducted. In this assessment, the maximum detected concentration from each environmental medium in each area was compared to established environmental criteria (*i.e.*, "screening values") that are designed for the protection of ecological receptors.

The following values were used for the screening of chemicals in surface water and sediment for inclusion in the aquatic ecological risk assessment:

- Surface Water: Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, 1999, updated 2007); and,
- Sediment: Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1999, updated 2002).

The following screening values, in order of preference, were used for the screening of chemicals in soil for inclusion in the terrestrial ecological risk assessment:

- CCME Canadian Soil Quality Guidelines for Residential/Parkland land use for protection of environmental health (1999, revised 2007, 2008, 2009 and 2010). Pathway-specific information from the individual fact sheets was reviewed to confirm ecological health guidelines;
- CCME Canada Wide Standards Tier I levels for surface soil for Residential/Parkland land use (2008);
- Alberta Environment Tier I and II Soil Remediation Guidelines for Residential/Parkland land use, ecological guidelines (2009); and,
- Ontario Ministry of the Environment guidelines for soil at a Residential site, ecotoxicity-based values (2004).

Maximum site concentrations were initially compared to the screening guidelines discussed above. Chemicals with concentrations that were less than the screening guideline were not carried forward for further assessment. Where an applicable guideline did not exist and a substance was detected in measurable concentrations, the substance was carried forward to the next step in the screening framework, which was a comparison to background concentrations.

If concentrations exceed an applicable guideline, it does not necessarily mean that unacceptable risks exist. Concentrations of each chemical were also compared to background concentrations. If the concentration of a chemical was considered comparable to the selected background concentrations and therefore represented a natural local condition, the chemical was not carried forward any further in the risk assessment. Where no background concentrations were available, the substance was carried forward to the next step in the screening framework.

Substances that are major mineral forming elements of low inherent toxicity, or that are nutrients and of low inherent toxicity were excluded as chemicals of concern. These included aluminum, iron, manganese, calcium, magnesium, sodium, potassium, chloride, nitrate, nitrite, phosphorus, silica and sulfate. Elevated concentrations of iron and manganese can be associated with the discharge areas for chemical plumes in groundwater, particularly plumes of organic substances that can degrade in the environment and consume oxygen. Surface deposits of iron and manganese in wetlands or stream beds are typically readily identified by iron staining (typically a rusty orange deposit). These deposits are typically not hazardous to wildlife receptors by themselves, although substances associated with the groundwater plume may be. However, such areas are typically identified in the field and sampled as areas of potential contamination. Therefore, for the purpose of this ERA, iron and manganese are considered non-hazardous, and it is assumed that any associated contaminants (such as heavy metals, TPH, PAHs, or solvents) will be identified and assessed on a substance-specific basis.

Limited toxicity information exits for bismuth, boron, lithium, rubidium, and strontium. These elements often occur naturally or are associated with seawater spray. The presence of low concentrations of these metals is unlikely to be a result of historical site activities.

8.7 Hazard Identification Results – Aquatic ERA

As discussed previously, three potential aquatic habitats exist within the Former U.S. Military Site in Northwest Point, these being Lake Melville, a small stream which runs through various areas of the Former U.S. Military Site and empties into Lake Melville, and an area of standing water at the Lake Melville Dumpsite where tadpoles were observed. The columns under the heading “Screening” in Tables 24.1 and 24.2 (Appendix 24) present the ecological screening for petroleum hydrocarbons and metals in sediment and surface water following the screening framework outlined above. For aquatic receptors, the risk assessment was limited to the separate consideration of the specific concentrations of substances in water or sediment that exceeded relevant guidelines or benchmarks. As mentioned previously, surface water and sediment samples considered in the aquatic ecological risk assessment included only those collected from the stream, Lake Melville and the standing water at Lake Melville Dump Site where tadpoles were observed (*i.e.*, did not include those collected from ditches and manholes).

Chemicals in surface water and sediment carried forward for further assessment at each aquatic site are summarized in Table 8.1. All other substances analysed for in the sediment and surface water of each aquatic habitat are either 1) not of toxicological concern, 2) were non-detectable in all samples, 3) in the event that they were detected, the maximum value was below the screening guideline, or 4) concentrations are comparable to background concentrations.

Table 8.1 Chemicals in sediment and surface water carried forward for further assessment in the aquatic ecological risk assessment

Site	Chemicals Requiring Further Assessment	
	Sediment	Surface Water
Stream, Lake Melville, Standing Water	TPH, Aluminum, Barium, Cobalt, Lead, Nickel, Uranium, Vanadium	TPH, Barium, Cadmium, Chromium, Cobalt, Copper, Lead

It should be noted that the reportable detection limits for antimony, arsenic, beryllium, bismuth, selenium, thallium, tin, uranium, and/or vanadium from Maxxam Analytics were elevated in surface water samples SWM-1 to SWM-6. This was because of sample matrix effects due to bromide and chloride present in the samples, likely due to the brackish nature of Lake Melville.

8.8 Hazard Identification Results – Terrestrial ERA

Given the size of the Former U.S. Military Site in Northwest Point and the complex pattern of anthropogenic contamination within the area, the Site was assessed differently for terrestrial VECs with small home ranges than for terrestrial VECs with large home ranges. The home range for Arctic hare, Short-eared owl, American robin and osprey are considered large enough so that it is likely that these VECs would spend substantial time foraging over the entire Former U.S. Military Site. Therefore, when determining exposure for these VECs, the chemical data for each medium for the entire site were compiled. The maximum concentration identified in this dataset was used for screening purposes. If the maximum concentration identified exceeded the screening guideline, the chemical was carried forward. All the site data were used to calculate an EPC that these VECs would be exposed to. It is conservatively assumed that these VECs would spend all their time (except for migratory animals), within the Study Area exposed to the EPC.

The home ranges for masked shrew, meadow vole and red fox are potentially smaller than the Site. It is therefore possible that these VECs could spend their entire life in one particular portion of the Site. Therefore, the Site was separated into two smaller areas (shown on Drawing No. 121410105-EE-24a) for assessment. These areas include:

- North Area (0.50 km^2): Dock Road Drum Storage Site, Lake Melville Dump Site, Sewer Discharge Area, Helicopter Pad Site, Underground Pipeline, Innu Healing Ground
- South Area (0.56 km^2): North Bulk Fuel Storage Site, Oil Shed Site, West Generator Site, Service Site, Transmitter Building Site, East Generator Site, Camp Road Dump Site, South Bulk Fuel Storage Site, East Bulk Fuel Storage Site, Camp Road Drum Storage Site

The data for each of the sites within each Area were compiled and the maximum concentration from the Area was used for screening purposes. The dataset for each Area was used to calculate an EPC that these VECs would be exposed to. It is further conservatively assumed that these VECs would spend all their time, within the area assessed exposed to the EPC. It is recognized that the home ranges of the vole (as small as 0.0002 km^2) and the shrew (may range from 0.0002 km^2 to 0.0006 km^2) are smaller than the Areas assessed. This was necessary, however, because few surface soil samples were collected from several sites. It was considered more representative to combine sites that are within close proximity to calculate an EPC.

As discussed in the human health risk assessment, concentrations of several metals including chromium, copper, lead, and zinc were elevated in one soil sample (09-SS14) from Camp Road Dump Site but were not elevated in any other samples. Metal debris was noted to be present in this area. This test pit is considered an anomaly for several metals and the results may skew the EPCs for metals such as molybdenum and tin. Therefore, the analytical results from this soil sample were not included in the calculations and the risk assessment. Instead, recommendations will be made later in this report to remove the soil and associated debris from this area. This soil sample is not included further in the ecological risk assessment.

Tables 24.3 to 24.5 (Appendix 24) present the ecological screening for petroleum hydrocarbons, PCBs, PAHs, and metals in soil following the screening framework outlined above. Chemicals in surface soil carried forward for further assessment at each Area are summarized in Table 8.2. All other substances analysed for in the soil at each Area are either 1) not of toxicological concern, 2) were non-detectable in all samples, 3) in the event that they were detected, the maximum value was below the screening guideline, or 4) concentrations are comparable to background concentrations.

Table 8.2 Chemicals in soil carried forward for further assessment in the terrestrial ecological risk assessment.

Site	Chemicals Requiring Further Assessment
	Soil
North Area:	TPH, PAHs, PCBs, Molybdenum, Tin
South Area:	TPH, PAHs, Tin
Whole Site:	TPH, PAHs, PCBs, Molybdenum

For mammals and birds, it is not realistic to assess the potential effects of a substance in one medium, to the exclusion of other media. This is because the dose to the receptor organism may exceed a critical level if doses from all media are summed, regardless of whether the concentration in any one medium was within an acceptable range or not. Therefore, when assessing exposure of mammals and birds, if a substance was carried forward for one medium, it was also carried forward for the other media.

8.9 Statistical Summary for COCs Carried Forward

The ESA process results in positively biased data, because the majority of samples are collected at locations where contamination is expected, or to delineate known areas of contamination. As a result, relatively few samples are usually taken from areas of the Site where human impacts have been minor or negligible, and the data will tend to overstate or over-represent the true presence and concentration of COCs in soil and other media.

In addition to this inherent source of conservatism, an additional layer of conservatism is introduced through statistical analysis of the data. The primary purpose of the statistical analysis is to determine representative exposure point concentrations (EPCs) for estimating potential risks associated with COCs in the various media. The EPC is an estimate of a reasonable upper limit value for the average chemical concentration in the medium, determined for each exposure unit (US EPA, 1989). The appropriate upper confidence limit (UCL) provides reasonable confidence that the true site average will not be under estimated (US EPA, 1992). ProUCL 4.0 (US EPA, 2007) was used to determine the appropriate upper confidence limit (UCL) given the specific distribution of the Site specific analytical results data.

At several sites, limited data were available for certain chemicals carried forward. If the number of samples analysed was less than ten, the maximum was used as the EPC. Where a chemical was not detected in any sample for one medium, but the concentration exceeded the screening guideline in another, the substance was assessed at half the detection limit in the former medium. EPCs are presented in Tables 24-1 to 24-5, Appendix 24.

8.10 Exposure Assessment

In order for chemicals to have adverse effects on organisms, they need to gain access to the organism or receptor. The route by which this occurs is referred to as an exposure pathway, and is dependent on the nature of both the chemical and receptor. A complete exposure pathway is one that meets the following four criteria (US EPA, 1989):

- a source of COC must be present;
- release and transport mechanisms and media must be available to move the chemicals from the source to the ecological receptors;
- an opportunity must exist for the ecological receptors to contact the affected media; and
- a means such as ingestion, inhalation, or direct contact. must exist by which the chemical is taken up by ecological receptors.

The sources of the COCs for the study area are:

- surface soils distributed throughout the Site;
- freshwater sediment and surface water associated with streams and ponds at the Site;
- terrestrial and aquatic plants, soil and aquatic/sediment invertebrates, fish and small mammals and birds consumed as prey items by VECs.

Subsurface soils and groundwater were not considered as potential sources of COC exposure. There are no direct exposure pathways for ecological receptors for either of these environmental media and transport of contaminants from these sources to surface soil was expected to have a negligible contribution.

An exposure route is the mechanism by which a receptor species might be exposed to a chemical from a given source medium. For surface soils and terrestrial receptors, including mammals and birds, exposure to COC may occur through one or more of the following routes:

- dermal contact (skin/fur/feathers) with soils;
- incidental ingestion of soil (*i.e.*, as a result of feeding or grooming and including inhalation of dusts);
- ingestion of surface water;
- ingestion of plants or prey species that have accumulated chemicals from the soil; or,
- inhalation of volatile contaminants migrating from the soil to ambient air.

The inhalation pathway is typically of negligible importance for wildlife receptors in open air situations. Therefore, inhalation of vapours has not been considered a significant exposure pathway for the ERA at the Site. Ingestion of dust and soil particles through feeding and grooming activities, however, is assumed to also implicitly account for both dermal contact and inhalation of dust.

In aquatic habitats, exposure of birds and mammals to contaminants in surface water and sediment may occur through the following routes:

- dermal contact with surface water and sediment;
- ingestion of surface water;
- incidental ingestion of sediment (*i.e.*, as a result of feeding or grooming); or,
- ingestion of aquatic prey species (amphibians, fish and/or invertebrates) that have accumulated chemicals from sediment or surface water.

Although in some cases aquatic plants are considered in an ERA, at the Site there were no significant stands of aquatic plants (weedbeds or reed-beds) that justified their inclusion in the present case.

Aquatic and sediment dwelling species such as amphibians, fish, invertebrates, and plants are subject to equivalent exposure pathways as those listed for birds and mammals. However, exposure pathways for the former are more typically limited to direct contact with surface water and sediment. This is primarily for practical reasons since quantitative data describing exposure factors and food-web interactions between aquatic species is incomplete, and contaminant aquatic toxicity is typically expressed in terms of either concentration in surface water or sediment. Deriving an exposure rate (mg/kg-day) for a fish would be difficult and of limited value for the risk assessment. The ingestion and related food-web pathways are not ignored. It is simply assumed that these pathways have been included in the overall guideline or benchmark that is assumed to be protective for these biota.

The choice of site-specific exposure pathways is dependent on the nature of the contaminants, their source environmental media, and nature of VECs being considered in the ecological risk assessment.

8.11 Conceptual Site Model

A conceptual site model was developed for the Former U.S. Military Site in Northwest Point, and is presented in Figure 24-1 in Appendix 24. This figure schematically represents the interactions between the VECs and the COCs, via the exposure pathways identified in previous elements of the problem formulation phase of the assessment. In Figure 24-1, the relevant exposure pathways are designated by arrows leading from the contaminant source media to each VEC. The pathway is considered to be complete (*i.e.*, functioning) for a VEC when the exposure pathway box is marked with an X.

8.12 Selection of Assessment and Measurement Endpoints

Assessment endpoints are explicit expressions of environmental values or characteristics to be protected at a site, and reflect societal and ecological values (Suter, 1993). Societal values address the need to protect species that are endangered, threatened, or of special interest, important as game or commercial species, or that are recognized as having aesthetic value. Ecological relevance refers to the importance of the species to the function of the ecosystem. Therefore, evaluation of potential for adverse effects at the population level (*i.e.*, the entity) is used to infer potential for adverse effects at higher levels of organization, such as communities and ecosystems. For the Site, assessment endpoints (*i.e.*, the attribute) implicitly focus on populations of aquatic organisms such as plants, fish and invertebrates that may be reduced due the presence and concentrations of chemicals of concern in surface water and sediments. For birds and mammals inhabiting the Site, assessment endpoints also focus on maintenance and protection of their populations, such that contaminants in the surface water, sediment and soil would not substantially affect either species abundance or diversity.

Based on the conceptual model for each ecological habitat, the following assessment endpoints are identified for the ecological risk assessment:

- Assessment Endpoint 1: Populations of aquatic invertebrates and fish should not be reduced as a result of increased mortality or decreased reproduction because of the presence of COCs in surface water or sediments.
- Assessment Endpoint 2: Populations of birds or mammals should not be reduced as a result of increased mortality or decreased reproduction because of the presence of COCs in soils, sediment or surface water.

The information needed to deal directly with the assessment endpoints is difficult to generate and rarely available. Thus measurement endpoints are used to bridge the gap. Measurement endpoints are measurable responses to stressors related to assessment endpoints, and are intended to provide a basis for assessing risk potential for the assessment endpoint. They may be defined in terms of an unacceptable level of impact to ecological receptors, such as a certain relative percent decrease in survival, growth or reproduction of ecological populations (Suter, 1993). As part of a weight-of-evidence approach, one or more measurement endpoints may be used for each assessment endpoint.

Choice of measurement endpoints for each interaction between a VEC and a chemical of concern is typically limited by available toxicity data. Those most commonly used to quantify the survival, growth and reproduction of receptors in bioassays include the lethal concentration, 50% (LC50) and lethal dose, 50% (LD50) (concentrations or doses that will be lethal to 50% of exposed organisms, over a defined period of exposure); the effective concentration, 50% (EC50) and effective dose, 50% (ED50) (concentrations or doses that elicit a defined response or effect over a defined period of time); the Lowest Observed Adverse Effect Level (LOAEL); and the No-Observed Adverse Effect Level (NOAEL). Although the dose-response relationships derived from these measurement endpoints are characteristic of test species exposed under controlled conditions, appropriate safety factors are included in order to consider the response of species in the natural environment.

The measurement endpoints for each ecological habitat type in this assessment are as follows.

Measurement Endpoints for Assessment Endpoint 1:

- Whether observed concentrations of chemicals in surface water or sediment are likely to result in increased mortality or decreased reproduction of fish, or decreased biomass, species richness, or diversity of aquatic invertebrates upon chronic exposure.

Measurement Endpoints for Assessment Endpoint 2:

- Whether observed concentrations of chemicals in water, sediment or soils are likely to results in doses to birds or mammals that are greater than those observed to result in increased mortality or decreased reproduction upon chronic exposure.

Therefore, the key component of this ecological risk assessment is:

- Characterization of relationships between the dose resulting from the amount of a chemical present in surface water, sediment and surface soils and a threshold dose for adverse effects.

8.13 Derivations of Oral Toxicity Reference Values for Mammalian and Avian Receptors

The toxicological database in support of a toxicity reference value (TRV) preferably includes a number of chronic or multi-generational exposure studies involving exposure of relevant test species (*i.e.*, the ecological receptor of interest or a phylogenetically similar species) to appropriate chemical forms of the substance of interest. Ideally, one or more relevant biological endpoints such as growth, reproductive effects, or survival were measured in the study. Databases that meet this requirement are available for some chemicals, but in most cases, available toxicity data are limited to studies conducted with laboratory animals (*e.g.*, mammals: mice, rats, rabbits; birds: quail, chicken, ducks).

TRVs for this ERA are based on dose-response studies, typically conducted with laboratory animals where the lowest observed adverse effects level (LOAEL) or no observed adverse effects level (NOAEL) has been quantified. Toxicity reference values used in this risk assessment were determined from studies in which endpoints were derived from the administered dose, rather than the absorbed dose. This is a conservative approach because compounds are often administered in a more available form than would be found in the environment

The preferred toxicity measure used for derivation of TRVs in this ERA is the LOAEL; however, in the absence of a suitable LOAEL, NOAEL-based TRVs were used. Generally, LOAELs used towards TRV derivation are based on long-term growth or survival, or sub-lethal reproductive effects determined from chronic exposure studies. As such, these endpoints are relevant to the maintenance of wildlife populations. The LOAEL represents a threshold dose at which adverse outcomes are likely to become evident (Sample *et al*. 1996). This threshold is considered an appropriate endpoint for ERA because TRVs are used as the denominator in the hazard quotient (HQ) calculation, and HQs equal to or greater than one may be considered indicative of potential adverse environmental effects. Hazard quotients calculated with NOAEL-based TRVs are more conservative because NOAELs relate to the threshold at which no individual environmental effects from COC exposure are observed.

Numerous sources were reviewed to obtain the most relevant TRVs for ecological receptors. Information sources included, but were not limited to:

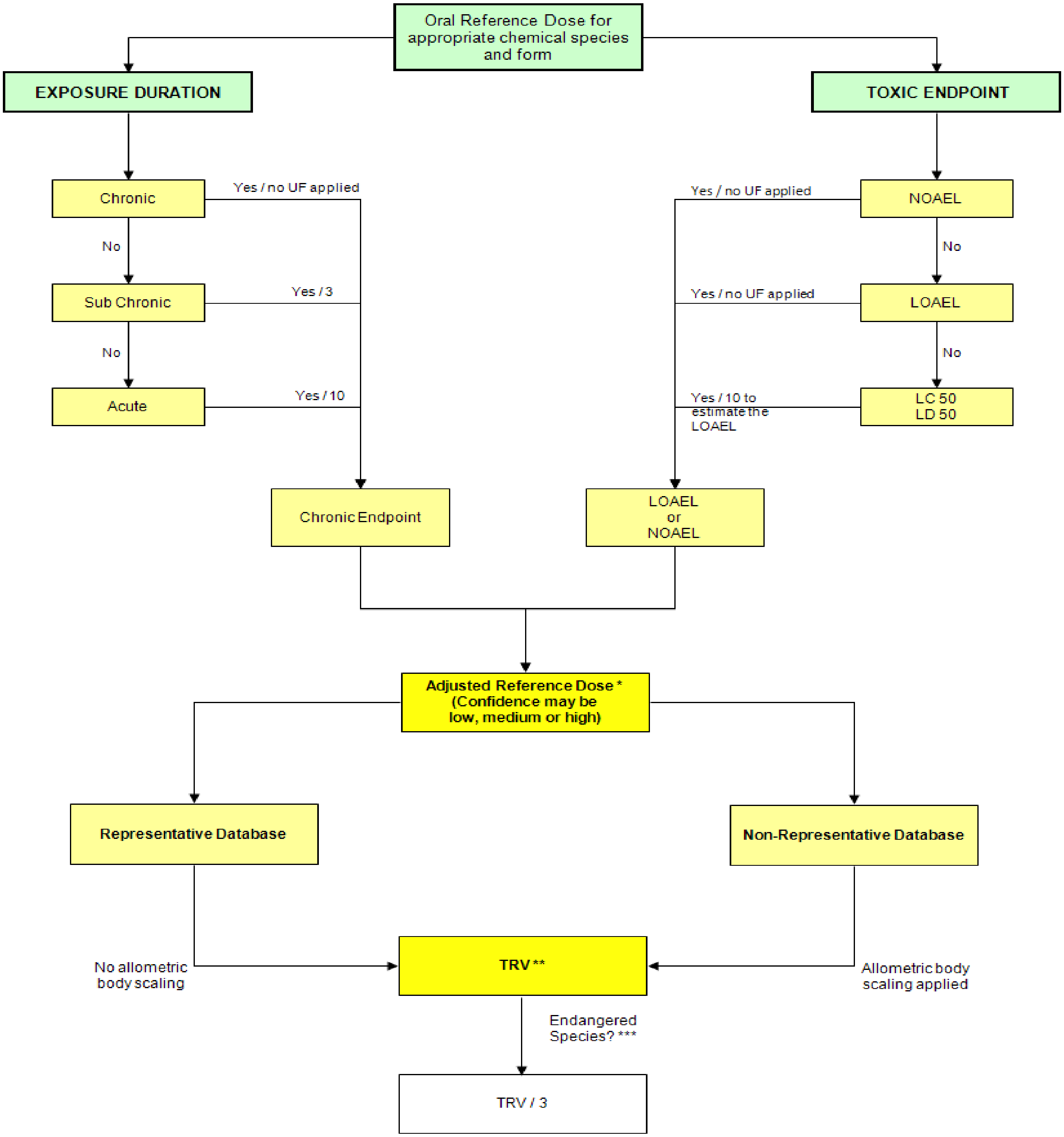
- Oak Ridge National Laboratory Toxicity Benchmarks for Wildlife (Sample *et al*. 1996);

- US Environmental Protection Agency's Ecological Soil Screening documents;
- Agency for Toxic Substances and Disease Registry (ATSDR);
- Canadian Environmental Protection Act (CEPA), Priority Substance List Assessment Reports; and
- primary scientific literature.

8.13.1 Uncertainty Factors

For COCs where LOAELs or NOAELs were not available, sub-chronic or acute toxicity measures such as median lethal dose (LD50) were obtained and modified using Uncertainty Factors (UFs) to convert these values to surrogate chronic values. Chronic LOAEL data derived from studies that assess reproductive, survival, or growth endpoints, as the basis for predicting wildlife population-level responses to contaminants is preferred. The LOAEL-based benchmark represents a threshold level at which adverse health outcomes are likely to become evident (Sample *et al*. 1996). The use of the LOAEL is appropriate because a TRV based on the LOAEL is used as the denominator in the hazard quotient (HQ) calculation, and HQ greater than 1.0 are considered indicative of potential adverse environmental effects. In cases where no chronic LOAEL is available, a NOAEL toxicity value may be selected, or UFs may be applied to other existing exposure and toxicological data using a tiered process to derive suitable ecological TRVs. When TRVs are based on US EPA Ecological Soil Screening Levels (Eco-SSLs), NOAELs are often the selected endpoint, but can vary depending on the chemical. The UF scheme outlined here (Figure 8.2) is based on guidance provided by Ohio EPA (2003, 2008), US EPA (2002), Sample and Arenal (1999) and professional judgment.

Figure 8.2 Tiered Approach for the Application of Uncertainty Factors in ERA



* A NOAEL can be used if no appropriate LOAEL is available but the resultant RfD should be considered more conservative than if it was derived using the LOAEL. Refer to document text for details.

** No inter-class UF is used to derive TRVs (*i.e.*, mammalian data are not used as the basis to derive avian TRVs)

*** An UF of 3 is not required if the RfD for an endangered species is based on a NOAEL. Refer to document text for details.

8.13.2 Uncertainty Factors for Exposure Duration

In cases where a search of scientific data indicates a lack of chronic studies for a particular COC, UFs may be applied to adjust toxicity data to a chronic exposure basis. Acute studies are those that are of short duration, generally less than one week. Sub-chronic exposures are of longer duration (generally less than 90 days), but may be considered equivalent to a chronic study if a critical life stage (such as the gestational period) is included. Chronic exposures would generally be greater than 90 days in length, exceeding 50% of the animal's lifespan, or including a reproductive period. An UF of 3 (half an order of magnitude on a log scale) is applied to adjust from sub-chronic to chronic, and 10 to adjust from acute to chronic. It should be noted that preference is given to longer duration exposure assessments in cases where published data are available, and acute data are relied on only when absolutely necessary.

8.13.2.1 Uncertainty Factors for Toxicity Endpoint

In cases where a search of scientific data indicates the absence of reproductive or other performance-based toxicity endpoints that would indicate a potential for adverse environmental effects at the population level, other less sensitive toxicity endpoints may be considered. Where only a lethal dose (LD50) is available, an UF of 10 (an order of magnitude) is applied to derive a LOAEL from LD50 data. Again, it should be noted that preference is always given to sub-lethal data, and lethal data are relied on only when absolutely necessary.

NOAELs are not adjusted upwards to estimate LOAELs. Where the only chronic endpoint available is a NOAEL, it is used directly and reported as such in the discussion of uncertainties. Hazard quotients based on the NOAEL may be permitted to exceed a value of 1.0 because the NOAEL is not an endpoint that signifies toxicological effects.

8.13.2.2 Uncertainty Factors for Individual Risk

In ERA, the focus of the assessment is normally to provide protection for wildlife at the population level. This is in contrast to human toxicology and human health risk assessment, where protection of individuals is of paramount concern. An exception to this, which has regulatory force through federal legislation such as the *Species at Risk Act* and equivalent legislation in most provinces, occurs when species that are formally protected are evaluated. To ensure that endangered species are afforded an appropriate level of protection in ERA, TRVs that are based on the NOAEL, or LOAEL with an UF of 3 applied are used. This is an arbitrary value based on professional judgment and is expected to be protective yet realistic. The two approaches (i.e., NOAEL or LOAEL) are considered to be equivalent, and are intended to ensure that endangered wildlife receptors are not exposed to levels of COCs that would cause an adverse effect at the individual level.

8.13.2.3 Body Mass Scaling Factors

Aside from the use of UFs, a number of other methods have been used to extrapolate toxicity data between species with different body masses. The application of acute-based extrapolation factors (derived using lethal dose, 50% (LD50), hazardous dose, 5% (HD5), and standard deviation) to reproductive toxicity data (*e.g.*, Luttik *et al*. 2005), interspecies correlation estimation (ICE) models (Raimondo *et al*. 2007) and allometric scaling (Travis and White 1988; Chappell 1992; Mineau *et al*. 1996, Sample and Arenal 1999) have all been used in ERA. Each of these methods has positive and negative attributes, and none is without its drawbacks for extrapolating toxicity data between laboratory and wildlife species. Ultimately, the choice in method for use in an ERA comes to scientific defensibility, practicality, and professional judgment. In this ERA, an allometric scaling factor of body mass raised to the exponent of 0.75 for both mammalian and avian receptors in the ERA is applied. The allometric scaling factor should hold true in any direction, however, to maintain conservatism in the ERA, a large test animal is not scaled to a much smaller receptor animal, which could potentially inflate the TRV.

8.14 Exposure Assessment

To evaluate the level of exposure for each ecological receptor to each potential COC evaluated in the terrestrial ERA, it is necessary to first estimate the concentration of each COC in various media or biological tissues (*e.g.*, for the current site, this would include soil, water, and representative plant and animal tissues). Soil, surface water, sediment, fish, small mammals, terrestrial vegetation samples were analysed for metals and/or PCBs. Other COCs (*e.g.*, TPH) were not analysed in biological tissues because they are not considered to bioaccumulate.

To estimate the potential environmental effects at the Site for each receptor, EPC values for soil, terrestrial plants, soil invertebrates, and small mammals were either calculated using site data where such data exists or in the absence of such data, were calculated using environmental fate and transport equations or uptake factors which describe the relationships between chemical concentrations in environmental media and concentrations in biota. In the following sections, details of the equations and methods used to derive EPC values for biota (where no such data exist for the Site) in the ERA are discussed.

The term “uptake factor” (UP) may be used generically in this document to refer to any of several specific terms, including:

- Bioaccumulation Factor (BAF), the ratio of a COC concentration in an organism or biological tissue (*e.g.*, a soil invertebrate) to the concentration in a surrounding medium (*e.g.*, soil); and
- Bioconcentration Factor (BCF), a specific term that refers to the ratio of a COC concentration in an aquatic organism (*e.g.*, fish) to the concentration in the surrounding water.

Common sources of error in environmental fate and transport calculations involve confusion between wet and dry weight units for chemical concentrations in soil, sediment, and biota, and unit errors stemming from the fact that inorganic substances are commonly reported in units of milligrams (mg/L or mg/kg) in environmental media, whereas many organic substances are reported in units of µg (micrograms), ng (nanograms), or even pg (picograms). To manage these problems in this ERA, all chemical concentrations are converted to units of mg/L or mg/kg. For water, all chemical concentrations and intakes are based on units of mg/L. For soil or sediment, all concentrations are expressed on a dry weight basis (mg/kg dry weight soil or sediment). For plant and animal tissues, all concentrations are expressed on a wet weight basis (mg/kg wet weight tissue).

The uptake factor literature is likewise inconsistent, with some uptake factors being expressed on a wet tissue basis, others on a dry tissue basis, and still others being normalized on the basis of tissue lipid to sediment organic carbon content. The ERA model requires EPC values on a wet tissue basis for biota that are ingested as foods by ecological receptors. Therefore, where possible, uptake factors are expressed on a wet tissue basis; where necessary, correction factors are applied in order to convert from dry weight tissue units to a wet tissue basis.

8.14.1 Biological Uptake Factors

The generalized uptake factor equation used to calculate a COC concentration in an organism or biological tissue (*e.g.*, soil invertebrates) from the concentration in a surrounding medium (*e.g.*, soil) is as follows:

$$EPC_j = EPC_i \times UP_{ij}$$

Where:	EPC_j	=	exposure point concentration in biological compartment *j* (*e.g.,* mg/kg wet weight soil invertebrate tissue);
	EPC_i	=	exposure point concentration in environmental medium i (*e.g.,* mg/kg dry soil); and
	UP_{ij}	=	uptake factor from surrounding medium (in this case soil) to the target biological tissue (*e.g.,* mg/kg wet tissue / mg/kg dry soil).

8.14.1.1 Soil to Terrestrial Plants, UP_{SP}

Most uptake factors are initially reported in dry weight units (*i.e.*, mg/kg dry weight plant / mg/kg dry weight soil) and converted to wet weight for plants by assuming an 85% water and 15% dry solids content (typical value for dicots; US EPA 1993). The conversion is effected by multiplying dry weight transfer factors obtained empirically or from the literature by the fraction dry solids content, typically assumed to be 0.15 for herbaceous terrestrial plants.

Bioavailability of selected compounds to plants may be modified using a soil-to-plant bioavailability factor (unitless, potentially ranging from 0 to 1). This empirically represents factors that limit the potential for organic compounds to cross the soil-root barrier, where this is not already factored into the uptake models based on empirical data. Compounds that have a high tendency to sorb to soil solids become inactivated or have low bioavailability. Graham-Bryce (1984) noted that this occurs for substances that have K_d values greater than 1000 L/kg, and Ryan *et al.* (1988) relate this to organic compounds having log K_{ow} values of between 5 and 6, or greater. The Ryan *et al*. (1988) model reflects variable bioavailability by including partitioning and competition between soil organic carbon and plants for uptake of organic contaminants in soil pore water. Presently, the bioavailability factor is set at 1 (*i.e.*, all contaminants are fully bioavailable).

In addition to having limited bioavailability, some organic compounds are also potentially metabolized by plants, or may be volatilized across plant leaf surfaces. Therefore, the potential loss of selected organic compounds from plant tissues can be represented using an empirical metabolic factor (unitless, potentially ranging from 0 to 1). Presently, this factor is set at 1 for all contaminants (*i.e.*, contaminants are not metabolized or volatilized).

Organic Compounds

Soil-to-terrestrial-plant uptake factors UP_{SP} for organic compounds are generally based on the model of Ryan *et al*. (1988), although for selected compounds, UP_{SP} are derived from *Attachment 4-1, Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs)* (US EPA 2007, Table 4b).

PAHs

For PAHs, compound-specific regression models are based on soil concentration or point estimators derived from measured data (US EPA, 2007). PAHs were classified as either low molecular weight (LMW; *i.e.*, less than or equal to 3 benzene rings) or high molecular weight (HMW; greater than 3 benzene rings) and class specific equations were calculated (US EPA 2007 Figure 4). Rinsed foliage equations were adopted for this model as soil or sediment ingestion by receptors is accounted for elsewhere in the model. These equations (US EPA 2007) are as follows:

$$\text{LMW PAHs: } UP_{SP} = e^{(4.544 \times \ln[Csoil] -1.325)} / [C_{soil}]\text{; and,}$$
$$\text{HMW PAHs: } UP_{SP} = e^{(0.9469 \times \ln[Csoil] - 1.7026)} / [C_{soil}].$$

These models apply to soil concentrations ranging from 1×10^{-8} mg/kg to 100 mg/kg above and below which the uptake factor is set to the respective limiting value (*e.g.,* for concentrations above 100 mg/kg dw, the UP_{sp} is set to a concentration of 100 mg/kg dw).

Inorganics

Trace element uptake factors from soil to plant tissue are based on a combination of constant uptake factors, or where available, regression-based uptake factors that take into consideration the underlying concentration in soil.

UP_{SP} models for inorganic elements were derived from *Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants* (Bechtel Jacobs 1998) where available (*i.e.,* barium, copper, lead, nickel and zinc).

8.14.1.2 Soil to Terrestrial Invertebrates UP_{SI}

Uptake factors for soil-to-terrestrial invertebrates (UP_{SI}) are generally reported for earthworms due to the availability of information in the literature, and a relative paucity of information with regards to insects. The ERA, therefore, focuses on earthworms as the "model" soil invertebrate, due to the relative abundance of data and models to predict contaminant uptake, as well as the perceived importance of earthworms in food webs.

The UP_{SI} are estimated in dry weight units (*i.e.,* mg/kg dry soil invertebrate / mg/kg dry soil) and are converted to wet weight where necessary assuming that the fresh earthworm contains 84% water and 16% dry solids (typical value for earthworms (US EPA 1993)).

Organics

The soil-to-earthworm bioaccumulation model for the organic compounds is derived from US EPA (2007) as based upon Jager (1998), presented here to give the uptake factor on the dry weight basis for the earthworm (mg/kg dw tissue / mg/kg dw soil) and is calculated as:

$$UP_{SI} = ((f_{water} + (f_{lipid} \times K_{ow})) / (F_{oc} \times K_{oc})) / 0.16$$

Where: f_{water} is the water content of the worm (0.84),

f_{lipid} is the lipid content of the worm (0.01),

f_{OC} is the fraction of organic carbon in soil (assumed to be 0.01), and

K_{OC} is the water to organic carbon partitioning coefficient (L/kg OC).

The value 0.16 is the dry solids content of the worm. Log KOW values were obtained from various sources and Log KOC values were calculated as Log Kow x 0.41.

Bioavailability and metabolic factors (unitless) for use with this equation as multipliers before calculating the final concentration in earthworms were estimated based on K_{OW}. Estimated values for bioavailability range from 0.1 to 1 while values for metabolic factor range from 0.05 to 1.

Inorganics

Soil-to-earthworm bioaccumulation models for inorganic elements were derived (on a dry weight basis) from Sample *et al.* (1998a), for the following COCs:

Molybdenum: $UP_{SI} = 0.953$

Tin: $UP_{SI} = (e^{(-0.218 + 0.807 * \ln(Csoil))}) / C_{soil}$

8.14.1.3 Soil or Plant to Terrestrial Animals, UP_{SA}

Concentrations of contaminants in small mammals are generally estimated using uptake or biotransfer factors directly from soil, or in some cases using biotransfer factors from feed (vegetation). Uptake factors (UP) are technically dimensionless and direct (*i.e.*, mg/kg dry weight mammal / mg/kg dry weight soil). Biotransfer factors (BA) are slightly different, with units of day/kg, and are multiplied by a soil or feed intake rate (kg/day) to generate an uptake factor, which is then multiplied by the contaminant concentration in the soil or feed (mg/kg) to estimate the concentration in the animal. It is very important to maintain consistency in wet weight or dry weight units.

To ensure this consistency, all uptake factors are initially reported in dry weight units (*i.e.*, mg/kg dry weight mammal / mg/kg dry weight soil) and subsequently converted to wet weight assuming that small mammals typically have approximately 68% water content and 32% dry solids content (data for small mammals; US EPA 1993). The conversion to wet-weight mammal units is accomplished by multiplying dry-weight transfer factors by the dry solids fraction of 0.32 for small mammals.

For biotransfer factors for organic contaminants, the most recent literature (*e.g.*, US EPA 2005b and RTI 2005) focuses on transfer from feed to lipid fraction in the animal. The lipid content of small mammals on a dry matter basis varies considerably, both seasonally and between species, with low-range values of <3% recorded for snowshoe hares, and high-range values of >40% recorded for Guinea Pig (Dierenfeld *et al*. 2002). Typical lipid content values for wild voles and mice appear to be in the range of 20% (of dry weight), and this can be converted to a value of 6.4% (wet weight) and this value (0.064) will be adopted for the purposes of deriving small mammal transfer factors from feed to lipid and whole body. Thus, where the biotransfer factor has provided an estimate of the contaminant concentration in the lipid fraction of a small mammal, multiplying this value by a correction factor of 0.064 will convert to whole animal wet weight units.

Organics

TPH and PAHs

For reasons that will be explained below, biotransfer into small mammal tissues for some organic contaminants is modeled on the basis of measured or expected contaminant concentration in feed (plant tissue) as well as from soils. Thus, the soil-and-plant-to-animal (SPA) biotransfer factor is defined as BA_{SPA} (day/kg). Note that this approach does not apply to dioxins and furans, or pentachlorophenol.

The uptake factor for soil and plant to animals (UP_{SPA}, mg/kg wet weight animal / mg/kg soil or plant) for TPH and PAHs was derived from BA_{SPA} values obtained following "*Methodology for Predicting Cattle Biotransfer Values*" (RTI 2005). This work was performed by Research Triangle Institute (RTI) on behalf of the United States Environmental Protection Agency, and is endorsed by the US EPA through the *Human Health Risk Assessment Protocol*. A key assumption is that the best available predictor of the contaminant concentration in small mammal tissues would be the contaminant concentration in a cow occupying the same habitat. Because the available BA_{SPA} values were developed for cattle, and must be multiplied by feed or soil intake rates and concentrations in order to convert them to animal tissue values, the appropriate feed ingestion rate is that of cattle. To multiply by the feed ingestion rate of individual VEC organisms, which range in weight from <10 g to more than 10^5 g, would make the expected contaminant concentration in tissues directly proportional to the feed ingestion rate, which is clearly not appropriate.

The UP_{SPA} value can therefore be visualized as the product of the cattle biotransfer factor (BA_{SPA}, day/kg, from RTI 2005) and the cattle food or soil ingestion rates (kg/day). When multiplied by the contaminant concentrations in the soil and feed (mg/kg) the result is the predicted contaminant concentration for the lipid compartment in cattle (mg/kg lipid). As always, careful attention to wet weight and dry weight units in the application of this approach is essential.

The biotransfer factor from soil or plant to animal (BA_{SPA}) is thus estimated as:

$$BA_{SPA} = 0.064 \times 10^{((-0.099 \log Kow^2) + (1.07 \log Kow) - 3.56)}$$

Where 0.064 is the lipid content of the small mammal relative to its wet weight (Dierenfeld *et al*. 2002); and the remaining equation (from RTI 2005) predicts the tendency for an organic contaminant compound to be concentrated in lipid, as a function of the log K_{OW} value. Note that the lipid fraction identified here for small mammals is lower than the lipid fraction for cattle as defined by RTI (2005). The equation is valid in the range of log K_{OW} values between -0.67 and 8.2, and the log K_{OW} values outside this range should be capped at the upper or lower range limits, respectively.

It is important also to note that the equation developed by RTI (2005) is applicable to organic compounds that are both bioavailable (*i.e.*, readily absorbed from feed), and relatively persistent (*i.e.*, resistant to metabolic breakdown and excretion). It is noted by RTI (2005) that many compounds are susceptible to breakdown and excretion, and such compounds were methodically removed from the database used to develop the equation predicting BA_{SPA} values. Further, it is noted by RTI (2005) that metabolic factors ranging from 0 to 1 can be implemented to better predict the bioaccumulation of non-persistent organic compounds, and that one such value of 0.01 has already been developed by the US EPA for bis(2-ethylhexyl)phthalate to reduce the predicted tendency to bioaccumulate by two orders of magnitude. Factors to represent bioavailability and metabolism will therefore be applied to those organic compounds that are considered to have low bioavailability or persistence as follows (refer to Table 8.3).

The expected contaminant concentration in small mammals is then estimated based on cattle tissue concentrations as:

$$C_{mammal} = BA_{SPA} \times ((60 \times C_{plant}) + (0.4 \times C_{soil})) \times B_i \times M_i$$

Where C_{mammal} is the contaminant concentration in animal tissue (mg/kg wet weight), BA_{SPA} is the biotransfer factor from soil or plant to animal (day/kg), 60 is the plant feed intake rate (60 kg wet weight/day for cattle), C_{plant} is the contaminant concentration in plants (mg/kg wet weight), 0.4 is the soil ingestion rate (0.4 kg dry weight/day for cattle), C_{soil} is the contaminant concentration in soil (mg/kg dry weight), B_i is the bioavailability of the contaminant in feed and soils (unitless, ranging from 0 to the default value of 1), and M_i is the metabolic factor for the contaminant (unitless, ranging from 0 to the default value of 1).

As a further check on bioconcentration by small mammals, which have relatively short life spans compared with cattle, a mass limitation is imposed on the bioaccumulation of contaminants. This mass limitation is based on the meadow vole, assuming a median 90 day lifespan (US EPA 1993), the daily food ingestion rate (0.011 kg wet weight/day), the daily soil ingestion rate (3.15E-04 kg dry weight/day) and the contaminant concentrations in wet food and dry soil, respectively. No credit is taken for metabolic losses or excretion of contaminants. The total lifetime contaminant intake (mg) is divided by the body mass of the meadow vole (0.042 kg) to derive the maximum theoretical contaminant concentration in meadow vole tissues (C_{max}) as: $C_{max} = (90 \times ((0.011 \times C_{plant}) + (0.000315 \times C_{soil})) \times B_i) / 0.042$, where C_{max} is lower than C_A, C_{max} is selected as the maximum possible contaminant concentration in small mammal tissues.

Table 8.3 Correction Factors for Bioavailability and Metabolism of Organic Compounds from Plant Foods by Small Mammals

Chemical or Chemical Class	Bioavailability Correction Factor	Rationale	Metabolic Correction Factor	Rationale
PAHs 3-ring 4-ring 5-ring	 1 1 1	Bioavailability decreases with increasing molecular size.	 0.1 0.1 0.5	Potential to be metabolized decreases with increasing molecular size.

Note: Bioavailability and metabolic factors apply only to organic compounds, and for inorganic substances (elements) are defined as 1.0 in all circumstances. These correction factors are based upon professional judgment.

Inorganics

Uptake from soil to animals (UP_{SA}) for inorganic substances is generally modeled directly (based on correlations or empirical regressions), without direct consideration of concentrations in plant tissues. Values for UP_{SA} for inorganic elements were derived from regression equations presented by Sample *et al*. (1998b) where available (*i.e.,* for As, Cd, Cr, Zn).

It is important to note that for those elements where regression equations are used, the resulting uptake factors are dependent upon the concentrations of the respective elements in soil. These equations should therefore only be used within realistic concentration ranges. For example, when estimating risk due to very small incremental inorganic element loadings, it may be necessary to first estimate risk for the baseline element concentration, and then to add the incremental concentration and re-estimate risk to determine the risk of the incremental concentration by difference.

Uptake factors or regression equations were not available for all elements. Therefore, biotransfer from soil or plant to animal (BASPA) point estimates for some elements were derived from A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture (Baes *et al*. 1984). These BASPA values were handled in the same manner as for most organic compounds to derive expected concentrations in small mammals based upon exposure of cattle to ingested soil and plant materials, except that metabolic factor is required to have a value of 1.0 because inorganic elements are not metabolized.

$$C_{mammal} = BA_{SPA} \times ((60 \times C_{plant}) + (0.4 \times C_{soil})) \times B_i \times M_i$$

As for organic contaminants, C_{max} can also be calculated, and where the estimated C_{mammal} value is greater than C_{max}, C_{max} is selected as the mass-limited concentration in small mammal (meadow vole) tissues.

8.15 Risk Characterization

Risk characterization is the final step of an ecological risk assessment. It includes a quantification of the potential nature and magnitude of adverse effects that may occur to receptor species due to the presence of chemicals in identified ecological habitats at the Site. In this step characterization of exposure and characterization of ecological effects for each chemical, are integrated into quantitative estimates (ecological hazard quotients or EHQ values) of the potential for adverse effects to ecological receptors.

8.15.1 Approach

The potential for adverse effects is quantified by comparing the dose of a substance that can be tolerated, or below which adverse effects are not expected (*i.e.*, TRV), to the expected daily dose, the amount of a COC an organism is expected to be exposed to on a daily basis (*i.e.*, average daily dose (ADD)). The ratio of the two is referred to as an ecological hazard quotient (EHQ), and the magnitude by which values differ from unity (*i.e.*, TRV = daily dose) is used to make inferences about the possibility of ecological risks. For birds and mammals, the exposure measure is the total ingested dose (mg/kg-day) summed over all exposure pathways. For the assessment of potential risk to community-based receptors (*e.g.*, benthic invertebrates and fish), the EPC of the associated environmental media (*e.g.*, sediment or surface water) is divided by a toxicological benchmark (rather than dividing an ADD by a TRV, as was done for birds and mammals).

An EHQ of <1.0 indicates that the exposure concentration is less than the threshold for adverse effects, and a low probability exists that adverse effects might occur. Given the overall tendency to introduce conservatism (through the use of data or assumptions that are likely to overstate, rather than understate risk) into risk assessments, it is likely no adverse effect would occur. Alternatively, an EHQ of >1.0 does not automatically indicate that there is an unacceptable level of risk. In this case, the conservative approach reduces the certainty of this conclusion, and dictates a need for more careful review of both predicted exposure levels and exposure limit derivations. As a result, EHQs greater than 1.0 should be examined carefully, and further more focused investigations may be required to reduce conservatism and provide a more realistic assessment of the actual risk level before selecting a risk management approach.

Occupancy factors are an estimate of the time spent at the subject site and estimate the time that an ecological receptor will be exposed to a contaminated area. Occupancy factors can be based on many factors including home range and migratory behaviors of the ecological receptor. For the current assessment, it is assumed that the masked shrew, meadow vole, red fox, Arctic hare, and Short-eared owl have 100% exposure to the impacted portions of the Site. Taking the migratory patterns into account, it is assumed that the osprey and the American robin would spend 50% of their time on the Site.

For the purposes of this assessment, the conservative assumption is made that each of the animals listed above will spend all of its time foraging at the Site, even though in many cases the home range size or migratory movements of the animals will take them elsewhere for some portion of the year. Further, they are assumed to be exposed to the EPC of each COC in water, sediments, and/or soil (as appropriate) at all times. In addition, the foods they consume are assumed to have grown or fed on media exposed to the EPC of each COC at all times. Therefore, this preliminary set of calculations has been completed in a highly conservative manner.

8.15.2 Risk Characterization for Aquatic Receptors

Exposure point concentrations of those substances that were identified as requiring further assessment during the hazard identification stage (Section 8.8) were subsequently compared to toxicological benchmarks intended for screening COCs for potential effects on aquatic biota. These benchmarks (where available) have been tabulated with the maximum and EPC values for the retained COCs in Tables 24.1 and 24.2 (under the heading "risk assessment") in Appendix 24. EHQs were calculated by comparing the concentrations of COC to the toxicological benchmark. COCs in sediment and surface water that exceed their applicable benchmark for each site are shown in Table 8.4. Only TPH in sediment and surface water were identified as potentially unacceptable risks. Potentially adverse effects due to aluminum concentrations were identified in one surface water sample as a result of a low pH (4.55). This surface water sample was collected in the vicinity of the sewage outfall and the low pH is likely attributable to runoff from the sewer.

Table 8.4 Magnitude of Impacts for Chemicals in Aquatic Habitats at the Former U.S. Military Site in Northwest Point

Site	Sediment	Surface Water	Magnitude of Impacts
Streams	TPH	TPH	TPH in sediment: One sediment sample (09-Sed-7 – 610 mg/kg) from an on-site stream exceeded the benchmark of 500 mg/kg Additional delineation would be necessary to determine the extent of the impacts. One sediment sample from the standing water at the Lake Melville Dump Site (09-SED-06 – 690 mg/kg) where tadpoles were observed exceeded the benchmark of 500 mg/kg. TPH in surface water: Two samples (SW1 (AMEC, 2000) and SW3 (AMEC, 2001) – 1.1 mg/L exceeded the benchmark of 1.1 mg/L.

8.15.3 Discussion of Risk Characterization for Aquatic Receptors

The ecological risk assessment indicated that there is potential for adverse effects to aquatic biota from exposure to TPH in the vicinity of 09-SED-7 which was collected from a stream on the Site. It is unknown if TPH impacts in the stream are localised because other stream samples were not collected in 2009. Additional delineation is necessary to determine the extent of the impacts. Two surface water samples collected by AMEC in 2000 and 2001 (SW1 and SW3) had a concentration of 1.1 mg/L. It is unknown whether impacts remain in this area of the stream as no samples were collected here during the 2009 sampling program. It is also uncertain if TPH impacts exist in sediment in the vicinity of these surface water samples because no sediment samples were collected by AMEC.

TPH concentrations in sediment sample 9-SED-06 which was collected from a standing water body at Lake Melville Dump Site where tadpoles were observed (690 mg/kg), also exceeded the benchmark of 500 mg/kg. This TPH concentration represents a potentially adverse risk to aquatic ecological receptors.

8.16 Risk Estimates for Avian and Mammalian Receptors – Whole Site

As discussed in Section 8.9, the American robin, Short-eared owl, Arctic hare and Osprey are considered to have a large home range and were thus assessed using chemical data from the entire site. A summary of the total EHQ for each VEC is provided in Tables 8.5 to 8.8. Tables showing the derivation of risk estimates for each VEC can be found in Appendix 24. The text below provides a synopsis of the risk estimates for each VEC. A summary of the total EHQ for each VEC is provided, with a detailed breakdown of the contribution of each exposure pathway provided in Appendix 24.

Risk Estimates for American Robin

For the American robin, the intake pathways include soil ingestion, terrestrial invertebrate ingestion, surface water ingestion and terrestrial plant ingestion. The robin feeds on invertebrates and berries. The American robin is assumed to forage over the entire site area and not just in impacted areas. Taking the migratory patterns into account, it is assumed that the American robin would spend 50% of their time on the Site.

As shown in Table 8.5, the risk (EHQ) for TPH and PCBs for the American robin exceeds 1.0 thus indicating a potentially adverse risk for American robin exposed to these COCs at the Former U.S. Military Site in Northwest Point.

Table 8.5 Total Ecological Hazard Quotients for the American Robin

Chemical	EHQ	Target EHQ
Total TPH	**7.8**	1.0
PCBs	**1.7**	1.0
PAHs	NA	1.0
Molybdenum	0.0068	1.0

Notes: For PAHs, there is insufficient data to define TRVs for avian receptors. However, available evidence (Kapustka, 2004) suggests that mammals are generally more sensitive to PAHs than birds, so if small mammals are protected, birds should also be adequately protected.
Bold/Shading indicates that the total calculated EHQ exceeds the target EHQ.

Risk Estimates for Short-eared Owl

For the Short-eared owl, the intake pathways include soil ingestion, terrestrial invertebrate ingestion, surface water ingestion, and mammal/bird ingestion. The Short-eared owl forages opportunistically, having been noted to also consume insects, small mammals such as muskrats, and birds. The Short-eared owl is assumed to forage over the entire site area.

As shown in Table 8.6, the risk (EHQ value) for TPH for the Short-eared owl exceeds 1.0 thus indicating a potentially adverse risk for Short-eared owl exposed to TPH at the Former U.S. Military Site in Northwest Point.

Table 8.6 Total Ecological Hazard Quotients for the Short-eared Owl

Chemical	EHQ	Target EHQ
Total TPH	**1.5**	1.0
PCBs	0.42	1.0
PAHs	NA	1.0
Molybdenum	0.0068	1.0

Notes: For PAHs, there is insufficient data to define TRVs for avian receptors. However, available evidence (Kapustka, 2004) suggests that mammals are generally more sensitive to PAHs than birds, so if small mammals are protected, birds should also be adequately protected.
Bold/Shading indicates that the total calculated EHQ exceeds the target EHQ.

Risk Estimates for Osprey

For the osprey, the intake pathways include soil ingestion, terrestrial mammal/bird ingestion, freshwater fish ingestion, surface water ingestion, soil, and sediment ingestion. The osprey is assumed to forage over the entire site area.

As shown in Table 8.7, risks (EHQ values) for the osprey were less 1.0 for all of the substances assessed. Given the high level of conservatism built into the assessment, risks associated with other substances are not considered to be significant. It is concluded that the Site poses no significant risk to osprey or other piscivorous avian species.

Table 8.7 Total Ecological Hazard Quotients for the Osprey

Chemical	EHQ	Target EHQ
Total TPH	0.54	1.0
PCBs	0.078	1.0
PAHs	NA	1.0
Molybdenum	0.000081	1.0

Notes: For PAHs, there is insufficient data to define TRVs for avian receptors. However, available evidence (Kapustka, 2004) suggests that mammals are generally more sensitive to PAHs than birds, so if small mammals are protected, birds should also be adequately protected.
Bold/Shading indicates that the total calculated EHQ exceeds the target EHQ.

Risk Estimates for Arctic Hare

For the Arctic hare, the intake pathways included soil ingestion, terrestrial plant ingestion, surface water ingestion and terrestrial mammal/bird ingestion. The Arctic hare feeds mainly on plants, but also consumes some meat as minor components of the diet. The Arctic hare is assumed to forage over the entire site area.

As shown in Table 8.8, the risk (EHQ value) for TPH for the Arctic hare exceeds 1.0 thus indicating a potentially adverse risk for Arctic hare exposed to TPH at the Site.

Table 8.8 Total Ecological Hazard Quotients for the Arctic hare

Chemical	EHQ	Target EHQ
Total TPH	**3.9**	1.0
PCBs	0.14	1.0
PAHs	0.079	1.0
Molybdenum	0.057	1.0

Note: Bold/Shading indicates that the total calculated EHQ exceeds the target EHQ.

Risk Characterization for Mammalian Receptors with Small Home Ranges

As discussed in Section 8.9, the Site was separated into smaller areas for assessment of VECs with smaller home ranges (red fox, masked shrew and meadow vole). Tables showing the derivation of risk estimates for these receptors can be found in Appendix 24. The text below provides a synopsis of the risk estimates for each VEC. A summary of the total EHQ for each VEC is provided, with a detailed breakdown of the contribution of each exposure pathway provided in Appendix 24.

South Area

Risk Estimates for Red Fox

For the red fox, the intake pathways included soil ingestion, terrestrial plant ingestion, terrestrial invertebrate ingestion, surface water ingestion and terrestrial mammal ingestion. The red fox feeds mainly on small mammals, but also consumes some invertebrates and plant material as minor components of the diet. Due to the small home range of this mammal, an occupancy factor of 1.0 was applied, which assumes that the fox spends all of its time in the impacted area.

As shown in Table 8.9, risks (EHQ values) for the red fox were less 1.0 for all of the substances assessed. Given the high level of conservatism built into the assessment, risks associated with other substances are not considered to be significant. It is concluded that the South area poses no significant risk to red fox.

Table 8.9 Total Ecological Hazard Quotients for the Red Fox

Chemical	EHQ	Target EHQ
Total TPH	0.75	1.0
PAHs	0.0055	1.0
Tin	0.013	1.0

Note: Bold/Shading indicates that the total calculated EHQ exceeds the target EHQ.

Risk Estimates for Masked Shrew

For the masked shrew the intake pathways include soil ingestion, terrestrial plant ingestion, surface water ingestion and terrestrial invertebrate ingestion. The masked shrew feeds mainly on soil invertebrates, with vegetation included as a minor component of the diet. Due to the small home range of this mammal, an occupancy factor of 1.0 was applied, which assumes that the shrew spends all of its time in the impacted area.

As shown in Table 8.10, the risk (EHQ values) for the masked shrew exceeds 1.0 for TPH thus indicating a potentially adverse risk for a masked shrew exposed to TPH at the South area.

Table 8.10 Total Ecological Hazard Quotients for the Masked Shrew

Chemical	EHQ	Target EHQ
Total TPH	**6.2**	1.0
PAHs	0.081	1.0
Tin	0.023	1.0

Note: Bold/Shading indicates that the total calculated EHQ exceeds the target EHQ.

Risk Estimates for Meadow Vole

For the meadow vole, which is a herbivore, the intake pathways included soil ingestion, terrestrial plant ingestion, surface water ingestion and terrestrial invertebrate ingestion. The meadow vole eats fresh grasses, sedges, herbs, bark, roots and fruit as well as a variety of seeds and grains. Voles may also sometimes eat insects. Due to the small home range of this mammal, an occupancy factor of 1.0 was applied which assumes that the vole spends all of its time in the impacted area.

As shown in Table 8.11, the risk (EHQ value) for the meadow vole exceeds 1.0 for TPH thus indicating a potentially adverse risk for a meadow vole exposed to TPH at the South site.

Table 8.11 Total Ecological Hazard Quotients for the Meadow Vole

Chemical	EHQ	Target EHQ
Total TPH	**4.3**	1.0
PAHs	0.0035	1.0
Tin	0.0050	1.0

Note: Bold/Shading indicates that the total calculated EHQ exceeds the target EHQ.

North Site

Risk Estimates for Red Fox

For the red fox, the intake pathways included soil ingestion, terrestrial plant ingestion, terrestrial invertebrate ingestion and terrestrial mammal ingestion. The red fox feeds mainly on small mammals, but also consumes some invertebrates and plant material as minor components of the diet. Due to the small home range of this mammal, an occupancy factor of 1.0 was applied which assumes that the fox spends all of its time in the impacted area.

As shown in Table 8.12, risks (EHQ values) for the red fox were less 1.0 for all of the substances assessed. Given the high level of conservatism built into the assessment, risks associated with other substances are not considered to be significant. It is concluded that the North area poses no significant risk to red fox.

Table 8.12 Total Ecological Hazard Quotients for the Red Fox

Chemical	EHQ	Target EHQ
Total TPH	0.040	1.0
PCBs	0.18	1.0
PAHs	0.068	1.0
Molybdenum	0.026	1.0
Tin	0.0013	1.0

Note: Bold/Shading indicates that the total calculated EHQ exceeds the target EHQ.

Risk Estimates for Masked Shrew

For the masked shrew the intake pathways include soil ingestion, terrestrial plant ingestion and terrestrial invertebrate ingestion. The masked shrew feeds mainly on soil invertebrates, with vegetation included as a minor component of the diet. Due to the small home range of this mammal, an occupancy factor of 1.0 was applied which assumes that the shrew spends all of its time in the impacted area.

As shown in Table 8.13, the risk (EHQ values) for the masked shrew exceeds 1.0 for PCBs thus indicating a potentially adverse risk for a masked shrew exposed to PCBs at the North area.

Table 8.13 Total Ecological Hazard Quotients for the Masked Shrew

Chemical	EHQ	Target EHQ
Total TPH	0.33	1.0
PCBs	**2.7**	1.0
PAHs	1.0	1.0
Molybdenum	0.23	1.0
Tin	0.023	1.0

Note: Bold/Shading indicates that the total calculated EHQ exceeds the target EHQ.

Risk Estimates for Meadow Vole

For the meadow vole, which is a herbivore, the intake pathways included soil ingestion, terrestrial plant ingestion and terrestrial invertebrate ingestion. The meadow vole eats fresh grasses, sedges, herbs, bark, roots and fruit as well as a variety of seeds and grains. Voles may also sometimes eat insects. Due to the small home range of this mammal, an occupancy factor of 1.0 was applied which assumes that the vole spends all of its time in the impacted area.

As shown in Table 8.14, risks (EHQ values) for the meadow vole were less 1.0 for all of the substances assessed. Given the high level of conservatism built into the assessment, risks associated with other substances are not considered to be significant. It is concluded that the Site poses no significant risk to meadow vole.

Table 8.14 Total Ecological Hazard Quotients for the Meadow Vole

Chemical	EHQ	Target EHQ
Total TPH	0.23	1.0
PCBs	0.12	1.0
PAHs	0.48	1.0
Molybdenum	0.044	1.0
Tin	0.0039	1.0

Note: Bold/Shading indicates that the total calculated EHQ exceeds the target EHQ.

8.17 Summary

Table 8.15 summarizes the COCs at each area of the Former U.S. Military Site in Northwest Point that were identified as potentially posing adverse risks to VECs based on the terrestrial ERA.

Table 8.15 Summary of Chemicals Identified as being of Potential Unacceptable Risk based on Terrestrial Ecological Risk Assessment at the Former U.S. Military Site in Northwest Point

Area	VEC	Chemicals	EHQ	Most sensitive receptor
South Site	Red fox	None	-	TPH – American robin PCBs– Masked shrew
	Masked shrew	TPH	6.2	
	Meadow vole	TPH	4.3	
North Site	Red fox	None	-	
	Masked shrew	PCBs	2.7	
	Meadow vole	None	-	
Whole Site	American robin	TPH	7.8	
	American robin	PCBs	1.7	
	Short-eared owl	TPH	1.5	
	Osprey	None	-	
	Arctic hare	TPH	3.9	

8.18 Site Specific Target Levels

Site specific target levels (SSTLs) for soil for the protection of the most sensitive receptor were estimated by adjusting the soil concentration in the model input file until the total EHQ for each COC equalled a value of 1.0. In this process, the expected concentrations of each COC in each environmental compartment that depends upon the soil concentration (*i.e.*, in terrestrial invertebrates, terrestrial plants, and small mammals) are recalculated as appropriate. Therefore, the overall EHQ value reflects the sum of all intakes.

At the same time, the COC concentrations in sediments, water, and any environmental compartments that depend upon water or sediments are held at the concentrations defined by the EPC. Therefore, exposure to present-day concentrations of COCs in water and sediments is maintained in the model while the soil concentration is manipulated. Risks to terrestrial biota at the Site were dominated by PCBs and TPH. Based on the calculated EHQs, American robin and masked shrew were the most exposed to these COCs.

Due to the highly localized distributions of PCBs and TPH in site soils, the ERA model as implemented (with biota exposed to the EPC at all times) is highly conservative. Nevertheless, the ERA model is helpful in establishing SSTLs for these substances. The conservative nature of the model helps to ensure that biota will be adequately protected provided the SSTL level is not exceeded on an area-wide basis.

Risks associated with the TPH fractions (C6-C10, C10-C21 and C21-C32) were summed, since the TPH compounds can be assumed to have a similar mode of toxic action and target organs. An SSTL for TPH was established by adjusting the concentrations of the TPH fractions in proportion to the concentrations observed in the contaminated areas until the summed HQ for the three fractions equalled 1.0. For the American robin, an SSTL was established at a TPH concentration of approximately 2,200 mg/kg dry soil, subject to the further requirements that the C6-C10 concentration does not exceed 80 mg/kg; the C10-C21 concentration does not exceed 2100 mg/kg, and the C21-C32 concentration does not exceed 300 mg/kg. This SSTL would also be protective of other ecological receptors at the Site. Removal of TPH impacted soil from the East Bulk Fuel Storage Site would be required (Drawing No. 121410105-EE-24b, Appendix 24).

For PCBs in soil, an SSTL of approximately 1.5 mg/kg dry soil was established. At this concentration, masked shrews exposed to soil, vegetation, and soil invertebrates for their entire life cycle would be close to a threshold at which reproductive effects might be expected. This concentration is slightly higher than the CCME (1999) guidelines for PCBs in agricultural (0.5 mg/kg) and residential/parkland soils (1.3 mg/kg). In contrast, it is substantially lower than the CCME (1999) guideline for PCBs at commercial or industrial sites (33 mg/kg). One area of the Site at the Lake Melville Dump Site would require remediation (Drawing No. 121410105-EE-24c, Appendix 24). The extent of PCB impacts at the Lake Melville Dump Site is unknown. It is therefore recommended that additional delineation of PCBs be carried out to delineate the impacts prior to conducting any remediation.

Table 8.16 Summary of SSTLs calculated based on Terrestrial Ecological Risk Assessment

Chemical	SSTL (mg/kg)
TPH	2,100
PCBs	1.5

8.19 Uncertainty Analysis

Uncertainties are inherent in every aspect of the ERA process. The most effective way to decrease uncertainty is to collect site-specific data. Application of site-specific information assists in reduction of uncertainty by allowing removal of generic data. For the Site, much site-specific data has been collected, but these data represent only soils.

Despite incorporation of a considerable amount of site-specific data, the ERA incorporates assumptions that lead to uncertainty. This section qualitatively discusses some significant aspects of uncertainty inherent in this risk assessment.

Valued Ecosystem Component (VEC) Selection. This risk assessment invested significant effort into a site visit and a thorough review of previous investigations carried out at the Site. The VECs that were selected are known to be present, or can reasonably be expected to be present on the Site. These VECs are also known to be reasonably or conservatively representative of other species that may be present on the Site and exposed to COCs. Use of site-specific receptors decreases uncertainty because local species are considered.

Utilization of VECs as Sentinels to Represent Other Organisms. The use of VECs is intended to limit the number of ecological receptors to a reasonable number. The VECs selected are considered sensitive, and consistently present in the study areas, and to be highly exposed to the COCs present at the Site via relevant exposure pathways. Therefore it is reasonable to assume that conclusions that are reached in respect of VEC organisms can be generalized to other biota that might use the Site.

Receptor-Specific Toxicity Data. For most COCs and VECs, toxicity data are available in some form. However, it is important to note that toxicity data are not necessarily available for the particular VEC species under consideration. Benchmarks are not necessarily specific to the VEC species, or to a reproductive or population-level endpoint. As a result, there is uncertainty associated with the extrapolations that are used to translate toxicity data for one species into a TRV for a second species. The toxicity data represent an organism that is expected to be sensitive to the COC. The conversion factors that are used are scientifically based, and are applied in a manner that is believed to be reasonable.

Data Limitations. The quality of a risk assessment calculation often hinges on the size, extent and quality of the data. In addition to making use of existing site data, a large number of samples were collected for this risk assessment, and a significant amount of data was reviewed for this study. The time available for collection of data precluded consideration of fluctuations in measured concentrations due to daily or seasonal influences. Because these data sets were summarized statistically, including calculation of a conservative representative value, such as the 95% UCL as the EPC, the values presented are conservative estimators of the true concentration to which native species would be exposed.

Selection of Chemicals of Concern. Chemicals of concern were selected independently in each of the media evaluated in the ecological risk assessment, and the analysis was completed to include all media if the substance exceeded screening criteria for any one of these. The approach for selecting chemicals of concern included comparison of each detected chemical value to values that are believed to be protective of most North American species, in most ecosystems. Because empirical data do not exist for all possible COCs and media, it is possible that relevant test species and sometimes even the same environmental media, have not been evaluated in the proper context for comparison.

Chemical Speciation. The fate, food chain interactions, and toxicity of a number of inorganic contaminants (such as aluminum) depend to a large extent upon their chemical form. As such, conservative assumptions about chemical form, bioavailability, and absorption over the gut were generally carried forward in the risk assessment, and the potential for toxicity is likely to be overstated. For example, it has been assumed that 100% of each ingested COC is absorbed from ingested soil or food, and is available to the organism as a potentially toxic substance. This may be reasonable for some COCs, but will be highly conservative for others.

Food Chain Interactions. Very limited "real world" data exist that allow quantification of the true relationship between a chemical in an environmental medium and chemical transfer through the food chain. Only a few classes of chemicals appear to be magnified through the food chain. These substances include methyl mercury, PCBs, some chlorinated pesticides (such as DDT), and some PCDD/PCDF compounds. These substances all have a tendency to partition into fatty tissue rather than water. They are also resistant to natural degradation processes by metabolic enzymes. Petroleum hydrocarbons (TPH) and PAHs are another hydrophobic class of chemicals present in the environment. While TPH and PAHs are hydrophobic, they may be poorly absorbed (*e.g*. F2 and F3 TPH) or are readily metabolized and/or excreted by some invertebrates and most vertebrates. For these reasons, food chain magnification does not tend to occur with TPH or PAHs. The extent of food chain magnification is another uncertainty that is generally treated in a conservative manner. Collection and chemical analysis of tissue samples from mammalian and avian species could have further reduced uncertainties associated with these values but were beyond the scope of the ecological field program.

Wildlife Exposure Factors. Virtually every factor incorporated into dose calculations for wildlife species possesses a site-specific component. Validity of each exposure factor is dependent on consideration of the site-specific nature of these factors. In the absence of site-specific validation, exposure factors are incorporated based on validations performed elsewhere for other cases and sometimes for other species. Considerations such as food ingestion rates, water ingestion rates, incidental soil ingestion rates, dietary composition, home range, and time spent at the Site were collected from the scientific literature based on other sites and locations. Because it has been assumed that each receptor organism spends its entire life cycle at the Site (exposed to the EPC concentration for each COC) it is likely that the level of wildlife exposure has been substantially overestimated, particularly for large-bodied or migratory VECs.

Habitat Survey and Valued Ecosystem Component (VEC) Selection. This risk assessment completed a review of existing habitats and the species that exist within them. Terrestrial habitats were examined to identify relevant species, and to support the selection of appropriate VECs. Therefore, the VECs that were selected are known to be present, or can reasonably be expected to be present on the Site. These VECs are also known to be reasonably or conservatively representative of other species that may be present on the Site and exposed to COCs. Use of site-specific receptors decreases uncertainty since local species are considered.

Measurement Endpoints from the Toxicity Data. The preferred measure of toxicity for TRVs in this ERA is the chronic LOAEL. For certain COCs the only chronic endpoints available were NOAELs. In this situation, the NOAEL was used as the TRV (without the application of uncertainty factors). The decision not to apply uncertainty factors to translate a NOAEL to a LOAEL is a conservative measure to avoid overestimating the LOAEL (and consequently underestimating potential risks).

8.19.1 Summary of Uncertainty Analysis

As a result of the scientific investigations, literature reviews, and risk assessment guidance that have been undertaken or followed in the preparation of this ERA, it is believed that the risk assessment results present a reasonable yet conservative evaluation of the risk to ecological receptors present at the Site. Where uncertainty or lack of knowledge were encountered in the development of the risk estimates, reasonable yet conservative assumptions were made, or data were selected, in order to ensure that risks were not underestimated.

9.0 REMEDIAL ACTION PLAN

9.1 Background

The end goals of the risk assessment were to quantify risk associated with the identified chemicals of concern at the Former U.S. Military Site in Northwest Point for the various receptor pathways that humans, animals and other biota may be exposed to. These receptor pathways have been determined for the overall site and associated risk evaluated for each of these pathways and, site-specific target levels (SSTLs) were calculated for the overall site. This output will assist NLDEC in focusing on those areas that require remedial efforts and provide more realistic clean up goals that are site specific and protective of both human health and ecological components, hence providing a cost effective approach to risk manage the Site. Public consultation will be an essential component for remedial efforts at this site. The SSTLs calculated for the overall site are present in Table 9.1 below.

Table 9.1 Summary of SSTLs to be applied to the Former U.S. Military Site

Chemical	SSTL (mg/kg)	Source	Areas Requiring Remediation
Soil			
PAHs (Benzo(a)pyrene TPE)	23	HHRA	Lake Melville Dump Site (Drawing No. 121410105-EE-25C, Appendix 25)
TPH	2,100	ERA	East Bulk Fuel Storage Site (Drawing No. 121410105-EE-25A, Appendix 25)[1]
PCBs	1.5	ERA	Lake Melville Dump Site (Drawing No. 121410105-EE-25C, Appendix 25)[1]
Sediment			
TPH	500[2]	ERA	Lake Melville Dump Site (Drawing No. 121410105-EE-25C, Appendix 25)

1 = Additional sampling required prior to remediation, as described in the following section
2 = Benchmark value used in the ecological risk assessment

The exposure point concentration (EPC) is an estimate of a reasonable upper limit value for the average chemical concentration in a medium, determined for each exposure unit through statistical analysis (USEPA, 1989). The areas of soil requiring remediation were selected in order to obtain area-wide EPCs that are less than the SSTLs for PAHs (i.e., Benzo(a)pyrene TPE), TPH and PCBs.

9.2 Evaluation of Remedial Options

9.2.1 Remedial Scope and Objectives

The following actions, remedial activities, and risk management strategies are recommended for the control of hazards related to petroleum hydrocarbon, PCB, PAH and metals impacts at the

Site. Some of these recommendations are intended to be flexible, and will be modified as appropriate, depending upon the results of consultation with regulators and local residents.

Actions

1. An area of TPH impacted soil exceeding the SSTLs generated for protection of ecological health was identified at the East Bulk Fuel Storage Site (Drawing No. 121410105-EE-25A, Appendix 25). However, because there were too few surface soil (i.e., <30 cm) samples analysed for TPH to calculate an EPC, the maximum concentration was used in the ecological risk assessment. In order to get an estimate of the area wide EPC, it is recommended that additional surface soil samples (< 30 cm) be collected and analysed for TPH. An area wide EPC can then be calculated and compared to the SSTL generated for protection of ecological receptors to determine if remediation is necessary.

2. An area of PCB impacted soil exceeding the SSTL generated for the protection of ecological health was identified at the Lake Melville Dump Site (Drawing No. 121410105-EE-25C, Appendix 25). Because there were too few soil samples analysed for PCBs to calculate an EPC, the maximum concentration of PCBs was used in the ecological risk assessment. Therefore, additional soil samples should be collected from this area to calculate an area wide EPC and to further delineate the PCB impacts prior to conducting any site remediation.

3. One surface water and one sediment sample was collected from the stream running through the Former U.S. Military Site during the 2009 field program. Concentrations of aluminum and iron and the pH value exceeded the generic CCME and Health Canada guidelines in the surface water sample. Because only one surface water sample was collected, it is uncertain if additional portions of the stream are impacted. A stream survey to determine the location of the streams on the Site as well as the collection of surface water samples and sediment samples from various portions of the stream are required in order to conduct an aquatic ecological risk assessment. Analysis should include TPH/BTEX and metals as well as PCBs and PAHs which had not been previously tested in sediment or surface water.

4. According to AMEC (2001), Innu from the area use surface water from the stream for drinking water. A pipe had been placed in the area of surface water sample SW1 for obtaining drinking water. Interviews with local residents (e.g., cabin owners) should be conducted to establish the use of surface water at the Site to ensure that all areas being used for drinking water are properly sampled.

5. Surface soil samples from the Service Site were not analysed for petroleum hydrocarbons. Petroleum hydrocarbons were present in the subsurface soil at the Site but it is unknown if the impacts are present in the surface soil. Because the knowledge of the presence of petroleum hydrocarbons in the surface soil is essential for the ecological risk assessment, surface soil samples should be collected and analysed for petroleum hydrocarbons at this site.

6. It is recommended that further sampling be conducted at the Helicopter Pad Site to verify the presence/absence of pesticides in surface soil.

7. Due to the dense vegetation present at the VOR site at the time of the site visit, a thorough site inspection could not be completed. It is recommended that the site be inspected in the late fall during a later site visit to assess for possible environmental issues related to the abandoned 900 L UST.

8. If site conditions or land uses change (e.g., residential usage, use of potable groundwater or further development on the Site), the results of the on-site risk assessment may need to be revisited to ensure that there are no additional or increased risks to potential receptors, on-site or off-site.

9. It is recommended that if vegetable gardens are grown in the future, they are kept away from contaminated areas of the Site. Clean imported topsoil should be brought in for this purpose.

10. It is our understanding that there is no current groundwater use for potable drinking water. The assumption is made that prior to any future use of groundwater for potable drinking water or other human use (i.e., showering, washing), the groundwater will be tested to demonstrate that groundwater quality is within the Guidelines for Canadian Drinking Water Quality.

Remedial Activities

1. Remove soil, metal and other debris from the area of soil sample 09-SS14 (approximately 86 m^2), which is located at the Camp Road Dump Site (121410105-EE-25a, Appendix 25). The Camp Road Dump Site was used for the disposal of non-recyclable, non-hazardous waste recovered during the 2001 remediation program conducted by AMEC. Waste was placed into 10 m^2 by 4 m deep pits along the north side of the site. This may explain the elevated metals concentrations in soil sample 09-SS14.

2. The pH in surface water sample (09-SWM6) which was collected in the vicinity of the sewage discharge structure was low (4.55). Because aluminum can be a potential concern for aquatic receptors at pH values lower than six, the sewage discharge structure should be removed from this area of Lake Melville.

3. An area of PAHs impacted soil exceeding the SSTL generated for protection of human health was identified at the Lake Melville Dump Site (Drawing No. 121410105-EE-25C, Appendix 25). Soil in this area should be remediated to a depth of 1.5 mbgs to be protective of human health.

4. The sediment sample collected from a small area of standing water at the Lake Melville Dump Site had a TPH concentration that exceeded the benchmark value of 500 mg/kg used in the ecological risk assessment. Concentrations of TPH are expected to be similar throughout the approximately 45 m^2 area of standing water. This area provides habitat for ecological receptors as evidenced by the presence of several tadpoles in the water during the 2009 field program. It is recommended that the sediment be removed from the area of standing water in the late fall season.

5. Free phase petroleum product was observed at the following sites: South Bulk Fuel Storage Site (09-TP21), Service Site (09-MW4), East Generator Site (09-MW20), Sewer System Site (second manhole). Because the Atlantic PIRI RBCA model is only applicable to sites where

free product is not present, it is recommended that the free product be removed from these areas.

Areas of soil and sediment requiring remediation or potentially requiring remediation (dependant on the results of further sampling) are identified in Table 9.2. Table 9.2 also identifies contaminant levels in the soil and shows the estimated volumes of soil.

Table 9.2 Summary of Soil and Sediment Requiring Remediation

Site	Remedial Objective (max. concentration)	Secondary Issues Identified[1] (max. concentration)	Sample Locations	Area (m^2)	Depth (m)	Volume (m^3)
East Bulk Fuel Storage Site	TPH (19,000 mg/kg)	-	09-TP27, 09-SS19	-	-	-
Camp Road Dump Site	Metals[3]	-	09-SS14	86	1.5	129
Lake Melville Dump Site	PAHs (120.9 mg/kg)	TPH (29,500 mg/kg)	09-MW27D, LD-TP1	72	1.5	108
	TPH (690 mg/kg)	-	09-SED6	45	0.5	23
	PCBs (3.1 mg/kg)	-	09-SS33	-	-	-

Totals for remediation:	Volume (m^3)	Weight (tonnes)[2]
PAHs-impacted soil	108	162
TPH-impacted sediment	23	34
PCB-impacted soil	-	-
TPH-impacted soil	-	-

Notes
1. Based on typical landfill acceptance criteria of TPH < 1,000 mg/kg, PCBs < 33 mg/kg or Metals/PAHs < CCME Industrial guidelines
2. Based on an estimated soil density of 1.5 tonnes/m^3
3. Soil sample 09-SS14 had elevated concentrations of various metals and was not included in the risk assessments. Soil in the area of this sample should be removed from the site.
"-" = No other issues identified or further sampling required

9.2.2 Remedial Options Evaluation

Where active remediation of soil and sediment was recommended, various remedial options were identified for each chemical of concern that could potentially be implemented at the Former U.S. Military Site in Northwest Point. Potential remedial options were evaluated against a variety of criteria to assist in screening out the most appropriate alternative. As a minimum, all options must meet two fundamental threshold criteria:

- Overall protection of human health and the environment; and
- Compliance with applicable requirements.

Based upon the threshold criteria listed above, the list of options was reduced and options were evaluated against the following secondary criteria:

- **Long-term effectiveness and permanence** with respect to residual risk after remediation;
- **Reduction of toxicity, mobility or volume**; for the noted contaminants on the site.
- **Implementability** (considering technical and administrative feasibility in the context of available services and materials necessary to implement the option);
- **Time Required** to implement and achieve remedial objectives; and
- **Cost** - both capital as well as operation and maintenance.

The options were evaluated on a relative basis against the secondary criteria. The applicability of each criteria as an option is shown as High, Moderate or Low. On a relative basis, High is preferred for long-term effectiveness and performance, reduction of toxicity, mobility and volume, and implementability, and Low is preferred for time required and cost.

Based on the available site characterization information, remedial strategies described in the following sections are considered feasible for the remediation of impacted soil and sediment at the Former U.S. Military Site in Northwest Point. Remedial options for PCBs-impacted soil at the Lake Melville Dump Site and TPH-impacted soil at the East Bulk Fuel Storage Site will be reviewed once further sampling, delineation and calculation of EPCs has been conducted.

9.2.2.1 PAHs-Impacted Soil

An estimated 108 m^3 of PAHs-impacted soil from the Lake Melville Dump Site requires remediation. The soil requiring PAHs remediation also contains concentrations of TPH exceeding 1,000 mg/kg, therefore soil will likely not be accepted at a local landfill. Prior to the selection of a remedial option for PAHs-impacted soil, leachability testing must be conducted on the soil requiring remediation.

Non-Leachable PAHs-Impacted Soil

Based on the available site characterization information, the following remedial strategies will be considered for the remediation of non-leachable PAHs-impacted soil:

- Option 1: Excavate soil and transport to a soil treatment facility
- Option 2: Cap area of impacted-soil

A brief description and the characteristics of each option are presented below. Table 9.3 summarizes the relative merits and deficiencies of the options with respect to the secondary criteria.

Option 1 – Excavate soil and transport to a soil treatment facility

The 108 m^3 of PAHs-impacted soil would be excavated from the Lake Melville Dump Site and transported by truck to a soil recycling facility for treatment to reduce the PAH content. There is an approved soil treatment facility in Goose Bay, Labrador, which is located approximately 50 km (by road) from the Site.

Option 2 – Cap area of impacted-soil

The results of the risk assessment indicate that the main remedial objective is to remove the soil ingestion/dermal contact/dust inhalation exposure pathways for soils impacted above the SSTL located in the upper 1.5 m layer of soil. Therefore, capping the 72 m^2 area of impacted soil at the Lake Melville Dump Site with 0.5 m of clean fill materials to reduce the expose pathways may be an effective remedial strategy to address the concerns at the site.

Table 9.3 Summary of Options for Remediation of Non-Leachable PAHs- Impacted Soil

Criteria	Option 1 Excavate soil and transport to a soil treatment facility	Option 2 Cap area of impacted-soil
Long-term effectiveness	High	Moderate
Reduction of toxicity, mobility or volume	High	Low
Implementability	Moderate	Moderate
Time Required	Moderate	Moderate
Cost	High	Moderate

Recommended Remedial Option

Based on conditions and constraints, Option 1 (Excavate soil and transport to a soil treatment facility) is the preferred remedial option for non-leachable PAHs-impacted soil at the Former U.S. Military Site in Northwest Point.

The advantages and disadvantages of this option are noted below.

Advantages

1. Long-term effectiveness;
2. Removes wastes from site;
3. Can be implemented using local resources and readily available technologies; and
4. NLDEC does not have to perform future monitoring at the site.

Disadvantages

1. Remediation cost per tonne is high.

Leachable PAHs-Impacted Soil

Based on the available site characterization information, the following remedial strategy will be considered for the remediation of leachable PAHs-impacted soil:

- Option 1: Transport soil to an out-of-province hazardous waste landfill
- Option 2: Cap area of impacted-soil

A brief description and the characteristics of this option are presented below. Table 9.4 summarizes the relative merits and deficiencies of the option with respect to the secondary criteria.

Option 1 –Transport soil to an out-of-province hazardous waste landfill

The estimated 108 m^3 of soil from the Lake Melville Dump Site would be excavated and transported to an existing commercial hazardous waste landfill in Quebec. Only vehicles approved for interprovincial transport of PAHs wastes would be suitable, and transportation.

Option 2 – Cap area of impacted-soil

The results of the risk assessment indicate that the main remedial objective is to remove the soil ingestion/dermal contact/dust inhalation exposure pathways for soils impacted above the SSTL located in the upper 1.5 m layer of soil. Therefore, capping the 72 m^2 area of impacted soil at the Lake Melville Dump Site with 0.5 m of clean fill materials to reduce the expose pathways may be an effective remedial strategy to address the concerns at the site.

Table 9.4 Summary of Options for Remediation of Leachable PAHs- Impacted Soil

Criteria	Option 1 Transport soil to a hazardous waste landfill	Option 2 Cap area of impacted soil
Long-term effectiveness	High	Moderate
Reduction of toxicity, mobility or volume	High	Low
Implementability	Moderate	Moderate
Time Required	Moderate	Moderate
Cost	High	Moderate

Recommended Remedial Option

Based on conditions and constraints, Option 1 (Transport soil to an out-of-province hazardous landfill) is the only practical remedial option for the reduction of toxicity, mobility or volume of leachable PAHs-impacted soil at the Former U.S. Military Site in Northwest Point. The advantages and disadvantages of this option are noted below.

Advantages

1. Long-term effectiveness;
2. Removes wastes from site;
3. Can be implemented using local resources and readily available technologies; and

4. NLDEC does not have to perform future monitoring at the site.

Disadvantages

1. Remediation cost per tonne is high.

9.2.2.2 TPH-Impacted Sediment

An estimated 23 m^3 of TPH-impacted sediment within an area of standing fresh water at the Lake Melville Dump Site requires remediation. Tadpoles were observed by Stantec within this area of standing water during the 2009 field program. Based on the available site characterization information, the following remedial strategies were considered for the remediation of TPH-impacted sediment:

- Option 1: Excavate sediment and transport to a local landfill
- Option 2: Monitor sediment concentrations
- Option 3: Infill the area of standing water

A brief description and the characteristics of each option are presented below. Table 9.5 summarizes the relative merits and deficiencies of the options with respect to the secondary criteria.

Option 1 – Excavate sediment and place in local landfill

The estimated 23 m^3 of sediment in the area of standing water would be excavated and transported to the local landfill for use as fill cover. It is assumed that permission would be obtained from the local landfill to place the sediment with a maximum TPH concentration of 690 mg/kg in the landfill. This would have to be verified with landfill operators. This option would temporarily disturb aquatic life within the area of standing water and may require permits for the alteration of fish habitiat.

Option 2 – Monitor sediment concentrations

Concentrations of TPH in sediment would be monitored in the area of standing water over a period of 1 to 3 years to determine if concentrations are decreasing over time. The maximum observed concentration of TPH in the area of standing water (i.e., 690 mg/kg) may decrease to below the benchmark value (i.e., 500 mg/kg) over time. This option involves minimal disturbance to aquatic life within the area of standing water; however, immediate risks to aquatic life are not eliminated and there is no guarantee that concentrations of TPH in sediment will decrease.

Option 3 – Infill the area of standing water

The estimated 45 m^2 area of standing water would be infilled with clean fill materials. This option would destroy the aquatic habitat, thereby eliminating the potential pathways for aquatic ecological receptors. Permits for the destruction of fish habitat would be required for this option.

Table 9.5 Summary of Options for Remediation of Petroleum Hydrocarbon Impacted Sediment

Criteria	Option 1 Excavate sediment and place in local landfill	Option 2 Monitor sediment concentrations	Option 3 Infill the area of standing water
Long-term effectiveness	High	Low	High
Reduction of toxicity, mobility or volume	High	Low	High
Implementability	Moderate	High	Moderate
Time Required	Moderate	High	Low
Cost	Moderate	Moderate	Moderate

Recommended Remedial Option

Based on conditions and constraints, Option 1 (Excavate sediment and place in local landfill) is the preferred remedial option for TPH-impacted sediment at the Former U.S. Military Site in Northwest Point.

The advantages and disadvantages of this option are noted below.

Advantages

1. Long-term effectiveness;
2. Removes wastes from site;
3. Can be implemented using local resources and readily available technologies; and
4. Does not permanently destroy aquatic habitat.

Disadvantages

1. Temporarily disturbs aquatic life;
2. Requires approval of local landfill to accept the sediment; and
3. Sediment must be drained or dewatered for handling, transportation and usage as fill cover.

9.2.2.3 Free Liquid Phase Petroleum Hydrocarbons

Groundwater

During the current investigation, free liquid phase petroleum hydrocarbons were observed on groundwater encountered in one (1) test pit (09-TP21 at the South Bulk Fuel Storage Site) and in two (2) monitor wells (09-MW4 at the Service Site and 09-MW20 at the East Generator Site), with levels ranging from of a “skim of fuel” (i.e., <1 mm) to 10 cm. Based on analytical results of soil and groundwater samples collected from the three (3) impacted sites, it appears that the product resembles mainly weathered fuel oil. Further delineation is required at the three (3) sites to fully delineate the free product plumes. This can be achieved through the installation of additional monitor wells in the areas of concern. Once the extent of free product at the three (3) sites is determined, a remedial option will be selected. The following options will be considered for the site:

- Option 1: Product recovery utilizing existing monitoring wells;
- Option 2: Product recovery utilizing passive bailers;
- Option 3: *In-situ* remediation utilizing Multi Phase Vacuum Extraction (MPVE)

A brief description of each option is presented below. A remedial option for the removal of free liquid phase petroleum hydrocarbons will be selected once further delineation has been conducted.

Option 1 – Product Recovery Utilizing Existing Monitoring Wells

Since monitoring wells already exist at the sites, they may be utilized to recover free product. This could be achieved simply by having a vacuum truck remove water and product from the monitoring wells and then monitor the return of product to the wells. Product could be removed from the wells on a periodic basis (e.g., once each day). If it is determined that product is being recovered in the wells at a more rapid rate, then a continuous pumping system could be put in place to recover the product. Conversely, if the rate of product entering the wells is small, absorbent material could be place in the wells to wick the free product from the groundwater surface. One disadvantage of using the existing wells may be the radius of influence or capture zone surrounding these wells, which may limit the effectiveness of the recovery. Depending on the extent of free product present at the sites, it could take several years (i.e., 2 to 5 years) to complete removal of free product at the sites using this method.

Option 2 - Product Recovery Utilizing Passive Bailers

The use of passive bailers in existing or new monitor wells and/or recovery wells is another option that may be considered for the removal for free product hydrocarbons. Passive bailers use a skimmer consisting of a hydrophobic membrane that removes hydrocarbons from the water surface. The skimmers are designed to float on the oil/water interface, allowing the free product to enter the bailer without the water. The bailer can be checked periodically and the accumulated product removed. The advantage of the passive system is that product is removed on a continuous basis and requires very little maintenance or operational cost. However a much longer period of time is required to remove the product. In addition, wells must be spaced close enough apart to effectively collect all of the product. Depending on the extent of free product present at the sites, it could take several years (i.e., 2 to 5 years) to complete removal of free product at the sites using this method.

Option 3 - *In-Situ* Remediation Utilizing Multi Phase Vacuum Extraction (MPVE)

Multi-Phase Vacuum Extraction (MPVE), also known as vacuum-enhanced extraction, or bioslurping, is an *in-situ* remediation technology that uses vacuum pumps to remove various combinations of contaminated groundwater, separate-phase petroleum product, and hydrocarbon vapour from the subsurface.

Extracted liquids and vapour are treated and collected for disposal, or re-injected to the subsurface (where permissible). MPVE systems can be effective in removing separate-phase product from the subsurface, thereby reducing concentrations of petroleum hydrocarbons in both the saturated and unsaturated zones of the subsurface. MPVE systems are typically designed to maximize extraction rates; however, the technology also stimulates biodegradation of petroleum constituents in the unsaturated zone by increasing the supply of oxygen, in a manner similar to bioventing.

The vacuum applied to the subsurface with MPVE creates vapour-phase pressure gradients toward the vacuum well. These vapour phase pressure gradients are also transmitted directly to the subsurface liquids present, and those liquids existing in a continuous phase (e.g., water and free petroleum product) will flow toward the vacuum well in response to the imposed gradients. The higher the applied vacuum, the larger the hydraulic gradients that can be achieved in both vapour and liquid phases, and thus the greater the vapour and liquid recovery rates. The depressed groundwater table that results from these high recovery rates serves both to hydraulically control groundwater migration and to increase the efficiency of vapour extraction.

Because of the varied nature of MPVE systems, the conceptual design objectives for MPVE can vary widely. MPVE is often selected because it enhances groundwater and/or product recovery rates, especially in layered, fine-grained soils. The application of MPVE also maximizes the effectiveness of SVE by lowering the water table and therefore increasing air-phase permeabilities in the vadose zone. Finally, MPVE can enhance biodegradation of petroleum contaminants by substantially increasing the supply of oxygen to the vadose zone.

MPVE provides a number of advantages and benefits over conventional pumping approaches. The foremost of these is the ability of MPVE to effectively function in moderate to low permeability soils. MPVE can provide contaminant source removal in lower permeability settings that may only be served otherwise by excavation of the source area. MPVE is versatile in that it can be employed to remediate multiple phases of contamination, including the vapour, residual, dissolved, and non-aqueous phases of contamination, while conventional pumping addresses only the latter two phases.

MPVE can potentially create a large radius of influence affecting greater capture of the contaminant plume. Conventional recovery approaches in low permeability formations tend to realize low flow rates with steep draw-down and limited capture. This forces the use of a greater number of recovery wells to affect mass removal and plume containment. MPVE requires significantly fewer wells due to its ability to maximize fluid recovery at the wellhead. MPVE also reduces the drawdown necessary to obtain a given flow rate. This is especially beneficial to settings requiring free product recovery. Conventional pumping approaches tend to smear free product along the face of the drawdown curve and have limited success in removing NAPL trapped in the capillary fringe.

Depending on the extent of free product present at the sites, it could take several years (i.e., 3 years) to complete removal of free product at the Site using this method.

As mentioned above, once the extent of free product at the three (3) sites is determined, a remedial option will be selected.

Sewer Water

During the current investigation, 15 cm of free liquid phase petroleum hydrocarbons were observed on sewer water encountered in the second manhole at the Sewer System Site. Based on analytical results of the product sample collected from the second manhole, it appears that the product resembles mainly weathered diesel. It is recommended that free product be purged from the sewer line and that the sewer line be capped.

9.3 Remedial Action Plan

9.3.1 General

The Remedial Action Plan (RAP) described in this section is based on the regulatory framework, site characterization information and the Remedial Options Evaluation presented in the previous section. Changes may be required in the Remedial Action Plan depending on comments or directions from NLDEC, following review of this report.

9.3.2 Disposal of Metal-Impacted Soil, Metal and Other Debris

Metal and other debris from the area surrounding soil sample 09-SS14 (i.e., approximately 86 m^2) at the Camp Road Dump Site would be transported by truck to a lay-down area where metals leachability swab sampling would be conducted. Similarly, surface soil in the area of sample 09-SS14 (i.e., approximately 129 m^3) should be sampled for metals leachability. If results of metals leachability soil and swab testing confirm that concentrations of leachable metals in the soil and debris are below the applicable guidelines, the soil and debris may be transported by truck to the local landfill for disposal. Alternatively, if the soil and debris contain measurable concentrations of leachable metals at concentrations exceeding the applicable guidelines, they would be handled as hazardous waste and would be removed and transported to an appropriate approved disposal facility. Only approved companies and facilities would be used for the handling, transport and disposal of hazardous soil, wastes and special wastes.

Demolition and disposal of the concrete foundations and floor slabs on the Site and surface debris and physical hazards is not included in the remediation plan at this time. Additional costs will be incurred if removal of this concrete or debris is required in the future.

9.3.3 Removal of the Sewage Discharge Structure

The abandoned sewage discharge structure at the Sewer System Site would be emptied of sludge by qualified personnel, following standard procedures. The removed sludge would be disposed of at local approved facilities. The discharge structure would be cleaned and removed from the Site. The discharge structure would be disposed of at the local landfill. Sewer piping would be left in place and capped.

9.3.4 Soil and Sediment Remediation

Soil and sediment requiring remediation or potentially requiring remediation (dependant on the results of further sampling) has been identified at two (2) sites at the Former U.S. Military Site, as identified in Table 9.2. Table 9.2 also identifies contaminant levels in the soil and shows the estimated volumes of soil. Prior to the remediation of site soils, leachability testing would be conducted to determine the remediation method for PAHs.

Soil and sediment remediation would be executed as per the options selected in Section 9.2 and summarized as follows:

- PAHs-Impacted Soil:
  - Non Leachable PAHs: Excavate soil and transport to a soil treatment facility.
  - Leachable PAHs: Excavate soil and transport to an out-of-province hazardous waste landfill.
- TPH-Impacted Sediment: Site specific toxicity test should be conducted.

Soil and sediment removal operations would be inspected on a continuous basis by an environmental consultant. Confirmatory soil and sediment sampling would be carried out in remediated areas to demonstrate that remedial objectives are obtained. Approval is needed from the local landfill, soil treatment facility and/or out-of-province hazardous waste landfill before soil or sediment can be sent there for disposal. It is assumed that approval would be received from the local landfill to accept the TPH-impacted sediment described in the previous sections, based on the site characterization information which describes the acceptable levels of contaminants in soil/sediment disposed of at the landfill.

Efforts would be made to preserve the integrity of the monitoring wells located within the zones to be remediated. If it becomes obvious that a well will be damaged, it will be properly decommissioned to avoid creating a long term preferential pathway to the water table.

Remedial options for PCBs-impacted soil at the Lake Melville Dump Site and TPH-impacted soil at the East Bulk Fuel Storage Site will be reviewed once further sampling, delineation and calculation of EPCs has been conducted.

9.3.5 Free Product Removal

Free phase liquid petroleum hydrocarbons have been identified on groundwater at three (3) sites (i.e., South Bulk Fuel Storage Site, Service Site and East Generator Site) at the Former U.S. Military Site in Northwest Point at levels ranging from a “skim of fuel” (i.e., < 1 mm) to 10 cm. Prior to the selection of a remedial option for free phase liquid petroleum hydrocarbons on groundwater, it is recommended that further delineation be conducted through the installation of additional monitor wells.

Free phase liquid petroleum hydrocarbons have been identified on sewer water encountered in the second manhole at the Sewer System Site at a level of 15 cm. It is recommended that free product be purged from the sewer line and that the sewer line be decommissioned through capping.

9.3.6 Site Closure

Once all free product, and soil and sediment requiring remediation have been removed from the Site, the EPCs for the Site are below the SSTLs and the identified human health and ecological risks at the Site have been mitigated, a summary report and record of site condition would be prepared and submitted to NLDEC to obtain site closure for the property.

10.0 CLOSURE

This report is for the exclusive use of Newfoundland and Labrador Department of Environment and Conservation, and no other party shall have any right to rely on any service provided by Stantec Consulting Ltd. without prior written consent from Newfoundland and Labrador Department of Environment and Conservation and Stantec Consulting Ltd.

All parties are subject to the same limit of liability as agreed to in the Stantec Standard Terms and Conditions. Any use which a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

Some of the information presented in this report was provided through existing documents. Although attempts were made, whenever possible, to obtain a minimum of two confirmatory sources of information, Stantec in certain instances has been required to assume that the information provided is accurate.

The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. The conclusions and recommendations presented represent the best judgement of Stantec based on the data obtained during the assessment. Due to the nature of assessment and the limited data available, Stantec cannot warrant against undiscovered environmental liabilities. Conclusions and recommendations presented in this report should not be construed as legal advice.

The conclusions presented in this report represent the best technical judgement of Stantec based on the data obtained from the work. The conclusions are based on the site conditions encountered by Stantec at the time the work was performed at the specific testing and/or sampling locations, and can only be extrapolated to an undefined limited area around these locations. The extent of the limited area depends on the soil and groundwater conditions, as well as the history of the Site reflecting natural, construction and other activities. In addition, analysis has been carried out for a limited number of chemical parameters, and it should not be inferred that other chemical species are not present.

Should additional information become available which differs significantly from our understanding of conditions presented in this report, we request that this information be brought to our attention so that we may reassess the conclusions provided herein. This report was prepared by Anna Roy, B.Sc.E., and Kelly Johnson, Ph.D., and reviewed by Tania Noble-Sharpe, M.Sc., P.Eng., and Malcolm Stephenson, Ph.D.

Respectfully submitted,

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