

NTI/DND ENVIRONMENTAL WORKING GROUP

PROGRESS REPORT #3

RECORD OF RECOMMENDATIONS - LANDFILLS &
HYDROCARBON CONTAMINATED AREAS

CAM-4 PELLY BAY

FOX-M HALL BEACH

FOX-5 BROUGHTON ISLAND

DYE-M CAPE DYER

PREPARED BY THE ENVIRONMENTAL WORKING GROUP

MARCH 2000

3.1 DYE-M Site Report

All of the hydrocarbon-contaminated areas at DYE-M were evaluated over the course of the fall. The landfills had been evaluated previously, at the EWG in-person meeting in May 1999. All of the EWG evaluations of both landfills and hydrocarbon-contaminated areas have been documented in a site report, according to the standard format established for FOX-5. The report is included with this progress report.

3.2 CAM-4 Site Report

Landfills and hydrocarbon-contaminated areas at CAM-4 were evaluated in January and February. The attached site report documents all of the EWG evaluations of both landfills and hydrocarbon-contaminated areas.

3.3 FOX-5 and FOX-M Site Reports

The EWG decisions for landfills and hydrocarbon-contaminated areas at FOX-5 and FOX-M had been largely finalized at the time of the last progress report: at that time the draft FOX-5 site report, which documented these decisions, was submitted to the Steering Committee. In the interim, the FOX-5 report has been finalized and the FOX-M decisions have been documented in a FOX-M site report. Both reports follow the standard format established by the EWG.

4 WORK PLANNED (March 2000 to September 2000)

- Preliminary Planning for the Year 2000 Field Investigations at CAM-3 Shepherd Bay and CAM-5 Macker Inlet. Due to the module train fire during 10-15 January at PIN-3 Lady Franklin Point this has been added to the list of sites to be investigated in order to allow for an advanced cleanup of the site.
- Review of Landfill Monitoring – FOX-4 Cape Hooper
- Re-evaluation of the FOX-M Hall Beach and DYE-M Cape Dyer landfill and hydrocarbon contaminated areas following the collection of additional data during Year 2000 Field Investigations.

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1.1 Background

This report has been provided to summarize the recommendations of the Nunavut Tunngavik Incorporated /Department of National Defence (NTI/DND) DEW Line Cleanup Environmental Working Group (EWG) regarding the evaluation of landfills and hydrocarbon contaminated areas at the FOX-5 Broughton Island DEW Line site.

The Environmental Sciences Group (ESG) carried out the preliminary assessment of the FOX-5 site in 1992. In August 1998, ESG conducted a detailed environmental investigation to delineate known and suspected areas of contamination, including those contaminated with hydrocarbons, as well as to provide a more detailed assessment of the environmental status of the existing landfill areas. The results and interpretation of the environmental investigation are provided in the FOX-5 Report, (ESG, April 1999). As identified in this report, a number of hydrocarbon contaminated areas may require additional information to confirm or complete the evaluation. ESG intends to carry out additional investigation of the FOX-5 site in the year 2000, if required, to collect these outstanding information requirements.

In conjunction with the environmental assessment, UMA Engineering Ltd. (UMA) carried out an engineering site investigation. The objectives of this investigation were to survey soil sampling locations, as marked by ESG, review and evaluate existing and proposed landfill areas from a geotechnical perspective, and complete demolition and debris inventories, as required to prepare Drawings and Specifications for the cleanup of the site. Concept Drawings for FOX-5 were prepared in June 1999.

In accordance with the DND/NTI agreement, technical and local representatives of the NTI inspected the FOX-5 site during the field investigation by ESG. The objective of this inspection was to confirm that the conclusions reached by ESG and UMA during the site investigations demonstrate an environmental standard that ensures long term preservation of the Arctic Environment. A report, prepared by Vista Engineering (Vista, 1998), summarized the observations and conclusions of this inspection.

The recommendations contained herein, are based on a review of the documents, as listed below, which were provided to the EWG as reference materials.

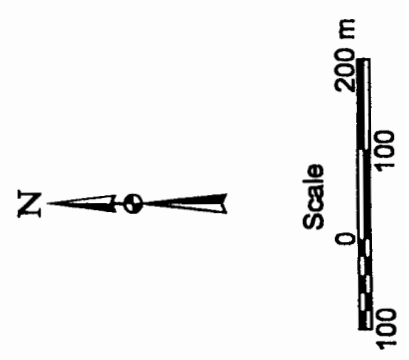
- **FOX-5, Broughton Island - Site Remediation - Phase One: Delineation**, Environmental Sciences Group (ESG) - Royal Military College of Canada, RMC-CCE-ES-99-11, April 1999.
- **DEW Line Cleanup Project FOX-5 Broughton Island - Conceptual Design Drawings**, For the Department of National Defence. UMA Engineering Ltd., June 1999.
- **DEW Line Cleanup Project. FOX-5 Broughton Island**. Pre-Construction Site Survey. For

1.3 Scope of Report

The remainder of this report is structured as follows:

- Section 2 provides a summary of the evaluation of the landfills at the FOX-5 site, including the corresponding recommendations for remediation.
- Section 3 identifies areas, potentially contaminated with hydrocarbons, and provides recommendations for environmental risk mitigation measures, as appropriate.
- In Annex A, an overview of the biophysical environment is presented, as it relates to the evaluation of landfill and hydrocarbon contaminated areas.
- Annex B presents a description of each of the landfills at the site, and the detailed scoring for the landfill evaluation.
- The detailed evaluation of hydrocarbon contaminated areas is provided in Annex C.

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2. LANDFILL EVALUATIONS

The two existing landfills at FOX-5 were evaluated in accordance with the DEW Line Landfill Evaluation Matrix, as provided EWG (1998) report. A summary of the evaluation is provided in Table 2.1, with supplemental information provided in Annexes A and B. The landfill locations are identified on Figures 2 and 3.



3. HYDROCARBON CONTAMINATED AREAS - EVALUATION

Hydrocarbon contaminated areas at the FOX-5 site were assessed in accordance with the Hydrocarbon Evaluation Method (EWG, 1999). A total of 13 areas, potentially contaminated with hydrocarbons, were evaluated. These areas are identified on Figures 2 and 3. The Airstrip Apron area was also investigated by ESG in 1998, and no evidence of contamination was found. As this area is under the jurisdiction of Arctic Airports, an evaluation sheet has not been prepared. A summary of the evaluation of the other 13 areas is provided in Table 3.1. As outlined in the Hydrocarbon Evaluation Method, the evaluation considers the likelihood of exposure and receptor sensitivity for three major pathways; atmosphere, soil and water. Only the primary pathway, which determines the recommended risk mitigation measures, is identified in the summary table. The detailed evaluation of all hydrocarbon contaminated areas is appended in Annex C.

continued

Hydrocarbon Evaluation				Recommended Risk Mitigation Measures ¹		Comments
Primary Pathway	Likelihood of Exposure	Receptor Sensitivity				
N/A	Low	Low		Area co-contaminated with Tier II soil. These contaminated will be excavated, thus mitigation risks from hydrocarbon contamination.		
Water	High	Moderate		- Excavate source of contamination to the depth and extent where TPH concentrations are less than 2500 ppm. - Backfill with clean fill.	- Surface materials are contaminated with Tier I and Tier II. - Additional investigation is required to determine the extent of contamination and to confirm risk mitigation measures.	- Surface soils are co-contaminated with Tier I. - The final land use to this area is determined and evaluated relative to remediation requirements. - Three stained areas; over 50% of is lubricating oil and grease.
Soil	Moderate	Moderate		Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first.	- Surface soils are co-contaminated with Tier I. - The final land use to this area is determined and evaluated relative to remediation requirements.	- Surface soils are co-contaminated with Tier I. - The final land use to this area is determined and evaluated relative to remediation requirements. - Three stained areas; over 50% of is lubricating oil and grease.
Soil	Moderate	Moderate		- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.	- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.	- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.
Soil	Moderate	Moderate		- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.	- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.	- Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. - Backfill with clean fill.

ations presented in *italics* are provisional pending review of additional investigation results.

Summary of Overall Biophysical Environment

The following provides a brief summary of the important characteristics of the biophysical environment at Broughton Island.

- Important migratory route for whales and seals exists along eastern Baffin Island.
- The area is also an over-wintering area for some whales and seals.
- World Wildlife Federation has identified an important summering area for bowhead whales at Isabella Bay, approximately 200 kilometres north of the station.
- The offshore waters of Davis Strait provide an important breeding and migration area for the hooded seal.
- Large populations of Arctic char constitute a significant food source for domestic and commercial use.
- Large populations of seabirds occur in this area.
- An important polar bear denning area occurs 120 kilometres south-east of Broughton Island; and a summering area is located 150 km to the north.
- Polar bear sightings in the area have been noted as a common occurrence.
- The Broughton Island site is characterized by sparse vegetation consisting mainly of lichens. Mosses may occur at the site within large boulder fields.
- Annual precipitation is approximately 280 mm annually (snowfall converted to equivalent rainfall).

A. CONTAMINANT SOURCE DESCRIPTION

- The Main Landfill encompasses an area of approximately 18 000 m².
- Estimated depth of the landfill is greater than 1.5 metres.
- There is evidence of contaminated leachate; however, no contaminated soil is identified in excess of DCC Criteria (low levels of PCBs).
- Scattered debris covers approximately 40 percent of area.

B. PATHWAYS/TRANSPORT MECHANISMS

- Leachate and low level contaminated soil has been identified, therefore potential for aerial transport is provided for in the evaluation.
- Topography: The landfill surface slopes at 5 to 10 percent grade, with portions of the landfill at approximately 12 percent grade.
- Cover materials consist of gravely sand, with some cobbles overlying sand and gravel. .
- Surface water run-off is considered moderate due to slopes. Area is also subject to snow drifting. There is localized evidence of erosion on portions of the landfill with finer grained materials and steeper slopes, likely associated with periods of high run-off.
- Annual precipitation is 280 millimetres.
- Drainage from the landfill goes overland to the north-northeast towards Davis Strait, approximately 1.4 kilometres distant.

C. RECEPTORS

- The receiving aquatic environment is Davis Strait, a known harvest area supporting diverse marine life, approximately 1.4 kilometres distant.
- Vegetation cover is sparse in the area of the landfill, with patches of vegetation including mosses, grass and heather in interstices between boulders.
- Terrestrial wildlife biodiversity is considered low to moderate. Caribou may occur in the region. As well, it is an area of known or suspected denning/wintering for polar bears. Arctic fox and lemmings are likely present.
- Raptors, including falcons, hawks and owls, are known to occur in the region.
- Fishing occurs off the coast for Arctic Char.
- The community of Broughton Island is approximately 14 kilometres by road from the landfill. Residents are known to visit the site; however, the duration of the stay is limited.
- No drinking water supplies are located within one kilometre of the landfill.

POTENTIAL ENVIRONMENTAL RISK - EVALUATION MATRIX					
DEW LINE LANDFILLS IN THE NUNAVUT REGION					
A.	CONTAMINANT SOURCE		Maximum Score	FOX-5 MAIN LANDFILL	FOX-5 AIRSTRIIP LANDFILL
A.1	LANDFILL EXTENT				
	>10,000 m2	10			
	For areas less than 10,000 = Area of Landfill X 10 / 10 000	2-9			
	Minimum Score	1	10	10	3
A.2	ESTIMATED DEPTH OF LANDFILL				
	greater than 1.5 m	5			
	less than 1.5 m	2-4	5	5	2
A.3	PRESENCE OF LEACHATE				
	Evidence of Leachate	10			
	No Evidence of Leachate	0	10	10	10
A.4	PRESENCE OF SURFACE CONTAMINATED SOIL				
	> DCC Tier II Stains	15			
	> DCC Tier I < DCC Tier II, Stains	10			
	Contaminated suspected, no surface contamination noted	5	15	5	15
A.5	PRESENCE OF SURFACE DEBRIS AT LANDFILL				
	>50% of surface area	10			
	<50% of surface area, pro-rated	1-9			
	No debris observed	0	10	9	10
	SPECIAL CONSIDERATIONS				
		+/- 5			
	TOTAL SCORE - CONTAMINANT SOURCE		50	39	40

POTENTIAL ENVIRONMENTAL RISK - EVALUATION MATRIX DEW LINE LANDFILLS IN THE NUNAVUT REGION					FOX-5 MAIN LANDFILL	FOX-5 AIRSTRIP LANDFILL
B.	PATHWAY/TRANSPORT MECHANISMS			Maximum Score		
B.1	AERIAL TRANSPORT OF CONTAMINANTS					
	All Landfills Scored as 2 if Surface Soil Contamination (A.4) or leachate (A.3) has been identified		2		2	2
B.2	WATER MOVEMENT					
B.2.1	TOPOGRAPHY					
	Steep Slope (>40 % Grade)	12				
	Sloping (10% to 40% Grade)	4-11				
	Subdued to 10% Slope	2-3				
	Flat (< 3%)	1	12	5	1	
B.2.2	COVER MATERIALS -DEPTH					
	No to little existing cover	4				
	Greater than 50% exposed/surface debris	3				
	Occasional exposed/surface debris	2				
	Existing cover, minimal debris.	1				
	Cover thickness > average active layer thickness	0	4	3	2	
B.2.3	COVER MATERIAL - TYPE					
	No cover	5				
	Silty/Sandy material	4				
	Sandy/Gravel material	3				
	Gravel material	1-2	5	4	3	
B.2.4	SURFACE WATER/RUN-OFF POTENTIAL					
	Very High - evidence of erosion, continuing run-off, or wave action	12				
	High - evidence of erosion, seasonal, widespread, storm waves	10				
	Moderate - % area affected by erosion	3-9				
	Low - no evidence of erosion, slight slopes	1-2	12	10	12	
B.2.5	PRECIPITATION					
	> 500 mm annual precipitation	5				
	< 500 mm annual precipitation (pro-rated)	1-4	5	3	3	
B.2.6	DISTANCE TO DOWNGRADIENT PERENNIAL SURFACE/ SEASONAL DRAINAGE CHANNEL					
	0 to 100 m	10				
	100 m to 300 m	7-9				
	300 m to 1 km	2-6				
	greater than 1 km	1	10	1	10	
	SPECIAL CONSIDERATIONS					
		+/- 5				
	TOTAL SCORE - PATHWAYS		50	28	33	

POTENTIAL ENVIRONMENTAL RISK - EVALUATION MATRIX						
DEW LINE LANDFILLS IN THE NUNAVUT REGION						
C.	RECEPTORS		Maximum Score	FOX-5 MAIN LANDFILL	FOX-5 AIRSTRIP LANDFILL	
C.1	POTENTIAL IMPACT ON RECEIVING FRESHWATER/MARINE HABITAT					
C.1.1	PROXIMITY TO RECEIVING FRESHWATER/MARINE HABITAT					
	0 to 100 m	6				
	100 m to 300 m	4-5				
	300 m to 1 km	2-3				
	greater than 1 km	1	6	1	6	
C.1.2	ESTIMATED HABITAT USAGE - FRESHWATER/MARINE					
	High: High Biodiversity/ High Occurrence/Calving or Spawning Area	5-6				
	Moderate: Moderate Biodiversity, Migratory	3-4				
	Low: Low biodiversity; rare sightings	1-2	6	6	6	
C.2	POTENTIAL IMPACT ON RECEIVING TERRESTRIAL HABITAT					
C.2.1	Extent of Vegetation					
	Extensive vegetation growth, (80 to 100 % ground cover)	6				
	Moderate vegetation growth (40 to 80% ground cover)	4-5				
	Low vegetation growth (20 to 40% ground cover)	2-3				
	Sparse vegetation (<20% ground cover)	1	6	1	1	
C.2.2	ESTIMATED HABITAT USAGE - TERRESTRIAL/AVIFAUNA					
	High: High Biodiversity/ High Occurrence/Calving, Denning or Nesting Area	5-6				
	Moderate: Moderate Biodiversity, Migratory	3-4				
	Low: Low biodiversity; rare sightings	1-2	6	4	3	
C.3	POTENTIAL HUMAN EXPOSURE THROUGH LAND USE					
C.3.1	Presence/Occupation					
	<i>Duration of contact</i>					
	High - Numerous visits, summer camp	high 8 moderate 6 low 4	8	6	7	
	Moderate - occasional summer camp	6 4 2				
	Low - Infrequent visits or winter camp	4 2 1				
C.3.2	Proximity to Drinking Water Source					
	0 to 100 m	8				
	100 m to 300 m	5-7				
	300 m to 1 km	2-4				
	greater than 1 km	1	8	1	1	
C.3.3	Food Consumption					
	High quantity of sedentary organisms - marine & plant life	8				
	Moderate quantity of sedentary organisms - marine & plant life	6				
	Low quantity of sedentary organisms - marine & plant life	4				
	No consumption	0	8	0	6	
	High quantity of migratory organisms	2				
	Moderate quantity of migratory organisms	1				
	Low quantity of migratory organisms	0.5				
	No consumption	0	2	2	2	
	SPECIAL CONSIDERATIONS					
		+/-5				
	TOTAL SCORE - RECEPTORS		50	21	32	
	TOTAL SCORE		150	88	105	

ANNEX C

Detailed Hydrocarbon Contaminated Area Evaluations

Summary Sheet

Hydrocarbon Contaminated Area Description

HYDROCARBON CONTAMINATION EVALUATION

DEW Line sites in Nunavut

Site:

Location:

Summary of areas

Area #	ID	Estimated Surface Area (m ²)	Estimated Volume (m ³)	Max. TPH Value (ppm)	Average TPH (ppm)
Area1	F5MOD2	1700	850	20000	10400
Area2	F5MOD3	72	36	11000	11000
Area3	F5DORM2	1000	1000	34000	20330
Area4	Station POL	3400	3400	15000	7700
Area5	Station MoGas	600	600	3900	3700
Area6	East Pad	210	84	38000	14644
Area7	Garage	7500	7500	41000	15200
Area8	Garage Pad	140	70	30000	19250
Area9	Beach POL	1000	1000	8000	5270
Area10	HVS Building	210	126	39000	14500
Area11	HVS Pad East	80	80	13000	7175
Area12	HVS Pad West	140	84	28000	15900
Area13	Gravel Pads	120	120	28000	7175

TPH = Total Petroleum Hydrocarbons
ppm = parts per million = mg/kg

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area1

FOX-5 Broughton Island

Name:

F5MOD2

Map reference:

B-1

Description of physical parameters

Maximum TPH concentration	20000	ppm
Number of surface samples analysed	5	
Number of depth samples analysed	6	
Approximate area of contamination	1700	m ²
Approximate depth of contamination	0.5	meter
Estimated volume	850	m ³
Number of samples used for average (>2500 ppm)	7	
Average TPH concentration	10400	ppm
Normalized volume factor	8840	
Type of hydrocarbon contamination	fuel	
Percentage of fuel oil	100	%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate slope of the area	<10	>10<20	>20<40	>40	%
Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60		%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500		meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area1

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Moderate	Low	Excavate to 30 cm depth, and backfill with clean fill.
Soil (dermal contact, ingestion, vegetation uptake)	Low	Low	No action required.
Water (dermal contact, ingestion)	Low	Low	No action required.

Additional information required for evaluation:

Additional information required for remediation design

no
Yes

(yes or no)

Recommended remediation solution:

Excavate to 30 cm depth, and backfill with clean fill.

Special factors to be considered:

Most contamination is at depth.

Other comments

Mitigating circumstances:

Cover material has to be maintained.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area2

FOX-5 Broughton Island

Name:

F5MOD3

Map reference:

B-1

Description of physical parameters

Maximum TPH concentration	11000	ppm
Number of surface samples analysed	1	
Number of depth samples analysed	0	
Approximate area of contamination	72	m ²
Approximate depth of contamination	0.5	meter
Estimated volume	36	m ³
Number of samples used for average (>2500 ppm)	1	
Average TPH concentration	11000	ppm
Normalized volume factor	396	
Type of hydrocarbon contamination	Lube Oil & Grease	
Percentage of fuel oil	0	%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate slope of the area	<10	>10<20	>20<40	>40	%
Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60		%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500		meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area2

FOX-5 Broughton Island

	Likelihood of Exposure	Receptor Sensitivity	Remediation Requirements
Atmosphere (inhalation of vapors)	Low	Low	No action required.
Soil (dermal contact, ingestion, vegetation uptake)	Low	Low	No action required.
Water (dermal contact, ingestion)	Low	Low	No action required.

Additional information required for evaluation:

no	(yes or no)
no	(yes or no)

Additional information required for remediation design

Recommended remediation solution:

Scarify for aesthetic reasons

Special factors to be considered:

No receptors identified in general area.
--

Other comments

On flat pad surface.

Mitigating Circumstances:

Lubricating Oil and grease are not easily mobilized.
--

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area4

FOX-5 Broughton Island

Name:

Station POL
B-4

Map reference:

Description of physical parameters

Maximum TPH concentration		15000	ppm
Number of surface samples analysed		24	
Number of depth samples analysed		11	

Approximate area of contamination		3400	m ²
Approximate depth of contamination		1	meter
Estimated volume		3400	m ³
Number of samples used for average (>2500 ppm)		18	
Average TPH concentration		7700	ppm
Normalized volume factor		26200	
Type of hydrocarbon contamination		Fuel	
Percentage of fuel oil		100	%
Approximate slope of the area		<10	>10<20
		>20<40	>40
			%

Area is estimated based on available data.
Depth is estimated based on available data.

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60		%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500		meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area4

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Moderate	Low	Excavate to 30 cm depth, and backfill with clean fill.
Soil (dermal contact, ingestion, vegetation uptake)	High	Low	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill.
Water (dermal contact, ingestion)	High	Low	Provide containment of source of contamination and/or reduce concentrations of contamination in situ.

Additional information required for evaluation:
Additional information required for remediation design

No
No

(yes or no)
(yes or no)

Recommended remediation solution:

Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill. See Mitigating circumstances

Special Factors to be considered

Other Comments

Mitigating circumstances:

The POL pad and berms are to be reshaped/regrading following removal and demolition of the tanks, The removal of hydrocarbon contaminated soil (50 cm or 2500 ppm) is to be from the final reshaped surface. The area is to be backfilled with clean soil.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area5

FOX-5 Broughton Island

Name:

Station Mogas

Map reference:

B-8

Description of physical parameters

Maximum TPH concentration		3900	ppm
Number of surface samples analysed		11	
Number of depth samples analysed		8	
Approximate area of contamination		600	m ²
Approximate depth of contamination		1	meter
Estimated volume		600	m ³
Number of samples used for average (>2500 ppm)		2	
Average TPH concentration		3600	ppm
Normalized volume factor		2160	
Type of hydrocarbon contamination		fuel	
Percentage of fuel oil		100	%
Approximate slope of the area		<10	>10<20 >20<40 >40 %

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat		<30	>30 <100 >100 <500 >500 meter
Estimated extent of vegetation cover in the vicinity		<20	>20 <60 >60 %
Approximate distance to marine/freshwater environment		<100	>100 <500 >500 meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area5

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Low	Low	No Action Required.
Soil (dermal contact, ingestion, vegetation uptake)	Low	Low	No Action Required.
Water (dermal contact, ingestion)	Low	Low	No Action Required.

Additional information required for evaluation:

no	(yes or no)
no	(yes or no)

Additional information required for remediation design

Recommended remediation solution:

No Action Required. If hydrocarbon contaminated soil is exposed during reshaping of POL berms, scarify surface to 30 cm depth.

Special factors to be considered:

Other comments

Contamination is at depth, therefore likelihood of exposure (atmosphere) is considered low.

Mitigating circumstances:

Evaluate area during construction when hydrocarbon contaminated soil may be exposed during reshaping of POL berms.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area6

FOX-5 Broughton Island

Name:

East Pad

Map reference:

B-5

Description of physical parameters

Maximum TPH concentration	38000	ppm
Number of surface samples analysed	7	
Number of depth samples analysed	2	
Approximate area of contamination	210	m ²
Approximate depth of contamination	0.4	meter
Estimated volume	84	m ³
Number of samples used for average (>2500 ppm)	9	
Average TPH concentration	14644	ppm
Normalized volume factor	1230	
Type of hydrocarbon contamination	Lube Oil & Grease	
Percentage of fuel oil	0	%
Approximate slope of the area	<10	>10<20
	>20<40	>40
		%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60	%	
Approximate distance to marine/freshwater environment	<100	>100 <500	>500	meter	

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area6

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Low	Low	No action required
Soil (dermal contact, ingestion, vegetation uptake)	Low	Low	No action required
Water (dermal contact, ingestion)	Low	Low	No action required

Additional information required for evaluation:
Additional information required for remediation design

no
no

(yes or no)
(yes or no)

Recommended remediation solution:

Scarify for aesthetic reasons.

Special factors to be considered:

Small isolated stains.

Other comments

Mitigating circumstances:

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area7

FOX-5 Broughton Island

Name:

Garage
B-6

Map reference:

Description of physical parameters

Maximum TPH concentration	41000	ppm
Number of surface samples analysed	20	
Number of depth samples analysed	22	
Approximate area of contamination	7500	m ²
Approximate depth of contamination	1	meter
Estimated volume	7500	m ³
Number of samples used for average (>2500 ppm)	26	
Average TPH concentration	15200	ppm
Normalized volume factor	114000	
Type of hydrocarbon contamination	fuel	
Percentage of fuel oil	90	%
Approximate slope of the area	<10	>10<20
	>20<40	>40
		%

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100	>100 <500	>500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60	>60	>500	%
Approximate distance to marine/freshwater environment	<100	>100 <500	>500	>500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area7

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Moderate	Low	Excavate to 30 cm depth, and backfill with clean fill.
Soil (dermal contact, ingestion, vegetation uptake)	High	Low	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill.
Water (dermal contact, ingestion)	High	Low	Provide containment of source of contamination and/or reduce concentrations of contamination in situ.

Additional information required for evaluation:

Additional information required for remediation design

yes

(yes or no)

yes

(yes or no)

Recommended remediation solution:

Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill. **See Mitigating Circumstances.**

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area7

FOX-5 Broughton Island

Special factors to be considered:

A large area that has hydrocarbon contamination in isolated areas on surface and is potentially extensive at depth.

Other comments

Mitigating circumstances:

The extent of contamination needs to be better defined. Approximately 500 m² are co-contaminated with Tier I. TPH at depth will attenuate over time, and the process may be accelerated with in situ remediation techniques. Evaluation of requirement for containment to be carried out when additional information on the extent of contamination is reviewed.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area8

FOX-5 Broughton Island

Name:

Garage Pad

Map reference:

B-7

Description of physical parameters

Maximum TPH concentration	30000	ppm
Number of surface samples analysed	8	
Number of depth samples analysed	5	
Approximate area of contamination	140	m ²
Approximate depth of contamination	0.5	meter
Estimated volume	70	m ³
Number of samples used for average (>2500 ppm)	4	
Average TPH concentration	19250	ppm
Normalized volume factor	1350	
Type of hydrocarbon contamination	Lube Oil & Grease	
Percentage of fuel oil	<10	%
Approximate slope of the area	<10	>10<20 >20<40 >40 %

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100 >100 <500 >500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60 >60	%
Approximate distance to marine/freshwater environment	<100	>100 <500 >500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area8

FOX-5 Broughton Island

Name:

Garage Pad

Map reference:

B-7

Description of physical parameters

Maximum TPH concentration	30000	ppm
Number of surface samples analysed	8	
Number of depth samples analysed	5	
Approximate area of contamination	140	m ²
Approximate depth of contamination	0.5	meter
Estimated volume	70	m ³
Number of samples used for average (>2500 ppm)	4	
Average TPH concentration	19250	ppm
Normalized volume factor	1350	
Type of hydrocarbon contamination	Lube Oil & Grease	
Percentage of fuel oil	<10	%
Approximate slope of the area	<10	>10<20 >20<40 >40 %

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100 >100 <500 >500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60 >60	%
Approximate distance to marine/freshwater environment	<100	>100 <500 >500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area9

FOX-5 Broughton Island

Special factors to be considered:

Area co-contaminated with Tier I and Tier II soils. The extent of hydrocarbon contamination at depth is not determined. A minimum area of contamination of 1000 m² over an average depth of 1.0 metres (may be deeper in the pad) is assumed.

Other Comments

Mitigating circumstances:

Tier I and Tier II soils on surface will be excavated. The POL area is to be reshaped following removal and demolition of the tanks. Require extent of contamination to be determined prior to confirming risk mitigation measures.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area10

Name:

Map reference:

FOX-5 Broughton Island

HVS Building

B-11(b)

Description of physical parameters

Maximum TPH concentration	39000	ppm
Number of surface samples analysed	11	
Number of depth samples analysed	1	
Approximate area of contamination	210	m ²
Approximate depth of contamination	0.6	meter
Estimated volume	126	m ³
Number of samples used for average (>2500 ppm)	5	
Average TPH concentration	14500	ppm
Normalized volume factor	1830	
Type of hydrocarbon contamination	fuel & lube oil	
Percentage of fuel oil	&grease	50 %
Approximate slope of the area	<10	>10<20 >20<40 >40 %

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100 >100 <500 >500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60 >60	%
Approximate distance to marine/freshwater environment	<100	>100 <500 >500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area10

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Moderate	Low	For surface lubricating oil contamination, scarify surface to 30 cm depth. For surface fuel oil contamination, excavate to 30 cm depth, and backfill with clean fill.
Soil (dermal contact, ingestion, vegetation uptake)	Moderate	Moderate	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first.
Water (dermal contact, ingestion)	Low	Moderate	No action required.

Additional information required for evaluation:
Additional information required for remediation design:

no
Yes

Additional depth sampling may be required.

Recommended remediation solution:

Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. The final land use of this area is to be determined and evaluated relative to the remediation requirements.

Special factors to be considered:

The area is co-contaminated with Tier I soils. This only includes the area within the HVS building. High contaminant levels of TPH associated typically with lubricating oil.

Other comments

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Mitigating circumstances:

Community uses building for storage, limited access. Tier I soils on surface will be excavated are co-contaminated with lube oil & grease. Fuel oil contamination is detected at depth; however, steel grate prevented more detailed depth sampling.

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area11

Name:

Map reference:

FOX-5 Broughton Island

HVS Pad East

B-11(b)

Description of physical parameters

Maximum TPH concentration	13000	ppm
Number of surface samples analysed	1	
Number of depth samples analysed	5	
Approximate area of contamination	80	m ²
Approximate depth of contamination	1	meter
Estimated volume	80	m ³
Number of samples used for average (>2500 ppm)	4	
Average TPH concentration	7175	ppm
Normalized volume factor	574	
Type of hydrocarbon contamination	both	Fuel & Lubricating Oil and Grease
Percentage of fuel oil	40%	%
Approximate slope of the area	<10	>10<20 >20<40 >40 %

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100 >100 <500 >500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60 >60	%
Approximate distance to marine/freshwater environment	<100	>100 <500 >500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area11 FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Moderate	Low	For surface lubricating oil contamination, scarify surface to 30 cm depth. For surface fuel oil contamination, excavate to 30 cm depth, and backfill with clean fill.
Soil (dermal contact, ingestion, vegetation uptake)	Moderate	Moderate	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first.
Water (dermal contact, ingestion)	Low	Moderate	No action required.

Additional information required for evaluation:

Additional information required for remediation design:

no	(yes or no)
no	(yes or no)

Recommended remediation solution:

Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill.

Special factors to be considered:

Three hydrocarbon stains, with over 50 percent of the area with lubricating oil and grease contamination.

Other comments

Mitigating Circumstances

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area12

Name:

Map reference:

FOX-5 Broughton Island

HVS Pad West

B-11(b)

Description of physical parameters

Maximum TPH concentration	28000	ppm
Number of surface samples analysed	3	
Number of depth samples analysed	4	
Approximate area of contamination	140	m ²
Approximate depth of contamination	0.6	meter
Estimated volume	84	m ³
Number of samples used for average (>2500 ppm)	5	
Average TPH concentration	15900	ppm
Normalized volume factor	1340	
Type of hydrocarbon contamination	lube oil & grease	
Percentage of fuel oil	<10	%
Approximate slope of the area	<10	>10<20 >20<40 >40 %

= Avg. TPH conc. X volume of impacted soil/1000

Description of environmental parameters

Approximate distance to potential camp site, terrestrial/avi-fauna habitat	<30	>30 <100 >100 <500 >500	meter
Estimated extent of vegetation cover in the vicinity	<20	>20 <60 >60	%
Approximate distance to marine/freshwater environment	<100	>100 <500 >500	meter

HYDROCARBON EVALUATION CHECKLIST AND WORKSHEET

Area12

FOX-5 Broughton Island

	Likelihood of exposure	Receptor sensitivity	Remediation requirements
Atmosphere (inhalation of vapors)	Low	Low	No action required.
Soil (dermal contact, ingestion, vegetation uptake)	Moderate	Moderate	Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first.
Water (dermal contact, ingestion)	Low	Moderate	No action required.

Additional information required for evaluation:

Additional information required for remediation design

no	(yes or no)
no	(yes or no)

Recommended remediation solution:

Excavate to 50 cm depth or to a depth at which TPH concentrations < 2500 ppm whichever is encountered first. Backfill with clean fill.

Special factors to be considered:

Other comments

Area to the immediate west of the HVS Building.

Mitigating circumstances:

