Nova Scotia Transportation and Infrastructure Renewal

Hydrogeological Investigation

Type of Document
Final

Project Name
Kurdistan and Arrow Oily Waste Disposal Sites
Hadleyville, Little Dover, Fox Island and Sandpoint

Project Number
SYD-00020401-A0

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Reviewed By: Fred Baechler, M.Sc., P.Geo.

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Date Submitted
July 2012

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July 2012

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Executive Summary

Nova Scotia Transportation and Infrastructure Renewal and Nova Scotia Environment contracted **exp** Services Inc., the new identity of ADI Limited, to undertake intrusive investigations at four Provincial oily waste management sites associated with cleanup of two marine based oil spills from the 1970s. The overall objectives for the work were to delineate any impacts to soil, groundwater and surface waters and to provide recommendations for managing risks at the sites, including monitoring.

On 04 February 1970 the tanker Arrow ran aground on Cerberus Rock in Chedabucto Bay, Nova Scotia, spilling approximately 5.9 million litres of Bunker C oil into Chedabucto Bay. Approximately 2.27 million litres was recovered and disposed of in nine sites. On 15 March 1979, the tanker Kurdistan split in two in the Cabot Straits, spilling 7.27 million Litres of Bunker C oil. Approximately 890,000 bags and 1,300 barrels of oil and oily debris were collected and disposed of in 10 sites.

The four sites described in this report include the 30 year old Hadleyville site associated with the Kurdistan spill and the 40 year old Little Dover, Fox Island and Sand Point sites, which were associated with the Arrow spill.

Four types of contaminants were disposed of including Bunker C oil, polyethylene bags, organic matter (dead birds, seaweed, and oiled fish) and miscellaneous materials (i.e., fish nets, oil booms, 205 litre drums). The composition of the buried oil was complicated by formation of a seawater-in-oil emulsion and weathering on the beaches prior to pick up and disposal. Once placed in the disposal sites, the oil was transferred from a high energy sea/beach environment to a low energy, subsurface environment. Therefore, natural degradation of the oil is minimized and the active life time of the sites expanded. The chemical characteristics of the oily waste leachate is generally characterized by elevated concentrations of total dissolved solids, pH, alkalinity, chloride, ammonia nitrogen, total organic carbon, iron, manganese and total petroleum hydrocarbons.

The main objectives for conducting the environmental assessment work were to assess soil, groundwater and surface water conditions around the disposal areas (except for Sand Point). This was to determine if any petroleum impacts, which may be cause for concern, had occurred as a result of the historical disposal activities. Since very little was documented at Sand Point, the intrusive program focused on delineating the extent and method of disposal.

Overall, no such impacts were in evidence that would warrant a more detailed assessment or that requires specific or immediate remedial action. Care and maintenance, with long-term monitoring and possibly some additional well installations are recommended. Additional recommendations for each site, which relate to ongoing maintenance and monitoring, are found within the report.

Hadleyville Site

The Hadleyville site is located on a logging road directly west of Highway 344, on a 5742 hectare parcel of Crown land, approximately 3 km north of the small coastal community of Hadleyville, Nova Scotia. The disposal site itself covers approximately 1.6 hectares.

The 30 year old site employed an entombment disposal methodology within a low permeable glacial till. Approximately 69,532 bags of Bunker C oil, sea water and oiled debris were disposed of at this site.

Investigations included installation of four groundwater monitoring wells and one surface water station; there was no indication for transport of hydrocarbons. There were preliminary indications for

release of inorganic parameters. There were no values elevated above the guidelines in soil and water for polycyclic aromatic hydrocarbons or total petroleum hydrocarbons/benzene, toluene, ethylbenzene and xylenes. The only elevated values noted downgradient were for nitrite and aluminum.

Given minimal dwellings in the vicinity, there is a low human health risk from the site. The proper management approach would include continual monitoring, care and maintenance, removal of trees growing over the site and trench cover caps, construction of a gate to prevent unauthorized entrance and identifying the site on existing mapping to restrict any other future land use.

Little Dover

The Little Dover site is located on an 8026 hectare parcel of Crown land located in the Canso Coastal Barrens Protected Area. The site itself covers an area of approximately 0.36 hectares. The site is located approximately 3.5 km north of the Town of Little Dover.

Oily waste disposal at this site was noted to be in one cell, placed directly on granite bedrock forming an above grade pile. It is not expected that a liner material was used and only a thin cover material was noted. On the south face of the disposal pile, beach stone, barrel fragments and beach sand were exposed. There were also other debris cast on the site, most likely post disposal era material, including shingles, wire, burn pits and vehicle frames.

Investigations included installation of four groundwater monitoring wells and two surface water stations. There were no detectable hydrocarbons or polycyclic aromatic hydrocarbon compounds in soils on the site. There were no total petroleum hydrocarbons/ benzene, toluene, ethylbenzene and xylene compounds detected or found above the guidelines in either the surface or groundwater samples. Polycyclic aromatic hydrocarbon compounds were detected, but not above guidelines, in all monitoring wells, but not in the surface water stations. Elevated values above guidelines were noted for inorganic parameters including colour, aluminum, manganese, ammonia, pH, cadmium and iron in groundwater and for pH, aluminum and iron in the surface waters.

Given minimal dwellings in the vicinity and placement within the Coastal Barrens, there is low human health risk from the site. The proper management approach would include consideration of construction of a mounded cover, removal of domestic wastes, continual monitoring, care and maintenance, removal of trees growing over the site, construction of a gate to prevent unauthorized entrance and identifying the site on existing mapping to restrict future land use. Additional intrusive testing is recommended to aid in better understanding the hydrogeological conditions under the site and understanding the nature and type of waste buried at the site. Consideration may also be given to the option of removing the waste from the site.

Fox Island

The Fox Island site is located on a 526 hectare parcel of Crown land located in Fox Island Main, Nova Scotia. The site itself covers an area of approximately 0.14 hectares. The site is located approximately 10 km west of the Town of Canso.

Oily waste disposal at this site was estimated to be in one above grade cell placed directly on the ground surface, apparently pushed over an embankment. It is not expected that a liner material was used and only a thin cover material was noted. On the southeast face of the disposal pile, beach stone and beach sand were noted to be exposed at surface. There were also other debris cast on the site, most likely post disposal era, including shingles, wire, burn pits, vehicle frames, wood debris, electronics and municipal solid waste.

Investigations included installation of three groundwater monitoring wells and one surface water station. There were no detectable polycyclic aromatic hydrocarbon compounds found in soils on the site. There were no total petroleum hydrocarbon/benzene, toluene, ethylbenzene and xylene compounds detected or found to be elevated above the guidelines in either the surface or groundwater samples. Polycyclic aromatic hydrocarbon compounds were detected in all monitoring wells and in the surface water station, but not at levels that were above the guidelines. Values elevated above the guidelines were noted for inorganic parameters including manganese, aluminum, colour, nitrite, nitrate+nitrite, cadmium, copper, iron and zinc in groundwater and for pH, aluminum and iron in the surface waters.

While there are dwellings within 0.5 km of the site that are suspected to be on groundwater supplies, monitoring data from the wells located on-site did not indicate any petroleum impacts that may be cause for concern. The proper management approach would include consideration for constructing a mounded cover cap over the disposal area, removal of domestic wastes illegally dumped on-site, continual monitoring, care and maintenance, removal of trees growing over the site, construction of a gate to prevent unauthorized entrance and identifying the site on existing mapping to restrict future land use. Additional intrusive testing is recommended to aid in better understanding the hydrogeological conditions under the site and understand the nature and type of waste buried at the site. Consideration may also be given to removing the waste from the site.

Sand Point

The Sand Point site is situated on a 5742 hectare parcel of Crown Land and covers approximately 0.15 hectares. It is located 1 km south of the community of Sand Point.

Very little is known concerning disposal operations. Test pitting indicated the 40 year old site did not employ any disposal methodology, as would be appropriate by today's standards. The disposal zone is placed near or within the water table, with no under till liner, minimal surface cover, no mounded cover cap and is overgrown with trees. The risk for release is, therefore, qualitatively high.

Investigations included excavating 20 test pits within and around the disposal area. Organic contaminants were visually noted scattered in discrete zones and present in sealed clear plastic bags, lab analyses of product layers did not exceed applicable guidelines. There was some visual evidence on the surface of beach stone along the north property boundary. There were also significant quantities of domestic waste disposed of on the site.

There were no elevated soil values for hydrocarbons, metals and volatile organic compounds.

Polycyclic aromatic hydrocarbon compounds were compared to the CCME 2010 Soil Quality Guidelines. There were no elevated values for polycyclic aromatic hydrocarbon compounds in relation to the Industrial Soil Quality Guidelines. The carcinogenic compounds were converted to Potency Equivalence factors for direct comparison as benzo(a)pyrene. The results from sample SP10-TP5 were elevated 3.7 above the protection of potable water (SGQ PW) guidelines.

1 Introduction

1.1 Contract

Nova Scotia Transportation and Infrastructure Renewal (NSTR) and Nova Scotia Environment (NSE) contracted **exp** Services Inc. (**exp**), the new identity of ADI Limited, to undertake intrusive investigations four Provincial oily waste management sites associated with cleanup of two marine based oil spills from the 1970s.

The Hadleyville site was associated with the 1979 Kurdistan oil spill. The Fox Island, Little Dover and Sand Point sites were associated with the 1970 Arrow oil spill.

The initial field program was carried out between May and September 2010. Additional intrusive work and monitoring was undertaken during November and December 2010.

1.2 Location of Sites

The location of the four sites covered is provided in Figure 1-1. The sites are positioned around Chedabucto Bay to accommodate the cleanup of the most heavily oiled shorelines.

1.3 Structure of Report

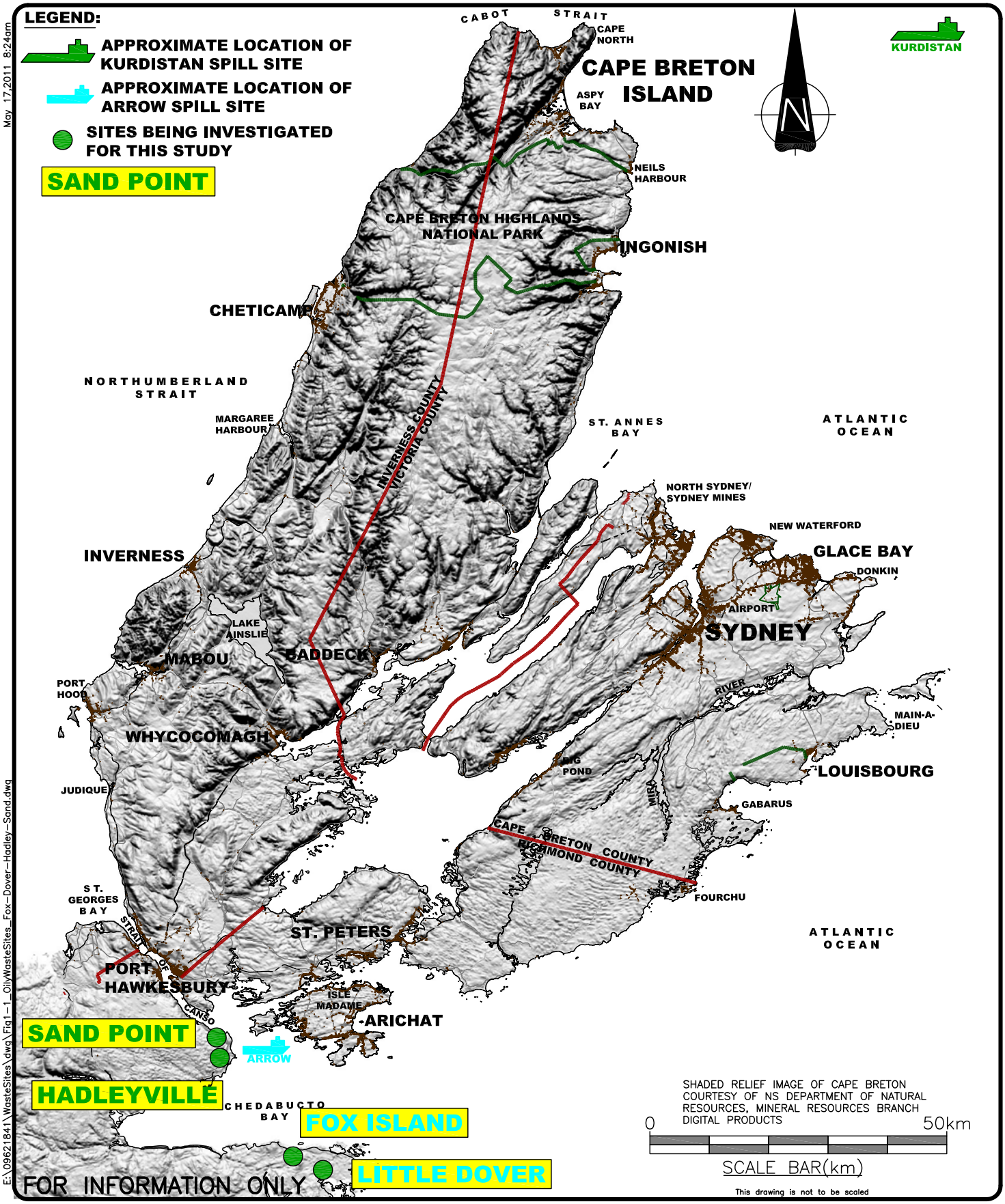
The report is structured to provide background information regarding the nature of the spills and reasons for selection of the sites in Section 2. Section 3 outlines the scope of work required for this assignment. Section 4 summarizes the field program employed to investigate the sites. Sections 5, 6, 7 and 8 outline the findings for the Hadleyville, Little Dover, Fox Island and Sand Point sites, respectively.

2 Background

2.1 Spill History

On 04 February 1970 the 18,000 DWT tanker Arrow, carrying 17.3 x 10^6 litres of Bunker C fuel oil, ran aground on Cerberus Rock in Chedabucto Bay, Nova Scotia (Figure 1-1). Approximately one-third of the cargo was recovered from the tanker and one-third driven out to sea. The remaining 5.9 x 10^6 litres (approximately) was trapped in Chedabucto Bay and was mainly on the beaches. Approximately 2.3 x 10^6 litres were recovered from 48 km of cleaned beaches and placed in nine selected disposal sites (Task Force Operation Oil, 1970). Three of the sites were the Little Dover, Fox Island and Sand Point sites discussed in this report. A preliminary assessment of the site was undertaken by Baechler et al (1976). Recommendations were made for intrusive investigations to better understand and monitor the impact of disposal operations.

On 15 March 1979, the tanker Kurdistan split in two in the Cabot Straits (Figure 1-1), spilling 7.3 x 10^6 litres of Bunker C oil. Approximately 890,000 bags and 1,300 barrels of oil and oily debris were collected on Cape Breton Island and the Canso Strait area; accounting for approximately 91% of all oil recovered (Baechler, 1980). One of the specially designed containment sites was constructed at



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Proj.	INVESTIGATION OF OILY WASTE SITES
Dwg.	LOCATION OF OILY WASTE DISPOSAL SITES

Drawn By: NB	Proj. No. SYD-00020401-A0	
Dwg. Standards Chk. By:	Dwg. No. FIGURE 1-1	
Designed By: FB	Dwg. Design Chk. By: FB	Rev. 0

the Hadleyville location discussed in this report. A report detailing design, construction and operations was provided by Baechler (1980). Recommendations were made for intrusive investigations to better understand and monitor the impact of disposal operations.

2.2 Reasons for Site Selection

At the time of the Arrow incident disposal sites had not been pre-selected; therefore, sites in proximity to the shorelines being cleaned up, i.e., Little Dover, Fox Island and Sand Point, were selected. A review of the sites 6 years after spill cleanup (Baechler et al, 1976) noted that as a result there was no time for intrusive investigations to assess and design the sites. Further, no information was collected during operations concerning the amount and type of oily waste or disposal methodology. No ground/surface water monitoring programs were established.

In the fall of 1975, NSE created a list of guidelines for selection of oily waste disposal sites (Brisco, et al, 1976), giving consideration to land ownership, accessibility, surficial material, topography, bedrock and surface/groundwaters. Preliminary site selections were made over the Province, of which the Hadleyville site was one. However, no intrusive investigations were undertaken prior to the Kurdistan incident.

2.3 Site Operations

The Hadleyville site was operational between approximately April and November 1979. This abandoned site is now over 30 years old. The Little Dover, Fox Island and Sand Point sites were operational during the winter of 1970; placing them at approximately 40 years old. Details are provided under the relevant sections describing each site.

2.4 Site Closure

No additional assessment and/or monitoring, except for visual assessment for general site conditions, have been undertaken on these sites since disposal operations ceased.

2.5 Wastes Disposed of and Potential Pathways for Release

Generally four types of contaminants were disposed of within these oily waste sites including:

- Bunker C;
- polyethylene bags;
- organic matter (including dead birds, kelp, seaweed, oiled fish); and
- miscellaneous materials (i.e., fish nets, oil booms, drums, some domestic waste).

No chemical dispersants were used in cleanup operations associated with the Kurdistan. Dispersants and cleaning solutions may have been associated with Arrow oily wastes disposed of at the Little Dover, Fox Island and Sand Point sites.

The principal contaminant in the disposal sites is a heavy, residual #6 fuel oil or Bunker C (C20 and greater) being transported by both the Kurdistan and Arrow tankers. No complete analysis is available of either cargo. A preliminary analysis of the Arrow product (Baechler, 1980) indicated:

Hydrocarbons (oils including paraffins, isoparaffins, cycloparaffins, mono-aromatics, polyaromatics and sulfur compounds)	73.1% wt.
Non Hydrocarbons (Resins – little known about composition)	16.31% wt.
Asphaltenes (little known about composition)	9.28% wt.
Unrecovered (little known about composition)	1.31% wt.

Notable elements present (as % wt.) included carbon (86.13), hydrogen (11.56), sulfur (2.21), oxygen (1.25) and nitrogen (0.39). Notable metals (at greater than 10 ppm) included: vanadium (272 to 386), aluminum (100), barium (970), nickel (50), iron (50), titanium (40) and cadmium (10).

The quality certificate for the Kurdistan cargo indicated:

Penski-Martin Flash Point	93^{o}C
Specific Gravity at 15.6^{o}C	0.9561
Pour Point	7^{o}C

This chemical composition is complicated by the fact that the oil was initially spilled into seawater at a time of extreme agitation by heavy pack ice, high wind and waves. This allowed the oil to form a seawater-in-oil emulsion prior to pick up and disposal. Weathering processes likely to have occurred during this time include evaporation, emulsification, solution, dispersion, photo-chemical reaction, oxidation and biodegradation. All of these will have acted to change the chemical/physical characteristics of the initial oil.

In addition, once ashore and depending upon priority placed upon beach cleanup, the oil may have remained exposed for up to 4 to 5 months prior to removal; leaving the oil exposed to wave action, microbiological activity and sunlight. It was noted that as summer proceeded, heating of the oil on the beach caused it to mobilize and sink into the beach sediment. Hence, bags disposed of during the summer months had more sediment and less oil than during the winter.

The ramifications of this characterization for assessing the risk of release at the disposal sites is four fold:

1. Once placed in the disposal sites, the oily wastes are transferred from an active, aerobic, high energy sea/beach environment to an anaerobic, low energy, low temperature subsurface environment. Therefore, the time for natural degradation of the oil is expected to be lengthened considerably and, therefore, the life time during which the site acts as an active source for release of contaminants is expanded.

2. Due to the low vapour pressure of Bunker C, high carbon numbers (> C20) and ground temperature (10 to 15^{o}C) in the subsurface disposal regime, evaporation may be disregarded. This is expected to eliminate formation and transport of volatiles in the unsaturated zone.

3. The initial release of the oil will be controlled by the 100% polyethylene bags used for transporting the oil from the beaches to the disposal sites. This method of transport was characteristic of the Kurdistan spill. Bulk transport of debris from the beaches in dump trucks characterized the Arrow spill. While the material comprising the bags can be broken down by contact with oil based material, the time frame is unknown.

4. This leaves the possibility of four pathways for transporting hydrocarbons off-site including:

- non-soluble Light Non-Aqueous Phase Liquid (LNAPL) components could move laterally downgradient on the water table/capillary fringe.
- the soluble components could move throughout the groundwater flow system.
- whether Dense Non-Aqueous Phase Liquid (DNAPL) components were formed as a result of weathering and emulsification of the oil is unknown.
- residual Phase will be present, adsorbed onto sediment within the trenches and available for leaching.

Minimal data was available in the literature concerning the composition of the leachate to be expected within an on-land disposal site for Bunker C type hydrocarbons from a marine based spill. To provide guidance in this regard and, therefore, indicator parameters to aid in detection of any plume movement, Baechler (1980) reported on samples collected from 11 in-trench wells at the Hadleyville, Fourchu and St. Peter's disposal sites. These samples represent water within the disposal trenches soon after capping. They, therefore, should represent the chemical characteristics of the contaminants in question. Details of each trench sample are reported within the discussion of the Hadleyville disposal site. Overall comments are provided below after Baechler (1980).

1. Generally the chemistry indicates a brackish to saline (total dissolved solids (TDS) of 748 to 12,832 mg/L), very hard (315 to 4,000 mg/L), encrusting, sodium-chloride to sodium bicarbonate type water, with a pH range of 6.6 to 7.5. Nutrients are characterized by elevated nitrogen (kejldahl N of 1 to 46 mg/L) and total organic carbon (27 to 1500 mg/L). Of the 20 metals analyzed for, iron (5.4 to 104 mg/L) and manganese (6 to 51 mg/L) were always elevated. There were also fluctuations in arsenic, barium, lead, antimony and selenium. Organics were characterized by non-detectable to 5 mg/L of total petroleum hydrocarbons (TPH). Microbiological traits were characterized by total and faecal coliforms ranging from 0 to plus 8000/100 ml.

2. Elevated concentrations of sodium and chloride, as well as sodium/chloride ratios of 0.83 (similar to seawater of 0.85) indicate the dominance of this source.

3. The relatively large concentration of nitrogen is predominately in the form of ammonia or organic nitrogen. Possible sources include hydrocarbons, biodegradation products, organics (kelp, dead birds, etc.).

4. Hydrocarbons were visually apparent in the leachate, but difficult for the lab to quantify. This was partly due to the large concentrations of sediment in the water and analytical techniques focused on <C20. Therefore, non-detects may still include the presence of higher carbon numbers. The data indicated a variable range of 0 to 5 mg/L in the liquid extract, with six out of 11 trenches showing nothing. The sediment extracts showed contamination in virtually the same trenches as the liquid extract. In those samples recording oil, however, large concentrations were found in the sediment involving a wide range of carbon numbers and a definite indication of the presence of C20 and above.

3 Scope of Work and Project Objectives

The overall objectives for the work performed, as outlined by NSTIR, were as follows:

1. Assess soil, groundwater and surface water conditions surrounding the disposal sites in order to determine if any contaminant impacts have occurred as a result of the historic disposal activities.

2. Provide recommendations for the risk management of the sites in the short and long-term (including any required immediate remedial or risk assessment activities, remedial plan or risk management plan) commensurate with the significance of identified impacts.

3. Provide recommendations for monitoring of the sites in the short and long-term, commensurate with the significance of identified impacts.

Work performed on the Sand Point site was solely to delineate the extent and method of disposal.

4 Field Program

4.1 Field Reconnaissance

A field reconnaissance was carried out by **exp** and NSE at the Hadleyville, Little Dover and Fox Island sites on 18 May 2010. Prior to the visit, NSE personnel had visited each site in an attempt to locate the disposal areas. Selection of potential drill sites, the extent of the disposal areas, surface water monitoring locations and any existing on-site monitoring wells were located with a hand-held GPS. These locations were provided to NSDNR, which provided cutting crews to clear access. Reconnaissance of the Sand Point site was undertaken initially on 18 May 2010 by **exp** and NSE and then again to assess intrusive investigation monitoring points on 16 November 2010. During the 16 November 2010 assessment, **exp** was accompanied by NSDNR representatives.

The Hadleyville site was flown by **exp** on 11 June 2010 to provide oblique aerial digital photographs. This supplemented oblique aerial photographs taken by NSDNR and NSE personnel in the fall of 2009 at Hadleyville, Little Dover and Fox Island.

4.2 Design of Intrusive Program

4.2.1 Hadleyville, Little Dover and Fox Island

The approach in designing the intrusive program for the disposal methodology utilized at the Kurdistan and Arrow sites recognized that:

1. The release pathways for contaminants to be transported off-site could include:
   - Pathway 1: downward flow into the shallow bedrock and then laterally off-site within the active Groundwater Flow Field.
   - Pathway 2: vertical upward transport through the seal and cap, then flow through the interflow zone within the shallow groundwater Quick Flow System.
   - Pathway 3: lateral flow through the till.

2. The thickness of overburden between the base of the trenches and the top of rock was an important consideration for assessing Pathway 1. Given the project scope it was decided that the first well on each site would go to approximately 19 metres. If bedrock was not encountered, then Pathway 1 was not a focus of the investigation and subsequent drilling and monitoring well installation targeted Pathway 3 down to a depth of 2 metres below the base of the trenches. This approach was not required at the Little Dover site as bedrock was visible at surface over most of the site.

3. For wells specifically targeting the overburden, the decision was made to focus on determining the presence of contamination, not to assess the horizontal and vertical components of the groundwater flow system in detail. Therefore, rather than short screened length piezometers, the entire length of the boreholes were screened to within approximately 2 metres of ground surface.

4. Monitoring wells were installed immediately downgradient of the operations area to detect the first sign of release, not at the edge of the property boundaries where regulatory compliance points maybe implemented. Identifying the lateral and vertical extent of any detectable plume was not part of this assignment. No intrusive testing was targeted directly within or under the operations area, to ensure the viability of the disposal area was not compromised.

5. Given the shallow nature of Pathway 2, assessment for the presence of contamination focused on: a) visual inspection of topographic depressions where interflow would come to the surface as storm saturated overland flow; b) evidence of staining and dead vegetation; and c) springs/seeps.

Given the absence of intrusive information and method of disposal for the Sand Point site, a test pit program was undertaken to delineate the lateral and vertical extent of the disposal area, as well as type of wastes disposed of, method of disposal and capping. To minimize contaminant transport to depth into the bedrock, test pits were excavated only to the bottom of the wastes.

Submissions were made to NSDNR requesting access to the Crown lands on which the sites were located. This included provision of Health/Safety and Fire Protection Plans. GPS coordinates for proposed intrusive sites and an outline of what clearing was required to provide access for the drill rig or track hoe were also provided.

4.3 Assessment and Evaluation Criteria

Discussions with the appropriate regulatory agencies defined the following guidelines to be applied to the sites.

1. Groundwater under and around the disposal sites, as well as the Crown land they are located on were to be deemed non-potable. Since the sites are all in non-serviced areas, a commitment would be made to ensure potability at the property boundaries.

2. TPH in soil and water would be screened against Atlantic PIRI Tier II screening for commercial use, with coarse grained soils, non potable groundwater use and soil ingestion pathways.

3. Metals and volatile organic compounds (VOCs) in soils would be screened against Canadian Council of Ministers of the Environment (CCME) Industrial Land Use.

4. Metals, general inorganic parameters, VOCs and PAH in water would be screened against draft NSE Environmental Quality Standards Tier 1 (EQS) (2011). Please note that errors in the quality standard tables were observed for pH and nitrate. Nitrate has been left as noted in the table, while pH has been compared to the Health Canada Guidelines for Canadian Drinking Water Quality 6.5 to 8.5.

5. Polycyclic aromatic hydrocarbons (PAHs) in soil and water would be screened against CCME 2010 Industrial Guidelines.

Guidelines are provided in appendices on summary soil and water tables for the respective sites.

4.4 Drilling and Well Installation

Drilling, installation of monitoring wells and collection of soil samples for analysis at the Hadleyville site was undertaken on 03 and 04 August 2010; at the Little Dover site on 05 and 06 August 2010; and at Fox Island on 07 August 2010. The drilling subcontractor was Boart Longyear, which provided equipment and personnel from their Sydney operation. All well sites were surveyed into geodetic for horizontal and vertical control.

Subsequent water monitoring was carried out 01 and 02 September 2010, representing a summer, non-rainfall event condition, including:

- collection of static water levels, measurement of field parameters and collection of water samples for chemical analysis from the recently installed monitoring wells;
- hydraulic conductivity testing on all newly installed monitoring wells using a rising head method;
- measurement of field parameters and collection of surface water samples for chemical analysis from nearby pertinent surface waters/springs; and
- collection of head levels and indicator chemistry from available in-trench monitoring wells.

A second suite of water samples was collected at the Hadleyville, Little Dover and Fox Island sites on 07 and 08 December 2010 to represent flushing action during fall recharge events.

Test pits in Sand Point were undertaken on 01 December 2010. These were located with a Garmin eTrex Summit HC hand-held GPS device, which was noted to be within ± 3 metres accuracy on the day of testing.

4.5 Laboratory Analyses and Quality Assurance/Quality Control

All soil and water samples were submitted to Maxxam Analytics Inc.'s (Maxxam) Sydney laboratory for chemical analysis. This laboratory is a Standards Council of Canada (SCC) and Canadian Association of Laboratory Accreditation (CALA) accredited laboratory.

A value of 10% of samples was duplicated as part of a Quality Assurance (QA)/Quality Control (QC) program through blind internal lab duplicates. The QA/QC program included <10% ion balance check on surface and groundwater samples and a comparison between original and duplicate samples for relative percent difference (RPD). Target duplication was considered to be 25% RPD with the maximum acceptable RPD at 50%.

4.6 Risk Assessment

No detailed human and/or ecological risk evaluation was requested as part of this assignment. However, a qualitative evaluation of potential risks was developed, based upon existing land use, site reconnaissance and activity in the area.

4.7 Data Appended

A separate appendix is provided for each of the four sites. Within each, information is provided for well logs, hydraulic testing, water levels, soil geochemistry and water chemistry.

5 Hadleyville

5.1 Location

The Hadleyville site is located on a logging road directly west of Highway 344, on a 5742 hectare parcel of Crown land, approximately 3 km north of the small coastal community of Hadleyville, Nova Scotia. The disposal site itself covers approximately 1.6 hectares (Figure 5-1). Two overview oblique aerial photographs characterize conditions during operations (Plate 5-1) and testing for this assignment (Plate 5-2).

Plate 5-1: Oblique aerial view of the Hadleyville site during oily waste disposal looking south.

Plate 5-2: Oblique aerial view of the Hadleyville site during this assignment (2009) looking north.

5.2 Land Ownership, Use and Access

Plate 5-3: Tree growth over the cover caps and around the in-trench monitoring wells for Trenches 1 (center background) and 2 (foreground).

The site is positioned on Provincial Crown land under the jurisdiction of the NSDNR.

The site is accessed off Highway 344, along a gravelled secondary woods road 0.3 km from the intersection with the former (Figure 5-1).

Prior to development for disposal, the site was naturally forested (Plate 5-1). Since disposal ceased, the site is gradually growing back in with shrubs and spruce (Plates 5-2 and 5-3).

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PROPERTY PLAN
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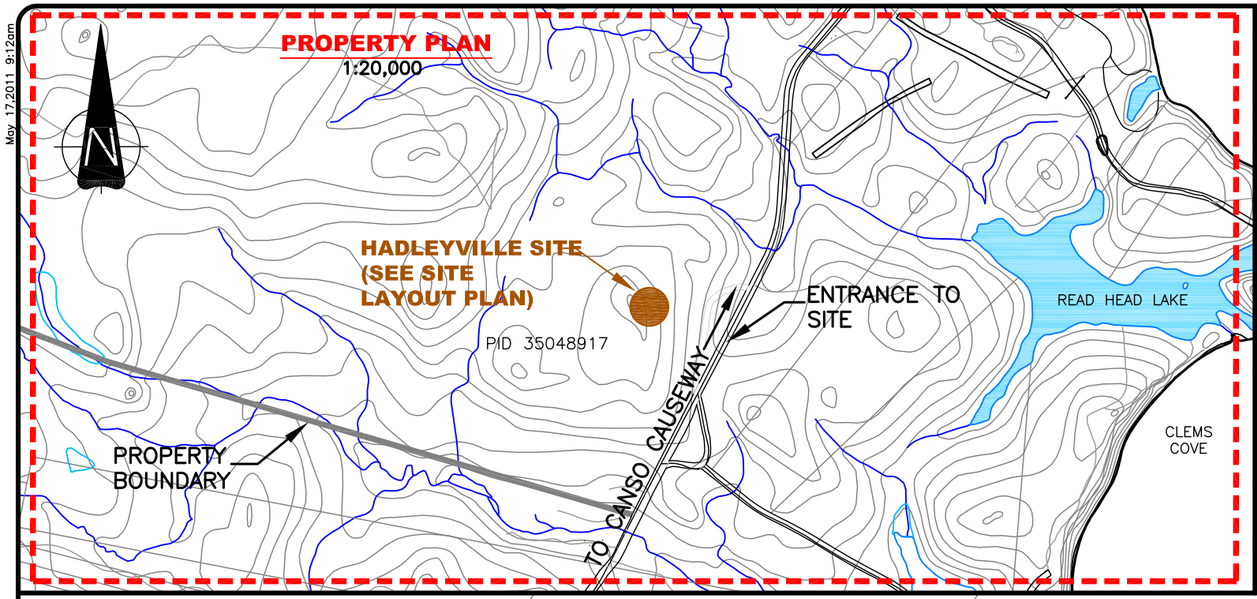

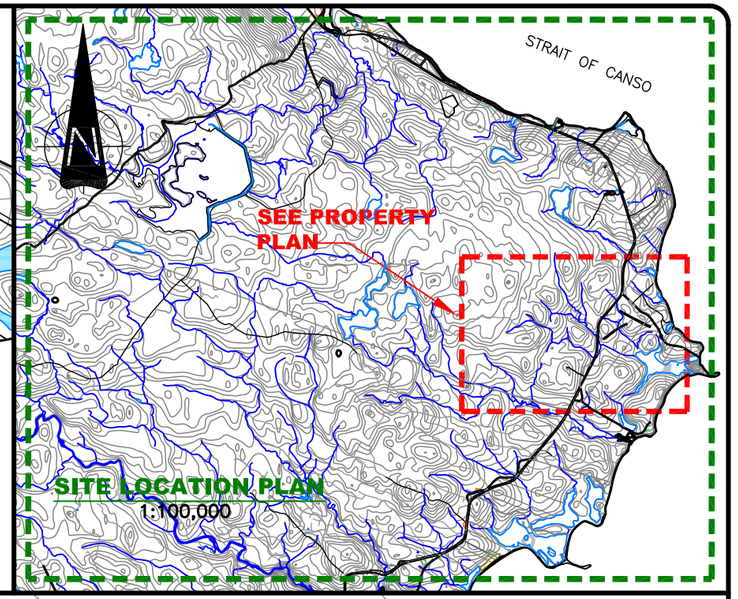

SITE LOCATION PLAN
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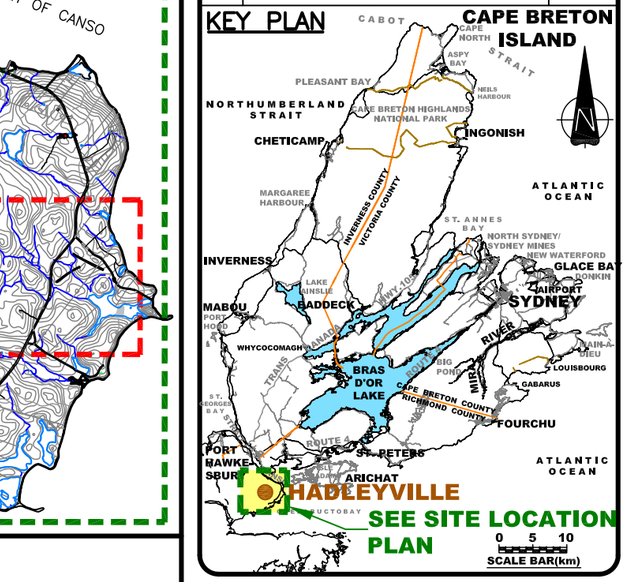
BASED UPON 1:10,000 DIGITAL
MAPPING WITH 5m CONTOUR INTERVAL

H10–SW01



FOR INFORMATION ONLY

No.	Issue	Date
1	FOR INFORMATION ONLY	26–APR–11

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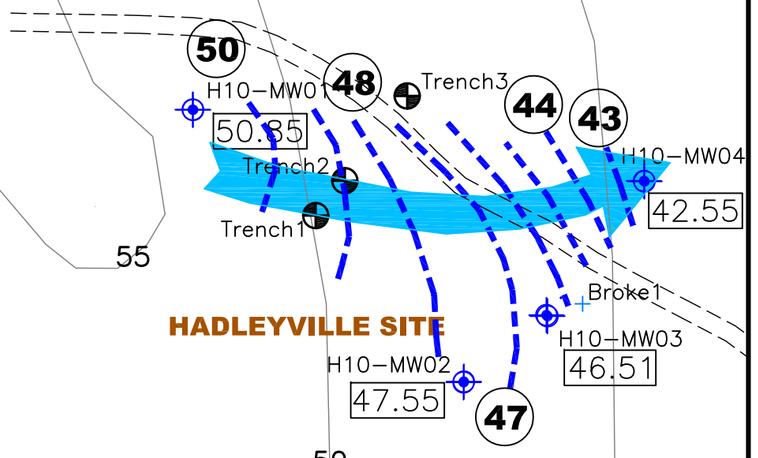
LEGEND:

- 50.85 / H10–MW01 — LOCATION & IDENTIFIER FOR MONITORING WELL(MW) LOCATIONS WITH WATER LEVEL ELEVATION(m)
- Trench1 — EXISTING IN–TRENCH MONITORING WELL LOCATIONS & IDENTIFIERS
- SURFACE WATER SAMPLING LOCATION
- 50 — GENERAL SURFACE CONTOUR ELEVATIONS(m) BASED UPON 1:10,000 DIGITAL MAPPING
- SITE ACCESS ROAD
- 47 — EQUIPOTENTIAL CONTOURS ON WATER TABLE WITHIN THE TILL HU (08 DECEMBER 2010) (APPROXIMATE; ASSUMED)

SITE LAYOUT PLAN
1:1000



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Dwg. Standards Ckd. By:	
Designed By:	FB
Date Printed	11.May.17
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Project Title

INVESTIGATION INTO OILY WASTE SITES

Dwg. Title

HADLEYVILLE KURDISTAN OILY WASTE DISPOSAL SITE

Project No.	SYD–00020401–A0
Dwg. No.	FIGURE 5–1
Rev. No.	0
Scale	AS SHOWN

This drawing is not to be scaled

E:\09621841\WasteSites\dwg\Figs_Hadley–Dover–Fox.dwg

To allow for site development, a new access road was constructed (Plate 5-1). This later allowed for forestry operations beyond the site following disposal (Plate 5-2). The road has remained open and is still used for forestry operations.

5.3 Site Reconnaissance

The site was visited by **exp** and NSE personnel on 18 May 2010. There were no gates or other barriers restricting access to the site.

As a result of this site being accessible to the general public, there has been some deposition of residential wastes non the property; mainly furniture, wood, building materials, some general household municipal solid waste and vehicle parts. It was noted that despite the road being used for forestry operations, cutting activities have not encroached over the disposal site.

The site was growing over with shrubs and spruce. The growth of the latter to heights of 2 to 4 metres on the cover caps was of concern, due to potential damage to the viability of the trench caps and seals (Plate 5-4).

Plate 5-4: Looking east at the damaged in-trench monitoring well downgradient of Trenches 1 and 2.

Three in-trench wells were observed to still be in place during the 18 May 2010 site visit. There was one monitoring well located downgradient (east) of the trenches that had lifted, most likely due to frost. The Trench 1 monitoring well was observed to be cracked at surface and obstructed at 0.60 metres depth. During the 18 May 2010 site visit there was a strong sewer odour coming from this in-trench monitoring well. This odour was not observed during any of the subsequent site visits. The Trench 2 monitoring well was found to be in acceptable condition and was noted to be unobstructed to an approximate 3 metre depth. The Trench 3 monitoring well was observed to be obstructed at 0.6 metres depth.

There were no visual or olfactory signs of hydrocarbon release at surface. There were no springs or seeps identified near the disposal site. There was a small perimeter drain located along the south side of Trench 1, which was observed to be dry during all site visits conducted during this assessment. There was an area of standing water and a small brook located approximately 0.3 km west of the site. There were no signs of hydrocarbon contamination. No zones of dead vegetation were in evidence.

5.4 Intrusive Program

For this assignment, a total of four sites were drilled and one monitoring well installed at each site (Figure 5-1), screened in the glacial till.

Monitoring well H10-MW01 was positioned upgradient of the disposal area to provide background conditions. The remaining three well sites were positioned immediately down topographic gradient of the disposal trenches. This assumed that groundwater flow in the overburden would in large measure be controlled by topographic constraints.

5.5 Site Design and Operations

The Hadleyville site was operational for the Kurdistan spill. It received oily wastes from approximately 275 km of shoreline from Country Harbour to the Canso Causeway. Information reported by Baechler (1980) indicated:

1. The site was operational between May and August 1979.

2. An entombment disposal methodology was utilized in the design. This included selection of sites with thick, low permeability, basal glacial till. Subsurface burial was within three, 3 to 3.5 metre deep trenches (Plate 5-5).

3. Daily disposal of material was followed by a thin cover of fill, derived from on-site till, which was graded to drain any rainwater to a sump for pumping to keep the trenches dry for disposal. This daily cover created numerous mini cells within each trench. Disposal ceased within approximately 1 metre of ground surface.

Plate 5-5: Trench 3 disposal with monitoring well construction commencing within the south side wall.

4. A seal of fill was emplaced to bring the trench to grade, but without any permeability stipulations.

Plate 5-6: An oblique aerial view of the site after capping, looking toward the northeast. Note the French drain and swale diverting shallow groundwaters around site.

5. The trench was then mounded above grade with the same fill (Plate 5-6) and seeded to both facilitate runoff and minimize erosion.

6. A monitoring well was installed in the side wall of each trench (Plate 5-5) during operations to allow for monitoring of water level and chemistry within each trench after burial ceased.

7. A French drain was installed upgradient of the trenches to direct shallow subsurface flow around the site into a linear topographic depression on the south side of the operations area.

8. A total of 69,532 bags of Bunker C oil, sediment, dead birds, sea water and oiled debris were disposed of at this site.

5.6 Hydrological Setting

5.6.1 Hydrological Region/District

The site is positioned within what would be equivalent to the Lowland Hydrogeological Region, Sedimentary Plain Hydrogeological District (Baechler et al, 2009). Distinctive features generally include a low relief, gently undulating, bedrock controlled topography, underlain by sedimentary rock,

comprised predominantly of argnaceaous beds, interbedded to varying degrees with siltstones and shales. The surface is blanketed by thin to thick continuous silty sand to clayey silt glacial till,

A three-dimensional conceptual block model of this District notes the active groundwater flow field is expected to be governed by the hydrostructural rock domain (Figure 5-2). This is semi-confined by a silty sand Till HU. Ground surface water interaction is expected to be controlled predominantly by a shallow groundwater quick-flow-system operating in the soil and upper weathered portion of the Till Hydrostratigraphic Unit (HU), usually within 1 to 2 metres of ground surface.

Hydrologically the site is positioned within provincial drainage basin 1ER-SD3 watershed, which drains southwest to discharge into Read Head Lake estuary and then the Atlantic Ocean in Clems Cove (Figure 5-1).

5.6.2 Hydrogeology

The drilling program confirmed the hydrological setting noted above, as well as the findings from the initial test pit program undertaken prior to site development (Baechler, 1980), which suggested good qualities for an entombment site. Specifically, the background well (H10-MW01) encountered over 19.2 metres of a compact to dense, gravelly, moderate brown, sandy silt basal glacial till; no bedrock was encountered. The initial test pit exposures confirmed the site was underlain with massive, very dense, reddish brown, stony, clayey silt basal till down to 4.67 metres depth. No sand lenses were observed.

Given the thickness of the overburden, the remaining three wells were drilled to 7.6 metres depth, 3 metres below the depth of the disposal trenches.

One grain size analysis, taken from a sample at H10-MW01 at 6.14 to 9.76 metres depth, indicated gravel at 11.7%, sand at 30.8% and silt/clay at 57.5%. This sample in general terms showed a lower percentage of gravels and a greater percentage of fines than those analyzed in 1979 (Baechler, 1980). Those samples indicated gravel (range 13 to 62%; average 32.5%), sand (range 15 to 34%; average 27.6%) and silt/clay (range 23 to 56%; average 39.8%). It should be noted that the range in depth and the sampling methodology employed in the 2010 sampling event may contribute to the variance in gradation.

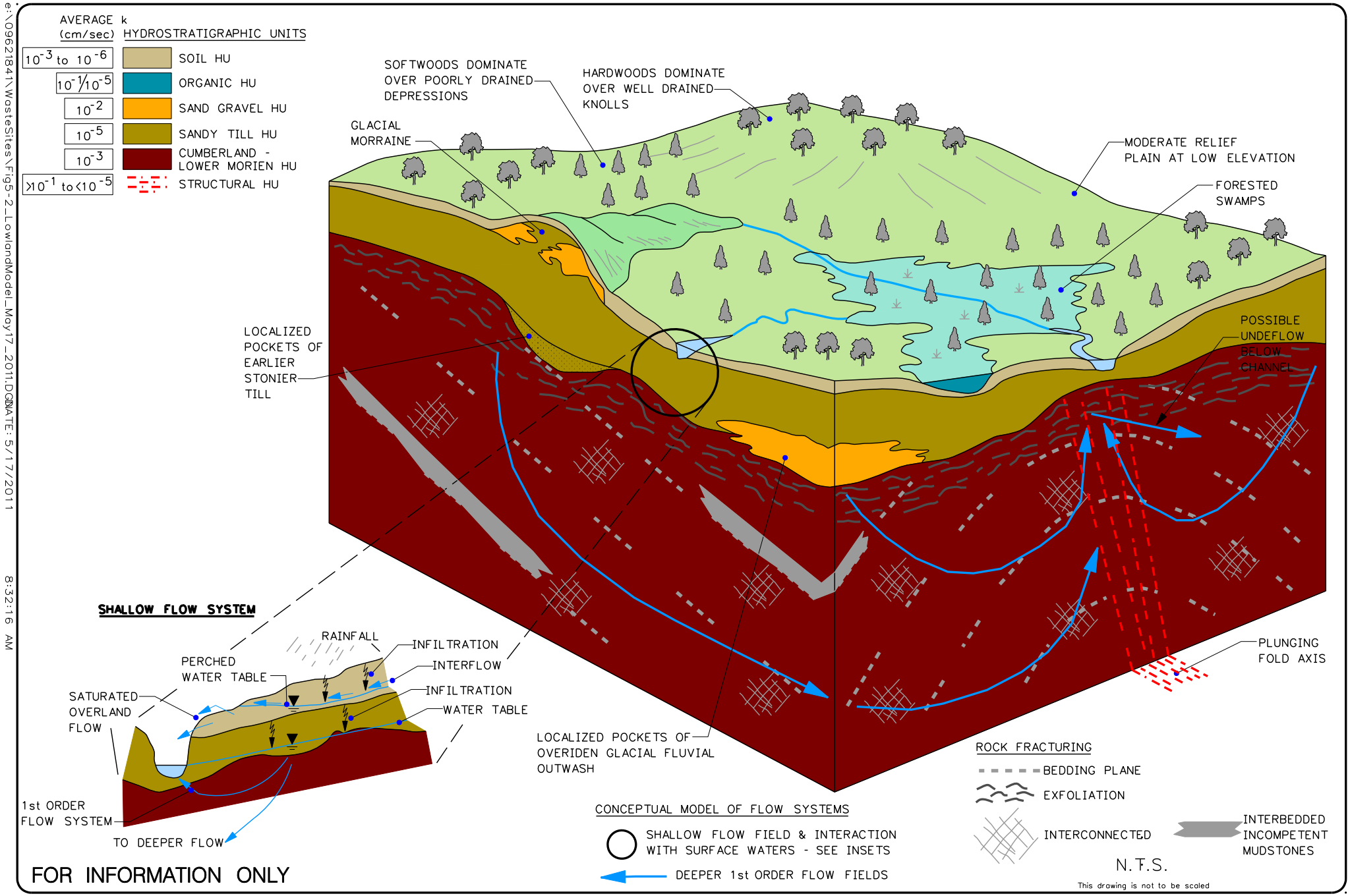
Geotechnically, the liquid limit of 25.5, plastic limit of 23.2 and plastic index of 2.3 indicated a soil symbol of ML (silt) or OL (organic silt) and Till soil type.

Hydraulic testing of the monitoring wells installed for this program indicated a range of hydraulic conductivity from 1.4×10^{-7} to 8.1×10^{-9} cm/sec, averaging 2.4×10^{-7} cm/sec.

During trench construction, seepage was not noted out of the trench wall, despite being opened for up to 107 days. No major seepage problems or slope stability problems arose. Sumps and pumps were required for dealing with heavy rains. There were no measured effects of dewatering one trench in adjacent trenches.

Two sets of water levels were collected to characterize:

- summer groundwater recession conditions (low water levels, low gradients) on 01 September 2010; and
- fall groundwater recharge conditions (high water levels, elevated gradients) on 08 December 2010.



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Proj.

INVESTIGATION OF OILY WASTE SITES
(CAPE BRETON WATER RESOURCE MANAGEMENT DATABASE)
(Baechler et al, in Progress)

Dwg.

LOWLAND REGION SEDIMENTARY PLAIN DISTRICT CONCEPTUAL HYDROLOGIC MODEL

Drawn By: NB	Proj. No. SYD-00020401-A0	
Dwg Standards Chk. By:	Dwg. No. **FIGURE 5-2**	
Designed By: FB	Date Last Modified: 28-APR-11	
Dwg. Design Chk. By: FB	Last Modified By: NB	Rev. 0

The water table within the Till HU was noted to be different during each of the monitoring events. During the summer event (01 September 2010) the static water levels ranged from 2.33 to 7.2 metres depth, with all three downgradient wells ranging between 6.93 and 7.13 metres depth. During the fall event on 08 December 2010, the water levels were noted to be closer to the surface and ranged from -0.05 metres to 2.57 metres depth. Whether this is an accurate representation of fluctuating seasonal water levels or slow response after well installation is unknown and will have to wait further monitoring.

The equipotential lines for the water table during the 08 December 2010 groundwater recharge event are provided on Figure 5-1 (site layout plan). They indicate that direction of lateral groundwater flow within the Till HU is from west to east at a maximum gradient of 8.4% due to the low water level in H10-MW04. The vertical flow component is unknown.

Assuming a porosity range for the Till HU of 30 to 50%, the steep gradient and the range in hydraulic conductivity indicates a theoretical, average, linear, groundwater flow velocity of 0.03 to 1.2 m/year. Given the 30 year life time of the site, the plume could have travelled a maximum of 1 to 37 metres through the Till HU. The actual position of the end of the trenches is unknown; with the in-trench monitoring wells usually positioned near the south, or downgradient end. Using the distance from the in-trench wells to the nearest downgradient monitoring well provides for a minimum travel distance of 30 to 35 metres. Therefore, any conservative indicator of plume transport would be considered upgradient of the wells.

5.6.3 Hydrology

No defined ephemeral or perennial stream channels were present on-site. No rills or gullies were developed over the former operations area. There are slight ditches along each side of the access road that divides Trench 2 from Trench 3, as well as a small perimeter drain located west of the operations area. There are several areas along the access road that exhibit signs of erosion due to overland flow during rain events.

One surface water sampling station was established for this assignment. The sample station was located north of the site in a small marshy area of standing water. This was the closest surface water to the actual site.

No flow was visually noticeable during either sampling event; standing water was sampled.

5.7 Soil Geochemistry

5.7.1 Geochemistry

One soil sample of the Till HU was analyzed per borehole (two in MW04). Each sample was analyzed for TPH/BTEX, as well as a suite of 32 metals and 19 PAH compounds. The results are provided in Appendix A.

Analysis of the data indicated:

1. Only one sample of five submitted for hydrocarbons indicated detectable concentrations in the downgradient Till HU. Detectable concentrations of benzene, toluene, ethylbenzene, >C10 to C21 hydrocarbons and >C21 to <C32 hydrocarbons were present in sample H10-MW04-4 collected from 4.6 to 5.2 metres depth.

2. Most metals analyzed for were detectable with the exception of antimony, beryllium, boron, cadmium, mercury, molybdenum, selenium, silver, thallium, tin and uranium. Of the heavy metals, the dominant ones in terms of concentration (exceeding 100 mg/Kg) were similar at all four sites and included in descending order of concentration:
   - iron (range 27,000 to 33,000 mg/Kg; background 27,000 mg/Kg);
   - aluminum (range 9,400 to 12,000 mg/Kg; background 9,700 mg/Kg);
   - manganese (range 560 to 790 mg/Kg; background 650 mg/Kg);
   - titanium (range 68 to 130 mg/Kg; background 90 mg/Kg); and
   - barium (range 97 to 180 mg/Kg; background 130 mg/Kg).

   As can be noted, the range of concentrations for these five metals resembles background concentrations and, therefore, are expected to be a result of normal geochemistry of the Till HU in this area.

3. All samples indicated non-detectable PAH concentrations except for sporadic, low concentrations of select parameters in one sample collected from downgradient monitoring well H10-MW04. Flouranthene and pyrene were detected in this sample at trace level concentrations on 0.02 mg/Kg, respectively.

   The presence of these low level PAH and hydrocarbon concentrations in the monitoring well established via horizontal flow direction calculation to be downgradient suggests that there is, at a minimum, a horizontal migration of contaminants from the trenches through the Till HU.

5.7.2 Soil Results Compared to Guidelines.

There were no elevated soil values for hydrocarbons, metals or PAHs.

5.8 Water Chemistry

5.8.1 In-Trench Leachate Wells

From examination of the initial in-trench monitoring well samples (Baechler, 1980) it was noted that Trenches 1 and 3 provided the worst-case scenarios for leachate chemistry while Trench 2 showed the best case scenario. Of these in-trench monitoring wells, only Trench 2 was still viable during the 2010 sampling. Trench 2 was sampled during both sampling events for this assignment to obtain a range in conditions after 30 years of dormancy.

Nine “indicator” parameters were selected to allow for a comparison not only between trenches, but with the initial leachate composition and background groundwaters, as summarized in Table 5-1.

Table 5-1: Oily Waste Leachate Indicator Chemistry from Hadleyville In-Trench Wells

Location	Date	TDS	pH	Cl	NH_4	Alk	Fe	Mn	TOC	TPH
	mg/L	mg/L	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Trench 1	1979	6926	6.7	1800	39	2000	38	51	1150	5.0
Trench 2	2010(1)	537	7.3	32	0.95	480	18	6	7.4	< 0.5
	2010(2)	516	7.6	29	1.5	460	12	6.1	7.2	< 0.5
	1979	1029	6.8	235	1.0	615	21	15	35	0.5
Trench 3	1979	10622	6.6	3750	35	2450	104	63	1500	1.0
Background Groundwater	2010 (1)	215	8.1	22	< 0.005	140	< 0.1	0.24	5.2	< 0.5
	2010 (2)	296	8.1	16	0.18	210	< 0.1	0.32	1.8	< 0.5

Notes:
TDS - total dissolved solids
TOC - total organic carbon (TOC)
Background groundwater taken from H10-MW01
1 – 01 September 2010
NH4 - nitrogen as ammonia nitrogen
TPH - total petroleum hydrocarbons
Alk - Alkalinity (as HCO_3)
2 – 07 December 2010
Mn - manganese
Fe - iron
Cl – chloride

The indicator parameters noted continual elevated concentrations for all parameters in comparison to background groundwaters in the Till HU, except for TPH, which was noted to be below detection in both sample sets. However, the indicator parameter concentrations in Trench 2 were considerably reduced in concentration when compared with initial samples collected in 1979 after dumping operations ceased. This suggests that dilution and other chemical reactions have reduced the strength of the leachate composition within Trench 2 over the last 30 years. This could be accounted for by: a) groundwater flow through the trenches (given the wastes were buried below the water table and the direction and rate of groundwater flow); and/or b) recharge through the cover cap.

No LNAPLs or DNAPLs were present in the in-trench wells during either monitoring event.

Detectable, but low concentrations of ethylbenzene (0.046 to 0.065 mg/L) and C6 to C10 (less BTEX) (0.01 to 0.02 mg/L) were noted in Trench 2 during the summer and fall sampling events.

No PAH compounds were analyzed for during the initial 1979 sampling event. Trench 2 was only sampled for PAH compounds during the fall sampling event. Relatively speaking, only low concentrations of PAH compounds were detected specifically 1-methylnaphthalene (0.53 µg/L), acenaphthene (0.01 µg/L), fluoranthene (0.05 µg/L), fluorene (0.02 µg/L), naphthalene (0.3 µg/L) phenanthrene (0.12 µg/L) and pyrene (0.03 µg/L). It is noteworthy that these parameters were common in the background groundwater station and the surface water station with the exception of 1-methylnaphthalene, acenaphthene and naphthalene.

5.8.2 In-Trench Monitoring Well Water Result Compared to Guidelines

The sample collected from the in-trench monitoring well exhibited elevated values for total dissolved solids (TDS), nitrogen (ammonia as N), iron and manganese during both sampling events. During the summer sampling event, only elevated colour was noted.

5.8.3 Groundwaters

In terms of major inorganic ion chemistry, the background chemistry of the Till HU at this site (H10-MW01) is characterized as a fresh (TDS of 215 to 296 mg/L), hard (100 to 170 mg/L), encrusting, sodium/calcium-bicarbonate type water with an alkaline pH (8.1) and alkalinity of 140 to 210 mg/L. Nutrients were exemplified by low concentrations of ammonia nitrogen (<0.05 to 0.18 mg/L) and TOC of 1.8 to 5.2 mg/L. Of the 26 “heavy metals” analyzed for, eight were consistently detectable, but at low concentrations including iron (non-detectable), manganese (0.24 to 0.32 mg/L) and aluminum (0.024 to 0.03 mg/L).

Using the seven major inorganic leachate indicators (Table 5-2), elevated concentrations above background were noted at MW02, MW03 and MW04. Therefore, inorganic chemical indicators suggest the presence of an oily waste contacted plume at these sites.

Table 5-2: Groundwaters Elevated Above Background In Inorganic Indicators

Location	Date	TDS	Cl	NH_4	Alk	Fe	Mn	TOC
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW02	01 Sept 2010	330	20	0.08	150	< 0.1	0.68	4.1
	07 Dec 2010	319	15	0.1	170	0.14	0.48	2.0
MW03	01 Sept 2010	451	24	< 0.05	210	< 0.1	031	2.2
	07 Dec 2010	326	12	0.1	200	0.23	0.54	2.9
MW04	01 Sept 2010	423	25	0.07	230	< 0.1	0.27	2.0
	07 Dec 2010	486	31	< 0.05	260	< 0.1	0.75	1.2
MW-1 **Background**	01 Sept 2010	215	10	< 0.05	140	< 0.1	0.24	3.3
	07 Dec 2010	296	22	0.18	210	< 0.1	0.32	5.2

Notes:
TDS – total dissolved solids
NH4 – ammonia nitrogen
Fe – iron
Cl – chloride
Alk – alkalinity
Mn – manganese
TOC – total organic carbon

No detectable TPH/BTEX parameters were present in the wells during either monitoring event. No LNAPLs or DNAPLs were present during either monitoring event.

PAH compounds were monitored during the summer event at H10-MW04 only and at all stations during the fall sampling event. All wells during the fall sampling event reported a varying number of detectable compounds, but all at relatively low levels. Common to all samples was the presence of fluoranthene, fluorine, phenanthrene and pyrene; exclusive to sample H10-MW02 was the presence of anthracene. The two indicator PAH compounds, naphthalene and benzo(a)pyrene, were non-detectable in any wells.

5.8.4 Groundwater Results Compared to Guidelines

Manganese values were elevated in comparison to the draft NSE Tier 1 EQS at all sample stations during both monitoring events. There was one elevated value noted in the background monitoring station for molybdenum and two NSE Tier 1 EQS elevated values at station H10-MW02 for nitrite and aluminum.

5.8.5 Surface Waters

Sample station H10-SW01 would be considered background for the site; located approximately 300 metres west of the disposal area. There were no flowing or standing bodies of water noted on the site during either sampling event.

Using the seven major inorganic leachate “indicators”, elevated concentrations at the surface water station were noted only for iron (0.77 to 0.81 mg/L). All other indicator parameters were noted to be lower than those observed in the trench and groundwater samples.

Toluene was present in the surface water sample during the summer sampling event and similar PAH parameters to those detected in the groundwater samples was observed during the fall sampling event, namely, fluoranthene, fluorine, phenanthrene, pyrene and anthracene.

5.8.6 Surface Water Results Compared to Guidelines

There were no elevated values in comparison with the NSE Tier 1 EQS for PAH parameters or the Atlantic RBCA Tier II guidelines to TPH/BTEX.

Values elevated above the NSE Tier I EQS for surface waters were noted during both sampling events for pH (5.9 to 6.1 versus 6.5 to 9.0); aluminum (0.088 to 0.12 mg/L versus 0.005 mg/L), cadmium (0.000048 to 0.00011 mg/L versus 0.00001) and iron (0.77 to 0.81 mg/L versus 0.3 mg/L) and during the summer event only for copper (0.0073 mg/L versus 0.002 mg/L).

5.9 Quality Assurance/Quality Control

Duplicate QA/QC samples were collected during each of the water sampling events. Results of the duplicate sample are presented in Table A2, Appendix A next to the original sample. Duplication during the summer sampling event was completed on sample H10-SW01. The results of the duplicate, when compared to the original, showed acceptable target duplication with all inorganic parameters falling below 25% RPD. Duplication completed during the fall event was completed on sample H10-MW01. The results of the duplication showed that there were two exceedences of the target 25% RPD for nitrogen and zinc, with zinc exceeding the maximum acceptable RPD. Duplication of this sample on the PAH results showed that all detectable parameters exceeded the maximum RPD. This scenario is not uncommon when dealing with very low concentrations that are near to the reportable detection limits. This data set is considered suitable for use based on the results of the duplication.

5.10 Preliminary Evaluation of Risk

No domestic dwellings are present within 1 km of the site.

The site is owned by Provincial Crown, which allows for employing restrictions on land use.

The site is growing over with trees, some of which are positioned on top of the cover caps, possibly degrading the viability of the seal. If not addressed, this could allow for release of contaminants through the quick-flow-system.

Forestry operations are ongoing in the general area, which increases the probability of encroachment onto the site by cutting and/or vehicle access.

The site has not been adequately secured to prevent access by vehicles along the site access road. The site has not been identified as restricted land use on existing mapping or in the field to ensure restrictions to future land use of the site.

There was initial evidence of an oily waste contacted groundwater plume being transported off the operations area as detected through inorganic and organic indicators at H10 - MW04 based upon soil and water sample results. However, they were not elevated in relation to the NSE Tier 1 EQS.

5.11 Conclusions and Recommendations

The field program for this assignment has confirmed the entombment characteristics of the site. The wastes are encapsulated below the water table within a tight, dense, relatively low permeable glacial till. The trench seals and cover caps have not been disturbed. The primary pathway for contaminant release appears to be through slow transport in the Till water table aquifer.

There are trace indications found in the results of the soil samples that there may be a slow horizontal migration of contaminants through the Till HU. Comparison of background water chemistry with that downgradient is inconclusive in that parameters found to be elevated above the guidelines were common at both locations. Where the site is located over a topographic high there may be more than one horizontal transport pathway that was not picked up based upon the present monitoring well network configuration. However, the monitoring data from the on-site wells did not indicate any petroleum impacts that may be cause for concern.

A long-tem monitoring program should include ground and surface water stations, as well as the in-trench monitoring wells. Initially the sampling should be on a quarterly basis. An analysis of the data should be on an annual basis to allow for refinements to the program when and where required.

Consideration should be given to installing an additional monitoring well to the west of H10-MW01 to further assess the groundwater flow direction. Consideration should be given to conducting repairs to the in-trench monitoring wells if possible.

It is recommended that all trees should be cut over the former operations area. Skidders or other heavy equipment should not be utilized to remove trees to ensure minimal damage to the cover caps. A care and maintenance schedule should be developed for the site to manually keep forest and understory development to a minimum.

A permanent gate should be constructed at the entrance to the site access road and a treed buffer zone maintained around the site to ensure access by unauthorized vehicles does not occur.

The site should be identified on existing government mapping to ensure restricted future land use.

Consideration for research opportunities could entail autopsying one of the trenches to assess the extent of degradation of the bags holding the oil, as well as the oil itself. This would aid in understanding how long the sites pose a risk and require monitoring.

6 Little Dover

6.1 Location

The Little Dover site is located on an 8026 hectare parcel of Crown land located in the Canso Coastal Barrens protected area. The site itself covers an area of 0.36 hectares based on hand-held GPS track logs. The site is located approximately 3.5 km north of the Town of Little Dover. Plates 6-1 and 6-2 show oblique aerial photographs of the site taken just prior to testing conducted for this assignment. There were no historical site photos available.

Plate 6-1: Oblique aerial view of the Little Dover site looking toward the south (2010).

Plate 6-2: Oblique aerial view of the Little Dover site (2010) looking to the northeast.

6.2 Land Ownership, Use and Access

The site is positioned on Provincial Crown land under the jurisdiction of Nova Scotia Department of Natural Resources (NSDNR) and is also located within the Canso Coastal Barrens Wilderness Area.

The site is accessed off a small foot path west off the Dover Road, which is a connector road from Highway 16 and the Town of Little Dover. The site is located approximately 1.3 km heading south on the Dover Road from Highway 16 (Figure 6-1).

Photographs of the site pre disposal were not available. Present conditions exhibit granite bedrock barrens with patches of coniferous forest. It can be assumed that the site once resemble this scene, however, it is now characterized by thick low lying grasses mixed with some deciduous and coniferous tree growth through the cover material.

To the south of the site and across the Dover Road a wood road was noted accessing lands owned by NSDNR. The road, while appearing to not have been used in the last 5 years has definitely seen activity in the last 10 years. Further, investigations on the site uncovered two hunting blinds within 30 metres of the disposal site. Other than these two developments, there was no further activity observed to have taken place within 1 km of the site.

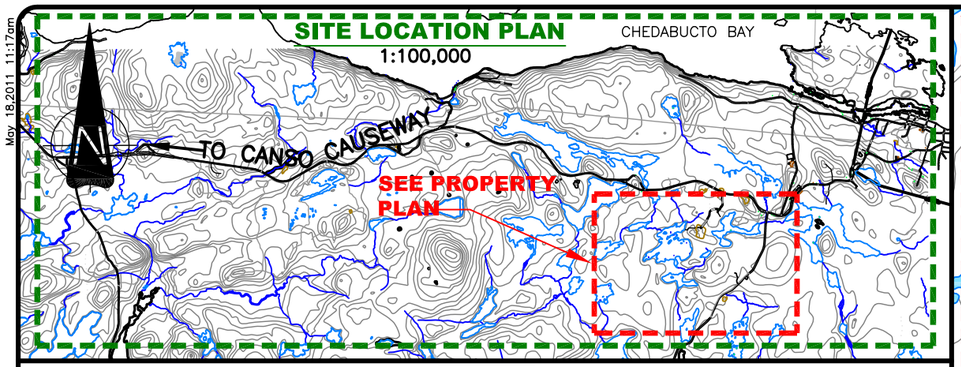
6.3 Site Reconnaissance

The site was visited by **exp** and NSE personnel on 19 May 2010. There had been no clearing activities conducted on the site at this point.

Oily waste disposal at this site was noted to be in one cell placed directly on granite bedrock forming an above grade pile. It is not expected that a liner material was used and only a thin cover material was noted. On the south face of the disposal pile, beach stone, barrel fragments and beach sand were noted to be exposed. There were also other debris cast on the site, most likely post disposal era material, including shingles, wire, burn pits and vehicle frames. Plate 6-3 shows an area just north of the disposal pile where oily waste material has oozed out of the pile and has weathered and solidified on the granite bedrock surface.

May 18,2011 11:17am

SITE LOCATION PLAN
1:100,000



PROPERTY PLAN
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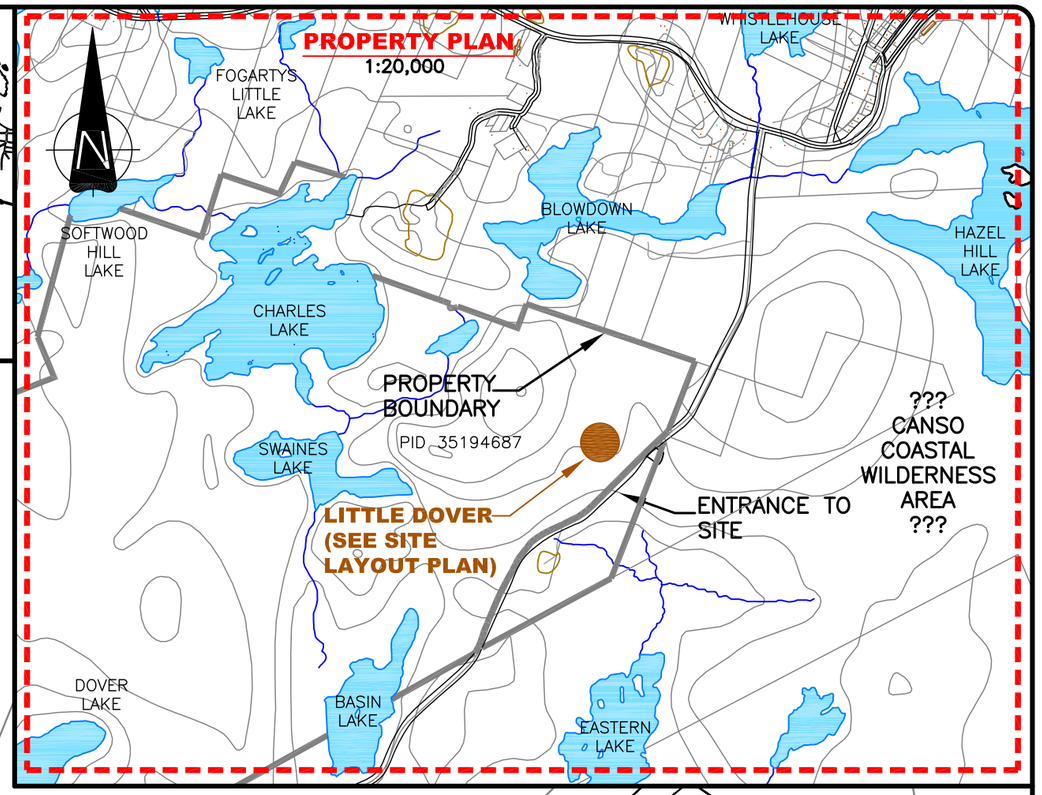


BASED UPON 1:10,000 DIGITAL MAPPING WITH 5m CONTOUR INTERVAL

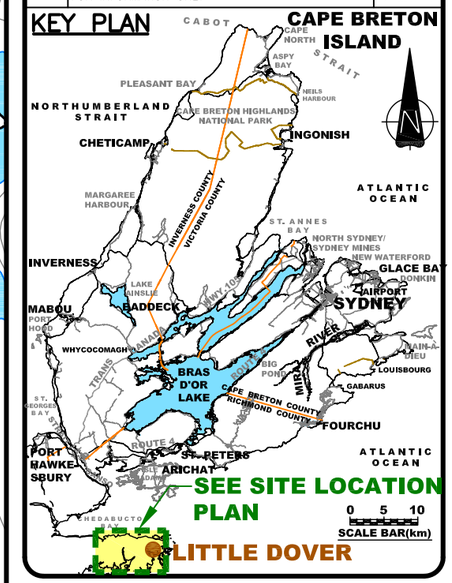
LEGEND:

- 18.45 / LD10-MW01 — LOCATION & IDENTIFIER FOR MONITORING WELL(MW) LOCATIONS WITH WATER LEVEL ELEVATION(m)
- SURFACE WATER SAMPLING LOCATION
- 20 — GENERAL SURFACE CONTOUR ELEVATIONS(m) BASED UPON 1:10,000 DIGITAL MAPPING
- SITE ACCESS ROAD
- 20 — EQUIPOTENTIAL CONTOURS ON WATER TABLE WITHIN THE GRANITE HU (02 SEPTEMBER 2010) (APPROXIMATE; ASSUMED)

SITE LAYOUT PLAN
1:1000

No.	Issue	Date
1	FOR INFORMATION ONLY	17-MAY-11

KEY PLAN



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Designed By: FB

Date Printed 11.May.18

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Project Title

INVESTIGATION INTO OILY WASTE SITES

Dwg. Title

LITTLE DOVER ARROW OILY WASTE DISPOSAL SITE

Project No.	SYD-00020401-A0	
Dwg. No.	FIGURE 6-1	Rev. No. 0
Scale	AS SHOWN This drawing is not to be scaled	

E:\09621841\WasteSites\dwg\Figs_Hadley-Dover-Fox.dwg

Plate 6-3: looking west at oily waste at the Surface of the disposal pile.

Plate 6-4: Tree and shrub growth over the disposal pile looking southeast.

The waste pile appears to have been left as is following disposal. The site was growing over with shrubs, mainly alders, and some spruce and pine trees. Because of the regional granite barrens, many of the local trees are low lying; however, on the disposal pile the vegetation appears to be very lush with some of the trees and shrubs ranging from 2 to 5 metres in height (Plate 6-4).

6.4 Intrusive Program

For this assignment a total of four shallow bedrock monitoring wells were installed. Shallow bedrock monitoring well locations are depicted on Figure 6-1.

Monitoring wells LD10-MW01 and LD10-MW02 were positioned in what was expected to be locations upgradient of the disposal area to provide background conditions. Local relief on the site ranged from 17 metres to 24 metres geodetic from south to north based on topographic mapping. The remaining two well sites were positioned immediately down topographic gradient of the disposal pile, assuming that groundwater flow would follow the bedrock elevation contours.

6.5 Site Design and Operations

Very little is known concerning disposal operations. It is expected that the site was operational during cleanup of the beaches associated with the Arrow oil spill; most probably between February and March 1970. The type of wastes were expected to include Bunker C oil associated with sand and gravel from beaches, as well as peat moss used as an absorbent. No data is available on quantity of wastes disposed of.

The site was apparently prepared by directly placing material on what was assumed to be non-fractured granite bedrock. To the west of the site there appears to be a berm ranging in height from 1 to 2 metres that was used to divide the oily waste from the nearest body of water. This berm runs parallel with the disposal pile from north to south. Based on local topography it is not expected that this is a natural feature, but may be comprised of push off material from preparation of the disposal site. Oily wastes were not placed into polyethylene bags prior to disposal, but excavated in bulk off the beaches and dumped in a loose state within the excavation. It is assumed that after disposal the site was covered with an unknown depth of fill, based from on-site observations.

6.6 Hydrological Setting

6.6.1 Hydrological Region/District

Map DP ME 36 Version 2 (2006), "Surficial Geology Map of the Province of Nova Scotia", characterizes the regional topography as ranging from flat to strongly rolling, with areas of exposed granite bedrock and areas of thin till cover. The bedrock is of various types and ages with glacially scoured basins and knobs, overlain by thin, discontinuous veneer of till.

Nova Scotia Department of Natural Resources, Minerals and Energy Division, "Map ME 2000-1, Geological Map for the Province of Nova Scotia" (2000), indicate that the subject property is underlain by the Liscomb Complex, which may be comprised of either fine-grained leucomonzogranite, muscovite leucogranite and/or muscovite biotite monzogranite.

The site hydrogeological setting is best represented by a three-dimensional conceptual block model developed by Baechler et al (in progress) typifying a highland peneplain district (Figure 6-2) and notes that the active groundwater flow field is expected to be governed by the hydrostructural rock domain created in the exfoliated Granite HU. This unit is unconfined. Ground to surface water interaction is expected to be controlled predominately by the shallow groundwater quick-flow-system operating in the exfoliated and vertical and sub horizontal fractures, usually within 1 to 5 metres of ground surface.

Hydrologically the site is positioned in Provincial watershed 1EQ-SDP. Topographic relief over the operations area is relatively low varying over only 7 metres between 17 and 24 metres geodetic. Flow is diverted to the south into Eastern Lake, then into the Atlantic Ocean at Dover Harbour.

6.6.2 Hydrogeology

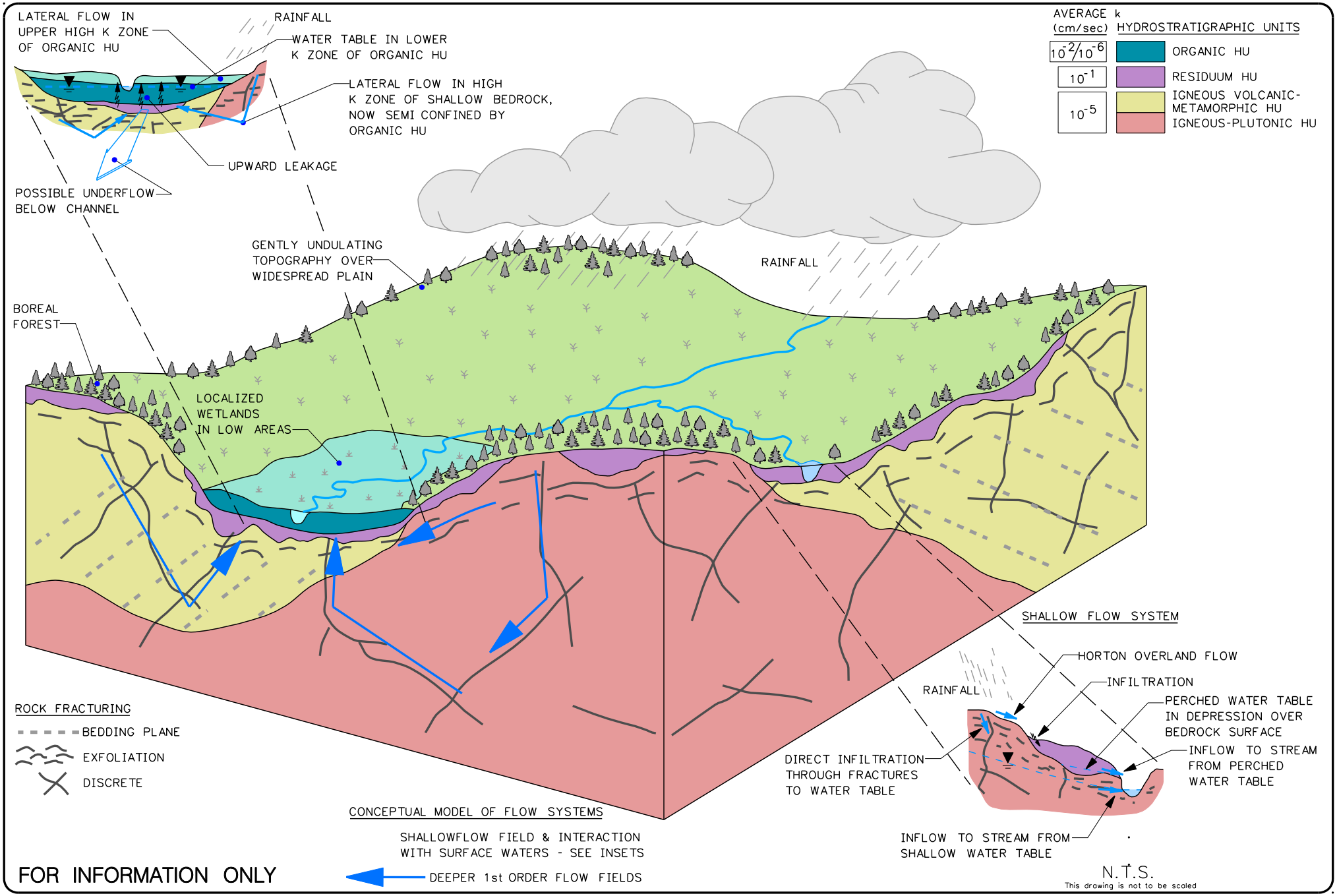
The drilling program confirmed the hydrological setting noted above.

Overburden was only noted near monitoring wells LD10-MW03 and LD10-MW04. Overburden near monitoring well LD10-MW04 was comprised on a thin (0.3 metre) layer of topsoil made up of loose, sand, gravel and organics (rootlets). Till was encountered in monitoring well LD10-MW03 to a depth of 1.2 metres. One grain size analysis taken from a sample of LD10-MW03 at 0.3 to 1.22 metres depth indicated gravel (12.1%), sand (56.2%) and silt/clay (21.7%) giving a classification as silty sand.

Given that bedrock was observed or encountered within 2 metres of surface, monitoring wells were installed into the shallow bedrock at all monitoring stations. At each location the bedrock consisted of granite with traces of muscovite noted on some of the fracture faces.

Hydraulic testing indicated a range of hydraulic conductivity (K) for the shallow bedrock HU ranging from 4.6×10^{-5} to 6.5×10^{-6} cm/sec; averaging 3.3×10^{-6} cm/sec. Of note is that the monitoring wells associated with the west side of the disposal pile were in the 4.6×10^{-5} to 7.9×10^{-5} cm/sec while the monitoring wells associated with the east side of the pile were generally lower ranging from 2.1 to 6.5 $\times 10^{-6}$ cm/sec.

Two sets of water levels were collected on 02 September and 07 December 2010. The former was used for plotting since monitoring well LD10-MW03 was flowing at the time of measurement in the fall



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INVESTIGATION OF OILY WASTE SITES
(CAPE BRETON WATER RESOURCE MANAGEMENT DATABASE)
(Baechler et al, in Progress)

Dwg.

HIGHLAND REGION PENEPLAIN DISTRICT CONCEPTUAL HYDROLOGIC MODEL

Drawn By: NB	Proj. No. SYD-00020401-A0	
Dwg Standards Chk. By:	Dwg. No. **FIGURE 6-2**	
Designed By: FB	Date Last Modified: 06.FEB.27	
Dwg. Design Chk. By: FB	Last Modified By: NEB	Rev. 0

sampling event. The water table within the Shallow Bedrock HU was relatively high, resembling ground surface. The water level ranged between 0.2 and 3.6 metres below ground surface. Therefore, there is a very thin unsaturated zone and, as a result, the wastes within the disposal pile may be placed at or below the water table. It is unknown whether there is a perched water table within the disposal pile.

The equipotential lines for the water table during the summer event are provided on Figure 6-1. They indicate an "apparent" direction of lateral groundwater flow within the shallow granite HU from both north to south, as well as from east to west. Each component joins and flows southwest through monitoring well LD10-MW03. The apparent gradient ranges from 4.8% from east to west and 7.9% from north to south.

Assuming a fracture porosity range for the Granite HU of 1 to 10% indicates a theoretical, average, linear, groundwater flow velocity of 5 to 50 m/yr for the east to west linear flow direction at 4.8% gradient and 8.3 to 83 m/yr for the north to south 7.9% gradient linear flow.

This would indicate that under maximum average, linear, flow conditions (7.9% gradient and 1% porosity), indicator parameters of plume transport would have reached monitoring well LD10-MW03 (10 metres from the base of the disposal pile) within 18 to 19 days.

6.6.3 Hydrology

No defined ephemeral or perennial stream channels were present on-site. No rills or gullies were developed over the former operations area. Just to the west of the site there was a small pond and a marshy area. Road side drainage flows through service ditching along Dover Road and drains into another small pond located east of the site, adjacent to the Dover Road. The pond is also fed by a small unnamed brook that flows under Dover Road and into the pond. The pond off Dover Road was noted surrounded by lush barren related vegetation. During both sampling events, a sheen was noted on this pond.

Two surface water stations were used during this assessment (Figure 6-1). LD10-SW01 was located in the pond west of the site and LD10-SW02 was located in the pond adjacent to Dover Road east of the site.

6.7 Soil Geochemistry

6.7.1 Geochemistry

Soil representing the Till HU was only encountered in one borehole, LD10-MW03. One soil sample of the Till HU was collected and submitted for analysis. The sample was analyzed for TPH/BTEX, as well as a suite of 32 metals and 19 PAH. This sample station represents downgradient conditions. The results are provided in Appendix B.
Analysis of the data indicated:

1. No hydrocarbons monitored for were detectable in the sample of the Till HU.

2. A total of 21 of 32 metals analyzed for were detectable. Of the detectable heavy metals, the dominant ones in terms of concentration (exceeding 100 mg/Kg) were as follows in descending order of concentration:
   - iron (22,000 mg/Kg);

- aluminum (13,000 mg/Kg);
- manganese (440 mg/Kg); and
- titanium (170 mg/Kg).

Without input from a background sample, it is unknown whether these conditions would be considered typical for soils present in this region.

3. There were no PAH compounds reported above the laboratory reportable detection limits.

6.7.2 Soil Results Compared to Guideline

There were no soil exceedences for hydrocarbons, metals or PAHs.

6.8 Water Chemistry

6.8.1 Groundwaters

Groundwater sampling occurred during two sampling events including summer low flow (02 September 2010) and fall recharge (08 December 2010). The following section discusses the results of the two groundwater sampling events that focused on the four on-site monitoring wells installed in the shallow bedrock HU.

During the drilling process it was necessary to obtain drill water from an off-site location. Drill water was extracted from a small brook flowing toward the Tickle near the Town of Canso. The drill water was considered fresh (TDS of 48 mg/L), soft (hardness of 10 mg/L), sodium- chloride type water with an acidic pH of 6.

In terms of major inorganic ion chemistry, the background chemistry of the shallow Bedrock HU at this site (LD10-MW01) is characterized as a fresh (TDS 58 to 67 mg/L), soft (19 to 25 mg/L), sodium-chloride type water with an alkaline pH (7.1 to 8.1) and alkalinity of 9 to 19 mg/L. Nutrients were exemplified by low concentrations of nitrate+nitrite (as N) (0.1 to 0.12 mg/L), ammonia nitrogen (< 0.05 mg/L) and TOC (8.8 to 12 mg/L). Of the 26 “heavy metals” analyzed for, 10 were consistently detectable, with most at low concentrations, including aluminum (0.22 to 0.53 mg/L), barium (0.01 to 0.018 mg/L), cadmium (0.00011 to 0.00013 mg/L), lithium (0.0041 to 0.0061 mg/L), strontium (0.023 to 0.027 mg/L) and uranium (0.001 to 0.0017 mg/L). Noted at moderate concentrations was iron (0.29 to 0.62 mg/L).

Using seven major inorganic ion leachate indicators (Table 6-1), elevated concentrations above background were noted at MW04 for TDS, ammonia nitrogen, alkalinity and iron and at MW02 and MW03 for ammonia, iron, manganese and TOC (only at MW02). Therefore, inorganic chemical indicators suggest the presence of an oily waste contacted plume at these sites. Based on the data available and the flow direction calculation, monitoring well MW02 would be considered an upgradient monitoring point. Based on the chemical analysis, this shows that there may be something unaccounted for in the existing model under the disposal pile that is affecting the groundwater flow direction interpretation. The variable concentration may indicate natural background fluctuations or some impact from disposal. Further monitoring is required.

Table 6-1: Groundwater Elevated Above Background in Inorganic Indicators

Location	TDS	Cl	NH_4	Alk	Fe	Mn	TOC
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW02	30 to 47	10 to 19	< 0.05 to 0.06	6	1.1	0.69 to 1.3	16 to 22
MW03	53 to 57	12	0.09 to 0.14	13 to 15	7.7 to 9.8	0.59 to 0.7	7.10 to 9.7
MW04	104 to 112	13 to 18	0.26 to 0.36	40 to 50	5.5 to 7.3	0.12 to 0.15	9 to 12
Background	58 to 67	17	< 0.05	9 to 19	0.29 to 0.62	0.14 to 0.39	8.8 to 12

Notes:
TDS - total dissolved solids
NH4 - ammonia nitrogen
Fe - iron
Cl – chloride
Alk - alkalinity
Mn - manganese
TOC - total organic carbon

No detectable TPH/BTEX was present in the wells during either monitoring event. No LNAPLs or DNAPLs were present during either monitoring event.

PAH compounds were sampled for in one monitoring well (LD10-MW04) during the summer event and in all monitoring wells during the fall sampling event. The background monitoring well (LD10-MW01) did not report any detectable concentrations of PAH compounds. All downgradient monitoring wells recorded a varying number of detectable compounds, but all at relatively low levels. The largest number (six) was encountered at MW03 during the fall and at MW04 during the summer. Common to all downgradient monitoring wells were the presence of fluoranthene, phenanthrene and pyrene. The two indicator PAH compounds, naphthalene and benzo(a)pyrene were non-detectable at all wells with the exception of naphthalene, which was detectable during the summer quarter at LD10-MW04.

6.8.2 Groundwater Results Compared to Guidelines

There were no values elevated above the NSE Tier 1 EQS for TPH/BTEX or for PAH.

There were common elevated values in comparison to the NSE Tier 1 EQS for colour, aluminum and manganese at all stations during both the summer and fall sampling event, including ammonia (as N) at LD10-MW04 during the summer event. At LD10-MW02 and LD10-MW-03 pH was exceeded during both sampling events. Only the background station (LD10-MW01) had an elevated value for cadmium during both sampling events and iron was elevated in LD10-MW02, LD10-MW03 and LD10-MW04 during both sampling events.

6.8.3 Surface Waters

While the two surface water stations examined for this assessment may be considered as background, they may also be hydrogeologically linked to the shallow bedrock water table directly under the disposal pile.

Table 6-2 presents the seven indicator parameters used in the assessment and shows the range in concentration for each parameters over the summer and fall sampling events.

Table 6-2: Surface Water Indicator Parameters

Location	TDS	Cl	NH_4	Alk	Fe	Mn	TOC
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
LD10-SW01	22 to 34	12 to 16	< 0.005	< 5	0.42 to 0.65	0.036 to 0.055	10 to 22
LD10-SW02	53 to 57	16 to 38	< 0.005	< 5	0.58 to 1.8	0.041 to 0.17	21 to 22

The results of the indicator parameter review shows that there are elevated concentrations of iron present in both nearby surface water bodies, but that the remainder of the indicator parameters except for TOC are relatively low in concentration. The elevated TOC is thought to be a function of minor wetlands surrounding the site in localized topographic lows. Further monitoring would be required to draw a linkage between the waste contacted groundwater plume and the surface water systems.

No detectable TPH/BTEX or PAH compounds were present in either surface water station during either event.

6.8.4 Surface Water Results Compared to Guideline

There were no elevated PAH or TPH/BTEX concentrations in reference to the NSE Tier 1 EQS during either sampling event.

There were elevated values to the NSE Tier 1 EQS for pH, aluminum and iron at both stations during the summer and fall quarters.

6.9 Quality Assurance/Quality Control

Duplicate QA/QC samples were collected during each of the water sampling events. Results of the duplicate sample are presented in Tables B1, B2 and B3 in Appendix A next to the original sample. Duplication during both events was completed on sample LD10-MW03. The results of the duplicate during the summer event, when compared to the original showed acceptable target duplication, with all inorganic parameters falling below 25% RPD. Duplication completed during the fall showed that there were no exceedences of the target 25% RPD any inorganic parameters. Duplication of this sample on the PAH results showed that there was acceptable target duplication for all parameters with the exception of phenanthrene. This scenario is not uncommon when dealing with very low concentrations that are near to the reportable detection limits. This data set is considered suitable for use based on the results of the duplication.

6.10 Preliminary Evaluation of Risk

No domestic dwellings are present within 1 km of the site.

The site is owned by Provincial Crown and is protected through its classification as Atlantic Coastal Barrens.

The site is growing over with trees, some of which are positioned on top of the disposal area, possibly degrading the viability of the seal. If not addressed, this could also promote increased infiltration into the trenches and hence contaminant transport.

Illegal dumping of municipal solid wastes has occurred on-site. Although based on appearances of such material this has not been done in some time.

There are two hunting blinds within 20 metres of the disposal pile. One was constructed between the summer sampling event and the fall sampling event. The oldest hunting blind is well weathered and situated at ground level near surface water station LD10-SW01, while the second is within 10 metres of monitoring well LD10-MW01 and is on an elevated platform overlooking a small clearing to the north.

While there is no direct access onto the site, the deepness and slope of the ditch near the site entrance does not impede access via all terrain vehicles. The site has not been secured or identified as restricted land use on existing mapping or in the field.

6.11 Conclusions and Recommendations

The field program for this assignment did not investigate the nature of the oily waste disposed of, the thickness of cover material, or the substrate in which it was placed. The main focus was to assess the potential shallow bedrock quick-release-pathway and the general water chemistry near the disposal pile.

Through the course of the assessment it was established that the wastes are encapsulated at or below the water table; however, it is unknown if there is a perched water table within the waste pile itself.

The disposal method at this site is assumed, based on visual observation, to have directly placed the waste materials on granite bedrock exposed at surface. Based upon examination of the core, there appears to be significant fractures (exfoliation) within at least the first 5 metres of bedrock. This leads to the conclusion that the shallow bedrock is the primary pathway for contaminant release. Average groundwater flow velocities would suggest that any oily waste contacted plume would have been transported past the monitoring wells within the time frame between disposal and this investigation.

There is a potential indication for the release of inorganic and organic contaminants at LD10-MW02, LD10-MW03 and LD10-MW04 due to the presence of select inorganic and PAH compounds detected in the groundwater. There were no elevated values in comparison to the NSE Tier 1 EQS for TPH/BTEX or for PAH.

There were common elevated values to the NSE Tier 1 EQS for colour, aluminum and manganese at all stations during both the summer and fall sampling event. At LD10-MW02 and LD10-MW03 pH was elevated during both sampling events. Only the background station LD10-MW01 had elevated values for cadmium during both sampling events and iron was exceeded in LD10-MW02, LD10-MW03 and LD10-MW04 during both sampling events.

The intrusive program to date has shown the site to be hydrogeologically complex. Additional drilling is recommended to further assess the Bedrock HU and test pits into the disposal pile to assess the depth, type and cover quality.

A preliminary evaluation of risk suggests that given minimal dwellings in the vicinity, there is a low risk from the site. Therefore, the proper management approach would include consideration of:

1. A long-term monitoring program, which should include ground and surface water stations, initially on a quarterly basis. An analysis of the data on an annual basis should be carried out to allow for refinements to the program when and where needed.

2. It is recommended that all trees be cut over the former operations area. Skidders or other heavy equipment should not be utilized to remove trees, to ensure minimal damage to the disposal.

3. A care and maintenance schedule should be developed for the site to manually keep forest and understory development to a minimum.

4. A permanent gate should be constructed at the entrance to the site access road and a treed buffer zone maintained around the site to ensure access by unauthorized vehicles does not occur.

5. The site should be identified on existing government mapping to ensure no other land use is allowed in the future.

6. Given the sites location in a protected area, the complexity of the site hydrogeological conditions and the relatively small volume of waste disposed of consideration could be given to removal of the oily waste and disposal in an approved landfill.

7 Fox Island

7.1 Location

The Fox Island site is located on a 526 hectare parcel of Crown land located in Fox Island Main, Nova Scotia (Figure 7-1). The site covers an area of 0.14 hectares based on hand-held GPS track logs and best estimations of the waste pile boundaries. The site is located approximately 10 km west of the Town of Canso. Plates 7-1 and 7-2 show oblique aerial photographs of the site taken just prior to testing conducted for this assignment. There were no historical site photos available.

Plate 7-1: Oblique aerial view of the Fox Island site looking toward the west (courtesy of NSE).

Plate 7-2: Oblique aerial view of the Fox Island site during this assignment (2010) looking north (Courtesy of NSE).

7.2 Land Ownership, Use and Access

The site is positioned on Provincial Crown land under the jurisdiction of NSDNR.

The site is accessed from a gravel driveway some 40 metres off Highway 16 (Figure 7-1).

Photographs of the site pre disposal were not available. Present conditions exhibit a small pit excavated into a terrain covered by dense coniferous forest. It is unknown whether the pit was created from disposal or previously present. It now exhibits a sparse tree covered open area primarily vegetated with fast growing elephant ear weeds. The site is heavily used by persons as a dump site for C&D material and municipal solid waste. To that extent, there is a substantial area that is not covered with vegetation and occasional beach stone can be observed at surface.

Plate 7-3: Looking south over Cavanaugh Lake, the nearest surface water to the disposal site.

To the south of the site there is a right-of-way that historically was the old Highway 16. Mapping from Service Nova Scotia and Municipal Relations show that this right of way is still an active road. Indications show that this road is used as a foot path or by the occasional ATV, but it has become largely overgrown and not used by large vehicle traffic. Just south and east of the right-of-way is Cavanaugh Lake (Plate 7-3). There was one small trailer noted on the opposite shore of the site, situated adjacent to the lake but it appeared to be un-serviced.

7.3 Site Reconnaissance

The site was visited by **exp** and NSE personnel on 19 May 2010. There had been no clearing activities conducted on the site at this point.

Oily waste disposal at this site was estimated to be in one cell placed directly on the ground surface forming more or less a pile, apparently pushed over an embankment. It is not expected that a liner material was used and only a thin cover material was noted. On the southeast face of the disposal pile, beach stone and beach sand were noted to be exposed at surface. There were also other debris cast on the site, post disposal era including, shingles, wire, burn pits, vehicle frames, wood debris, electronics and municipal solid waste (Plate 7-4).

Plate 7-4: Looking east at C&D material dumped directly on top of the disposal area.

The waste pile appears to have been left as is following disposal. As noted above the site was growing over with weeds and some spruce trees.

As shown in Plate 7-4, some of the vegetation over the site is fairly low lying. Some of new spruce trees are starting to grow over the site. It is assumed that some of the larger spruce trees, present on the site, are outside of the disposal area.

7.4 Intrusive Program

For this assignment a total of three shallow bedrock monitoring wells were installed. Shallow bedrock monitoring well locations are depicted on Figure 7-1.

Monitoring wells FI10-MW02 and FI10-MW03 were positioned in what was expected to be locations downgradient of the disposal area, while monitoring well FI10-MW01 was installed to provide background conditions. Local relief on the site (approximately 10 metres) ranged from 28.6 metres to 39 metres geodetic from west to east. This was based on topographic mapping and on a geodetic survey of ground surface near the monitoring stations.

7.5 Site Design and Operations

Very little is known concerning disposal operations. It is expected that the site was operational during cleanup of the beaches associated with the Arrow oil spill; most probably between February and March 1970. The type of wastes were expected to include Bunker C oil associated with sand and gravel from beaches, as well as peat moss used as an absorbent. No data is available on the quantity of wastes disposed of.

There is no evidence or information available concerning preparations that were conducted to the site prior to disposal. It is assumed that at a minimum, vegetation was grubbed off the site to the east. To the east of the site there appears to be a steep vertical drop of push off material to the northeast which tapers off to some undulating (less than 1 metre) hillocks to the southeast. These features occur right up to where the tree line begins. Oily wastes were not placed into polyethylene bags prior to disposal, but excavated in bulk off the beaches and dumped in a loose state within the excavation. After disposal the site was covered with an unknown depth of reworked till, possibly excavated from an area immediately west of the site.

7.6 Hydrological Setting

7.6.1 Hydrological Region/District

Map DP ME 36 Version 2 (2006), “Surficial Geology Map of the Province of Nova Scotia”, characterizes the regional topography as ranging from flat to rolling with many surface boulders. The site is described as a stony till plain with a stony, sand matrix, material derived from local bedrock sources.

Nova Scotia Department of Natural Resources, Minerals and Energy Division, “Map ME 2000-1, Geological Map for the Province of Nova Scotia” (2000), indicate that the Subject Property is underlain by the Goldenville Formation, which is comprised of quartzites and slate (in places metamorphosed into schist and gneiss).

The site hydrogeological setting is best represented by a three dimensional conceptual block model developed by Baechler, et al (in progress) typifying a highland peneplain district (Figure 7-2). The

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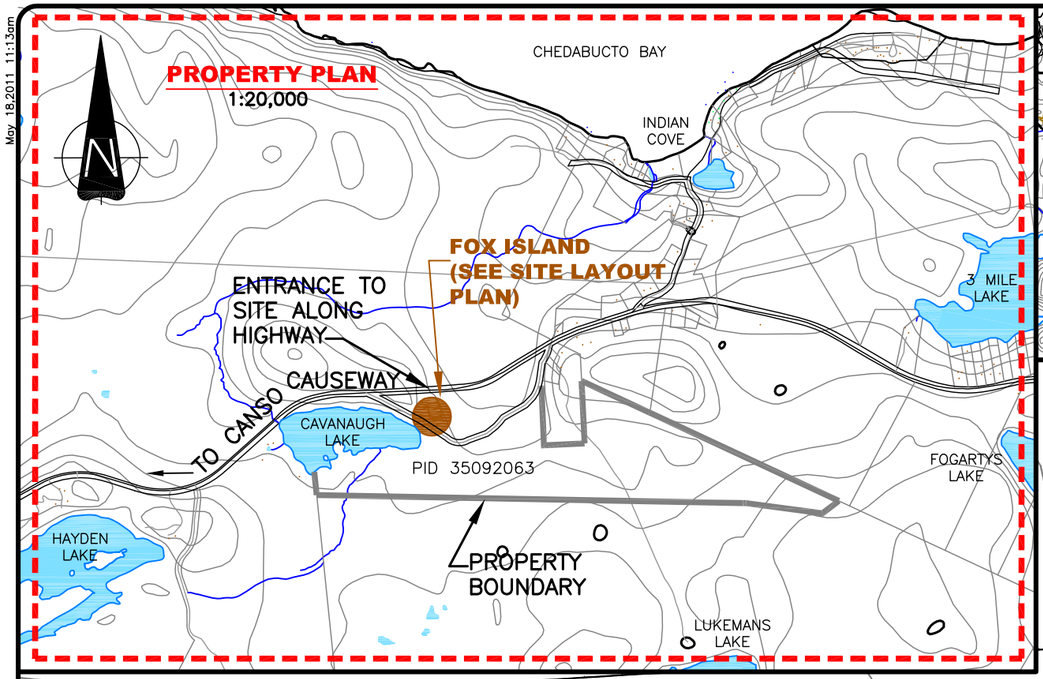

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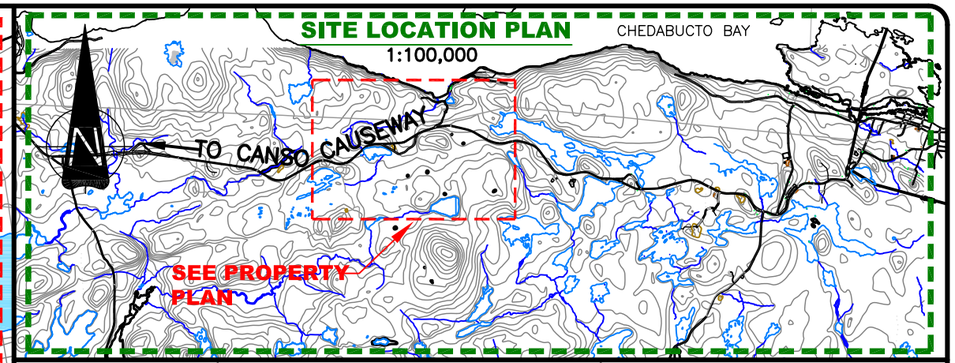

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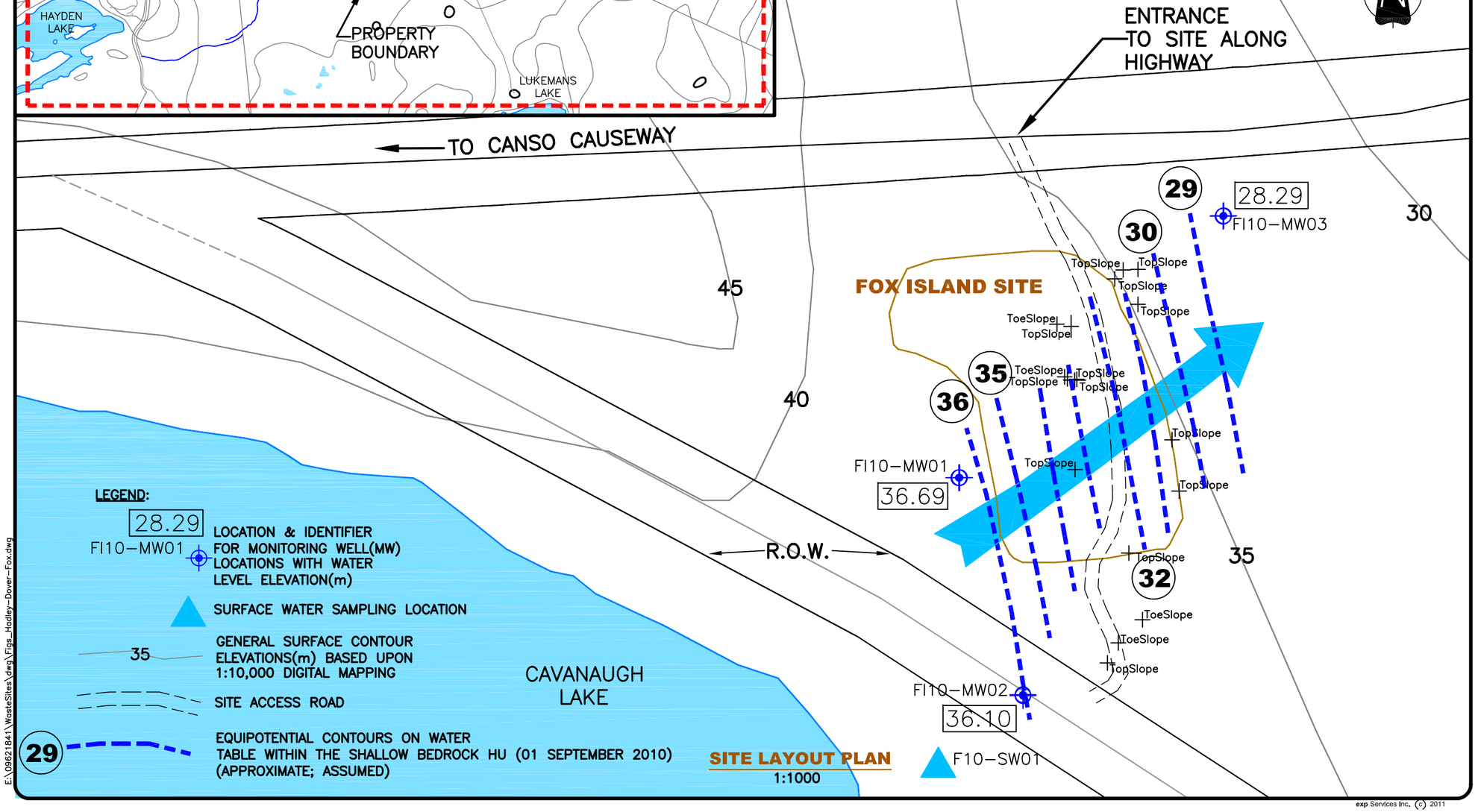

LEGEND:

- 28.29 / FI10-MW01 — LOCATION & IDENTIFIER FOR MONITORING WELL(MW) LOCATIONS WITH WATER LEVEL ELEVATION(m)
- SURFACE WATER SAMPLING LOCATION
- 35 — GENERAL SURFACE CONTOUR ELEVATIONS(m) BASED UPON 1:10,000 DIGITAL MAPPING
- SITE ACCESS ROAD
- 29 — EQUIPOTENTIAL CONTOURS ON WATER TABLE WITHIN THE SHALLOW BEDROCK HU (01 SEPTEMBER 2010) (APPROXIMATE; ASSUMED)

SITE LAYOUT PLAN
1:1000

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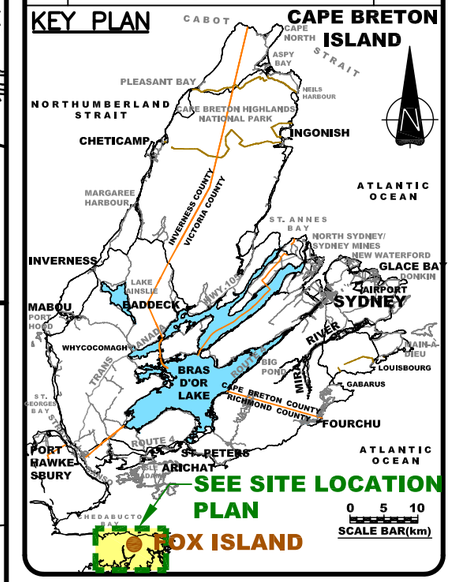
KEY PLAN



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Project Title

INVESTIGATION INTO OILY WASTE SITES

Dwg. Title

FOX ISLAND ARROW OILY WASTE DISPOSAL SITE

Project No. SYD-00020401-A0

Dwg. No. FIGURE 7-1

Rev. No. 0

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active groundwater flow field is expected to be governed by the hydrostructural rock domain created in the Goldenville HU; this unit is partially confined by the Till HU. Ground surface water interaction is expected to be controlled predominately by the shallow groundwater quick-flow-system operating in the soil and upper weathered portion of the Till HU, usually within 1 to 5 metres of ground surface and/or in the highly fractured shallow bedrock.

Hydrologically the site is positioned in Provincial watershed 1EQ-SD6. Topographic relief over the operations area is relatively low, varying over only 7 metres, between 17 and 24 metres geodetic. Flow is directed to the north through an unnamed book to discharge into Chedabucto Bay at Indian Cove.

7.6.2 Hydrogeology

The drilling program confirmed the hydrological setting noted above, although with localized thicker Till.

The overburden ranged from 1.5 metres at FI10-MW03 to 10 metres thick at FI10-MW01. In each monitoring location there was approximately 0.3 metres of topsoil, made up mostly of organics (root mat) over glacial till.

Given that bedrock was encountered within 2 metres of surface in the first monitoring well advanced (FI10-MW02), monitoring wells were installed into the shallow bedrock at all monitoring stations. At each location the bedrock consisted of highly fractured fine-grained greywacke-quartzite.

One grain size analysis of the till, taken from a sample of FI10-MW01 at 6.1 to 6.7 metres depth, indicated gravel (13.6%), sand (35.3%) and silt/clay (51.2%) giving a classification as silty lean clay.

Geotechnically the liquid limit of 25.7 and plastic limit of 17.3, with a plastic index of 8.4, indicated a soil symbol of CL and Till soil type.

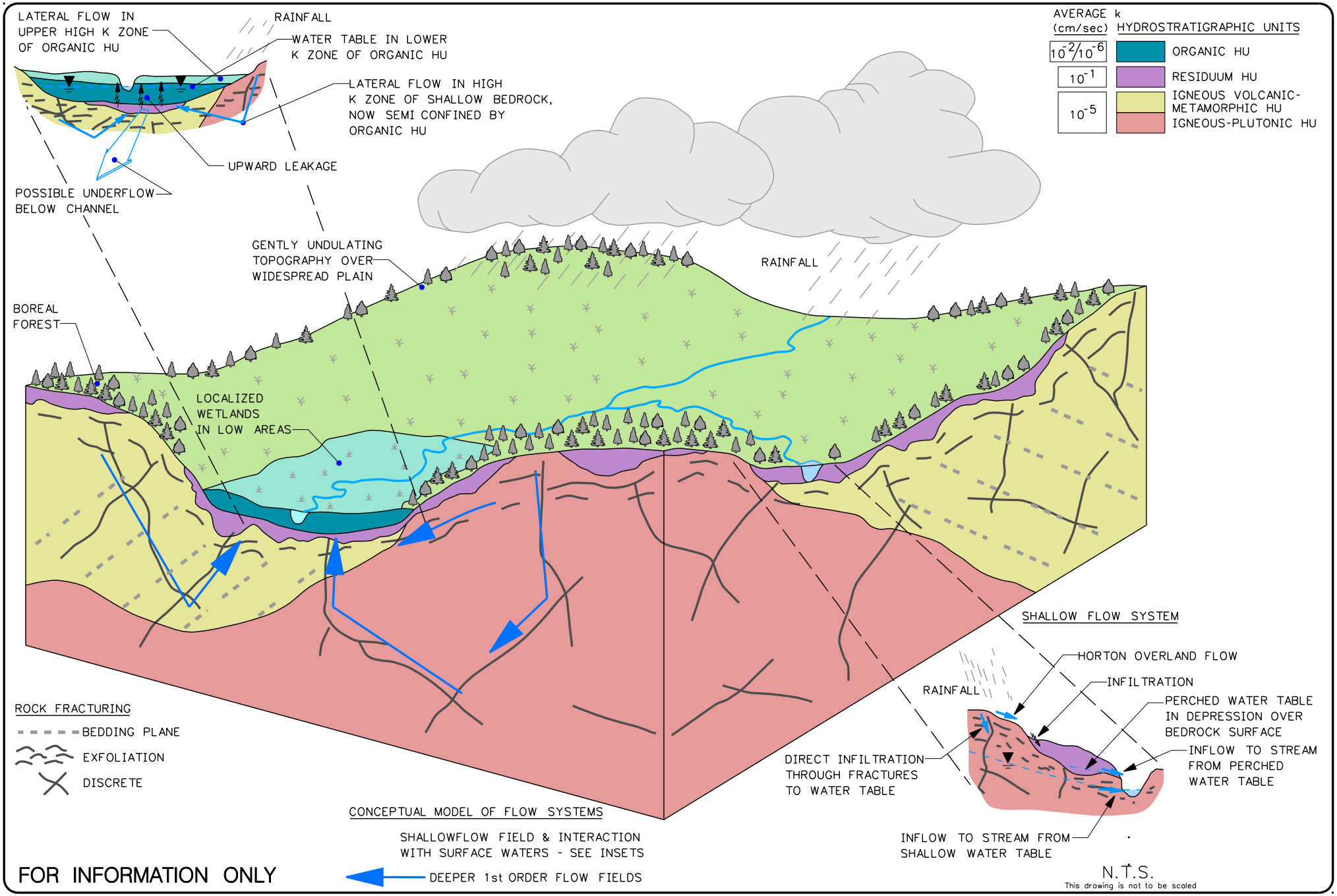
Hydraulic testing indicated a range for hydraulic conductivity (K) for the Shallow Bedrock HU ranging from 6.6×10^{-5} to 4.4×10^{-6} cm/sec; averaging 2.5×10^{-5} cm/sec.

Two sets of water levels were collected on 01 September and 07 December 2010. The former was used for plotting and calculation of horizontal flow direction. The water table within the Shallow Bedrock HU was relatively high, resembling ground surface. The water level ranged between 0.8 and 2.99 metres below ground surface. Therefore, there is a very thin unsaturated zone and, as a result, the wastes within the disposal pile may be placed at or below the water table. Whether a perched water table exists in the disposal area is unknown.

The equipotential lines for the water table during the summer event are provided on Figure 7-1. The contours indicate an “apparent” direction of lateral groundwater flow within the shallow bedrock is generally from southwest to northeast at an apparent gradient of 12.5%.

Assuming a porosity range for the shallow bedrock of 5 to 30%, this indicates a theoretical, average, linear, groundwater flow velocity of 3 to 20 m/yr.

This would indicate that under maximum average, linear, flow conditions, indicator parameters of plume transport would have reached monitoring well FI10-MW03 (estimated 30 metres from the base of the disposal pile) within 210 days and, therefore, should have encountered the monitoring wells.



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Proj.

INVESTIGATION OF OILY WASTE SITES
(CAPE BRETON WATER RESOURCE MANAGEMENT DATABASE)
(Baechler et al, in Progress)

Dwg.

HIGHLAND REGION PENEPLAIN DISTRICT CONCEPTUAL HYDROLOGIC MODEL

Drawn By: NB	Proj. No. SYD-00020401-A0	
Dwg Standards Chk. By:	Dwg. No. **FIGURE 7-2**	
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7.6.3 Hydrology

No defined ephemeral or perennial stream channels were present on-site. No rills or gullies were developed over the former operations area. To the south of the site there was a small lake and a marshy area. Road side drainage flows through service ditching along Highway 16. It was noted that off-site, near FI10-MW03 (a topographic low spot), that there was some sediment and erosion rills near the Highway 16 ditch; most likely receiving some overland runoff from the disposal site. There was no water observed in this feature during either sampling event.

Only one surface water station was used during this assessment (Figure 6-1). FI10-SW01 was located in Cavanaugh Lake 30 to 40 metres south of the site along the edge of the Lake closest to the site.

7.7 Soil Geochemistry

7.7.1 Geochemistry

Soil representing the Till HU was encountered in all three boreholes. Samples were collected and submitted from varying depths from FI10-MW01 and FI10-MW02. Samples were analyzed for TPH/BTEX, as well as a suite of 32 metals and 19 PAHs. These two sample stations, based on the results of the groundwater flow field, represent both background conditions. The results are provided in Appendix C.

Analysis of the data indicated:

1. Only one hydrocarbon parameter (>C21 to <C32) was encountered at 3.0 to 3.6 metres depth from monitoring well FI10-MW01. Product identification provided by Maxxam indicated the hydrocarbon was in the lube oil range. It should be noted that this was detected in the background monitoring well.

2. A total of 23 of 32 metals analyzed for were detectable. Of the detectable heavy metals, the dominant ones in terms of concentration (exceeding 100 mg/Kg) were as follows in descending order of concentration:
   - iron (27,000 to 31,000 mg/Kg);
   - aluminum (12,000 to 13,000 mg/Kg);
   - manganese (1100 to 1400 mg/Kg);
   - titanium (150 to 170 mg/Kg); and
   - barium (150 mg/Kg) at FI10-MW02.

   Without exact delineation of the disposal pile and further input into the groundwater flow model, it is difficult to interpret these results in terms of background versus downgradient concentrations, mainly due to the presence of hydrocarbons in the lube oil range in the present theoretical background station. It is unknown whether these conditions would be considered typical for soils present in this region. Also unknown is the nature of the wastes buried within the disposal pile. It is unknown if other wastes were disposed of prior to or concurrently with oily waste.

3. There were no PAH compounds reported above the laboratory reportable detection limits.

7.7.2 Soil Results Compared to Guideline

There were no elevated soil values for hydrocarbons, metals or PAHs.

7.8 Water Chemistry

7.8.1 Groundwaters

Groundwater sampling occurred during two sampling events including summer low flow (01 September 2010) and fall recharge (07 December 2010). The following section discusses the results of the two groundwater sampling events that focused on the three on-site monitoring wells installed in the shallow bedrock HU.

During the drilling process it was necessary to obtain drill water to advance the diamond bit drilling into the bedrock. Nearby Cavanaugh Lake was used as drill water source and one sample was collected and submitted to Maxxam for analysis. The drill water was considered fresh (TDS of 26 mg/L), soft (hardness of 5 mg/L), sodium- chloride type water with an acidic pH (4.8).

In terms of major inorganic ion chemistry, the background chemistry of the Shallow Bedrock HU at this site (FI10-MW01) is characterized as a fresh (TDS of 134 to 144 mg/L), moderately hard (73 to 74 mg/L), calcium bicarbonate type water with an alkaline pH (7.9 to 8.3) and alkalinity of 62 to 72 mg/L. Nutrients were exemplified by low concentrations of nitrate+nitrite (as N 0.09 to 0.16 mg/L), ammonia nitrogen (< 0.05 mg/L) and TOC (<0.5 to 1.2 mg/L). Of the 26 “heavy metals” analyzed for eight were consistently detectable, with most at low concentrations, including aluminum (0.0.049 to 0.11 mg/L), arsenic (0.0013 to 0.0015 mg/L), barium (0.014 to 0.018 mg/L), lithium (0.0059 to 0.0062 mg/L), molybdenum (0.0054 to 0.011 mg/L), strontium (0.072 to 0.074 mg/L), uranium (0.0015 mg/L) and manganese (0.25 to 0.31 mg/L).

Using the seven major inorganic ion leachate indicators (Table 7-1), elevated concentrations above background were only for iron at all three stations; and for TOC at FI10-MW02. Review of the inorganic chemical indicators does not conclusively suggest the presence of an oily waste contacted plume at these sites. Based on the data available and the flow direction, monitoring well MW02 may also be considered an upgradient monitoring point. Based on the chemical analysis, this shows that there may be something unaccounted for in the existing model under the disposal pile that is affecting the groundwater flow direction interpretation. Further monitoring is required and further investigation into the materials entombed at the site is recommended.

Table 7-1: Groundwater Elevated Above Background in Inorganic Indicators

Location	TDS	Cl	NH_4	Alk	Fe	Mn	TOC
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
FI10-MW02	79 to 126	15 to 25	< 0.05	21 to 79	< 0.1 to 0.35	0.15 to 0.32	< 0.5 to 9.2
FI10-MW03	73 to 79	20 to 21	< 0.05 to 0.07	14 to 16	< 0.1 to 0.27	0.088 to 0.51	< 0.5 to 0.6
FI10-MW01 Background	134 to 144	19 to 23	< 0.05	62 to 72	< 0.1	0.25 to 0.32	< 0.5 to 1.2

Notes:
TDS - total dissolved solids
NH4 - ammonia nitrogen
Fe - iron
Cl – chloride
Alk - alkalinity
Mn - manganese
TOC - total organic carbon

No detectable TPH/BTEX was present in the wells during either monitoring event. No LNAPLs or DNAPLs were present during either monitoring event.

PAH compounds were sampled for in one monitoring well FI10-MW02 during the summer event and in all monitoring wells during the fall sampling event. During the summer sampling event no PAH compounds were detected in FI10-MW02. The background monitoring well FI10-MW01 reported five detectable PAH compounds, while the two downgradient monitoring wells recorded four detectable compounds each. Common detectable parameters to all monitoring wells were the presence fluoranthene, fluorene, phenanthrene and pyrene. Anthracene was also detected in the background sample. The two indicator PAH compounds, naphthalene and benzo(a)pyrene, were non-detectable at all wells.

7.8.2 Groundwater Results Compared to Guidelines

There were no elevated values in comparison to the NSE Tier 1 EQS for TPH/BTEX or for PAH.

There were common elevated values at all stations during both the summer and fall sampling event in relation to the NSE Tier 1 EQS for manganese and aluminum (except at FI10-MW01 during the fall event). Single elevated values to the NSE Tier 1 EQS were noted at the following monitoring stations:

- Colour at FI10-MW02 during the fall event;
- Nitrite at FI10-MW01 during the summer event;
- Nitrate+nitrite at FI10-MW03 during the fall event;
- Cadmium at FI10-MW03 during the summer event; and
- Copper, iron and zinc at FI10-MW02 during the fall event.

7.8.3 Surface Waters

While the surface water station examined for this assessment may be considered as background, it may also be hydrogeologically linked to the shallow bedrock water table directly under the disposal pile, under certain conditions.

Table 7-2 presents the seven indicator parameters used in the assessment and shows the range in concentration for each parameters over the summer and fall sampling events.

Table 7-2: Surface Water Indicator Parameters

Location	TDS	Cl	NH_4	Alk	Fe	Mn	TOC
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
LD10-SW01	22 to 32	14 to 16	< 0.05	< 5	0.57 to 0.77	0.053 to 0.072	15 to 16

The results of the indicator parameter review shows that there are elevated concentrations of iron present in the nearby Cavanaugh Lake, but that the remainder of the indicator parameters are relatively low in concentration. Further monitoring would be required to draw any linkage between the waste contacted groundwater plume and the surface water systems.

No detectable TPH/BTEX compounds were present in the surface water station during either event.

FI10-SW01 was only sampled for PAH compounds during the fall event. Flouranthene, phenanthrene and pyrene were reported at low level concentration while all other PAH compounds were reported as non detectable.

7.8.4 Surface Water Results Compared to Guideline

There were no elevated PAH or TPH/BTEX values in comparison to NSE Tier 1 EQS during either sampling event.

There were elevated values in relation to the NSE Tier 1 EQS for pH, aluminum and iron during the summer and fall quarters.

7.9 Quality Assurance/Quality Control

Duplicate QA/QC samples were collected during each of the water sampling events. Results of the duplicate samples are presented in Tables C6, C7 and C8 in Appendix C next to the original sample. Duplication during the summer event was completed on FI10-SW01, while duplication during the fall event was completed on FI10-MW03. The results of the duplicate sample during the summer event, when compared to the original, showed acceptable target duplication, with all inorganic parameters falling below 25% RPD. Duplication completed during the fall showed that there were three exceedences of the target 25% RPD for phenanthrene, nitrogen and cadmium. These three parameters were noted to fall within the maximum acceptable RPD of 50%. It is expected that this data set is suitable for use based on the results of the duplication.

7.10 Preliminary Evaluation of Risk

There is a commercial auto parts store located 0.5 km to the west of the site and a domestic dwelling 0.5 km east of the site. It is expected, but not confirmed, that both rely on groundwater for a water supply.

The site is owned by Provincial Crown, which allows for employing restrictions on land use.

The site is growing over with trees, alders and elephant ears, some of which are positioned on top of the disposal areal. If not addressed, this could also promote increased infiltration into the wastes and contaminant transport.

Illegal dumping of municipal solid wastes and construction and demolition debris has occurred on-site. This is an ongoing concern with addition material deposited between the summer and fall sampling events.

There was one hunting blind within 5 metres of the disposal pile and FI10-MW01 noted during the 07 December 2010 sampling event.

The site has not been secured or identified as restricted land use on existing mapping or in the field.

7.11 Conclusions and Recommendations

The field program for this assignment did not investigate the nature of oily waste disposed of, the thickness of cover material, or the substrate in which the oily waste was placed. The main focus was to assess potential shallow bedrock quick release pathways and the general water chemistry near the disposal pile.

Through the course of the assessment it was established that the wastes may be encapsulated at or below the water table. However, it is unknown if there is a perched water table within the waste pile itself.

The disposal method at this site is assumed, based on visual observation, to have included placement of the waste materials on the existing ground surface and push off over a slope. Based on the core examined from the drill program, there appears to be significant fractures (exfoliation) within at least the first 5 metres of bedrock. This leads to the conclusion that the shallow bedrock is the primary pathway for contaminant release.

Average groundwater flow velocities suggest that the leading edge of any oily waste contacted plume could potentially have reached the monitoring wells. While there is an indication for such with select, inorganic and PAH compounds, some indicators were also present in the background well. In addition, there were no values elevated above the NSE Tier 1 EQS for TPH/BTEX or for PAH in the groundwater or surface water samples collected.

There were common elevated concentrations found in groundwater at all stations during both the summer and fall sampling event to the NSE Tier 1 EQS for manganese and aluminum (except at FI10-MW01 during the fall event). Single elevated concentrations in relation to the NSE Tier 1 EQS were noted at the following monitoring stations:

- Colour at FI10-MW02 during the fall event;
- Nitrite at FI10-MW01 during the summer event;
- Nitrate+nitrite at FI10-MW03 during the fall event;
- Cadmium at FI10-MW03 during the summer event; and
- Copper, iron and zinc at FI10-MW02 during the fall event.

There were values elevated above the NSE Tier 1 EQS for pH, aluminum and iron during the summer and fall quarters in Cavanaugh Lake.

The intrusive program to date has shown the site to be hydrogeologically complex. Additional drilling is recommended to further assess the Bedrock HU and test pits into the disposal pile to assess the depth, type and cover quality.

A preliminary evaluation of risk suggests that given the proximity of residential dwellings within 1 km of the site there is a moderate risk from the site. Therefore, the proper management approach would include consideration of:

1. A long-term monitoring program, which should include relevant ground and surface water stations, initially this should be on a quarterly basis. An analysis of the data on an annual basis should be carried out to allow for refinements to the program when and where needed.

2. It is recommended that all trees should be cut over the former operations area. Skidders or other heavy equipment should not be utilized to remove trees, to ensure minimal damage to the trenches.

3. A care and maintenance schedule should be developed for the site to manually keep forest and understory development to a minimum.

4. A permanent gate should be constructed at the entrance to the site access road and a treed buffer zone maintained around the site to ensure access by unauthorized vehicles does not occur.

5. The site should be identified on existing government mapping to ensure no other land use is allowed in the future.

6. Given the site's location and ease in accessibility, coupled with the relatively small volume of waste disposed of, consideration could be given to removal of the oily waste and disposal in an approved landfill facility.

8 SAND POINT

8.1 Location

The Sand Point site is situated on a 5742 hectare parcel of Crown land and covers approximately 0.15 hectares (Plate 8-1). It is located 1 km south of the community of Sand Point (Figure 8-1).

Plate 8-1: Oblique aerial view of the Sand Point site looking south (2009), courtesy of Nova Scotia Environment.

8.2 Land Ownership, Use and Access

The site is positioned on Provincial Crown land under the jurisdiction of NSDNR. The site is accessed off a graveled secondary woods road created for forest harvesting operations (Figure 8-1).

Prior to development for disposal the site was an aggregate pit. Since disposal the areas west of the site have been recently harvested for wood.

8.3 Site Reconnaissance

The site was visited by **exp** and NSDNR personnel on 16 November 2010.

The site access road was not gated. Forestry operations had not damaged the main portion of the site. There was no indication of damage by off-road and/or recreational vehicles over the main part of the site. Some wastes have been deposited on the site in the northwest corner of the disposal area. Wastes included vehicles, automotive parts, glass, wood, general household wastes. These have all been dumped over the embankment that defines the north boundary of the disposal area.

Plate 8-2: Tree growth over the disposal area near the middle of the disposal pile.

The site was growing over with shrubs and trees, primarily spruce. The growth of latter to heights of 2 to 4 metres was of concern, due to potential damage to the viability of whatever cover cap had been employed (Plates 8-1 and 8-2).

During the 01 December 2010 test pit program, along the north disposal pile boundary near test pit SP10-TP20, oily waste rock was noted protruding from the nearby embankment.

8.4 Intrusive Program

For this assignment a total of 20 test pits were excavated in a grid pattern over and around the site to determine: a) the areal and vertical extent, as well as method of disposal; b) nature of wastes; and c) groundwater level within the wastes. No monitoring wells were emplaced; soil samples were collected specifically of visually contaminated materials.

8.5 Site Design and Operations

Very little is known concerning disposal operations. Information reported by Baechler et al (1976) indicated the site was operational during cleanup of the beaches associated with the Arrow oil spill; most probably between February and March 1970. The type of wastes were expected to include Bunker C oil associated with sand and gravel from beaches, as well as peat moss used as an absorbent. No data is available on quantity of wastes disposed of.

The site was apparently prepared by excavation of a depression to an unknown depth. A small berm was constructed along the east property boundary to restrict overland drainage into the water filled aggregate pit. Oily wastes were not placed into polyethylene bags prior to disposal, but excavated in bulk off the beaches and dumped in a loose state within the excavation. After disposal, the site was covered with an unknown depth of re-worked till excavated from an area immediately east of the site.

The test pit program noted:

1. Oily wastes were present in test pits SP10-TP02, 05, 06, 12, 13, 14, 15, 18 and 19.

2. When present, hydrocarbons took the form of discrete layers (Plate 8-3) containing oil, sand and gravel in localized lenses within some of the test pits (rarely throughout the excavation). Also noted were staining on clasts, hydrocarbon odour and/or tar. Test pits advanced in the middle of the disposal pile uncovered intact clear plastic bags containing waste material (Plate 8-4).

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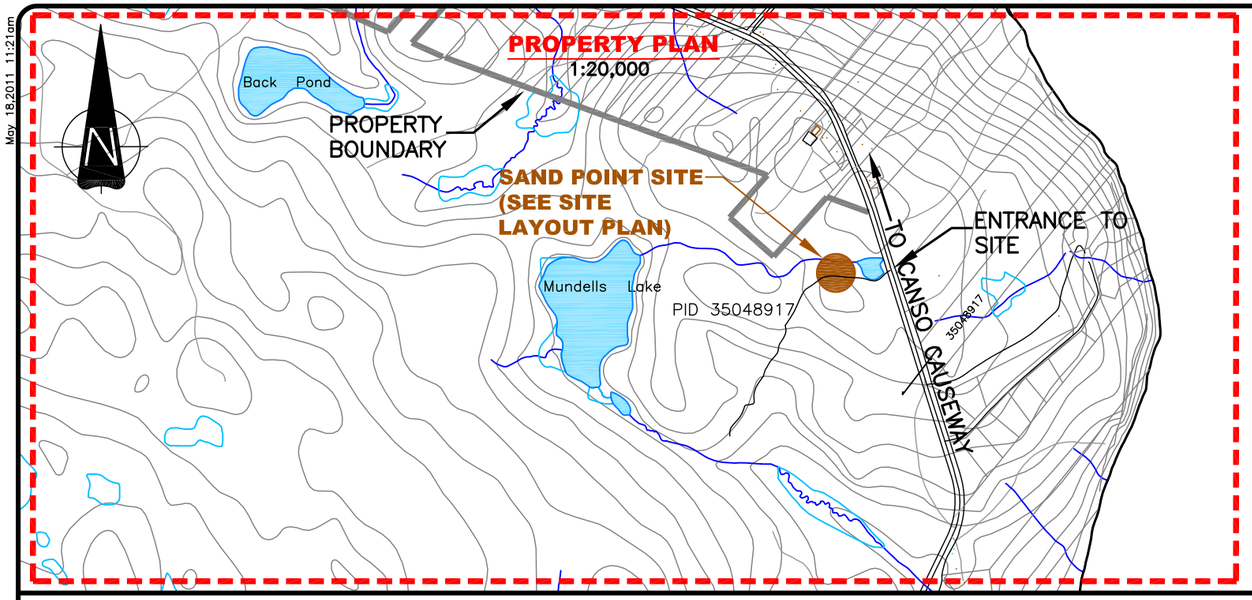

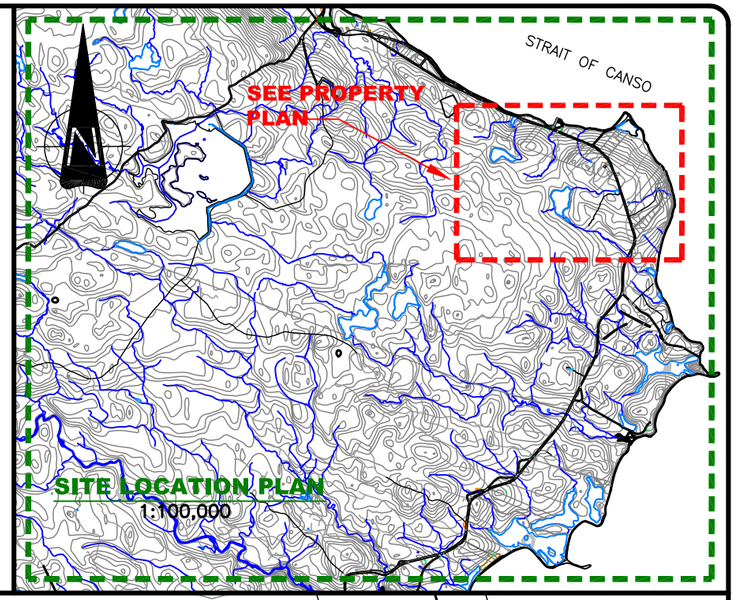

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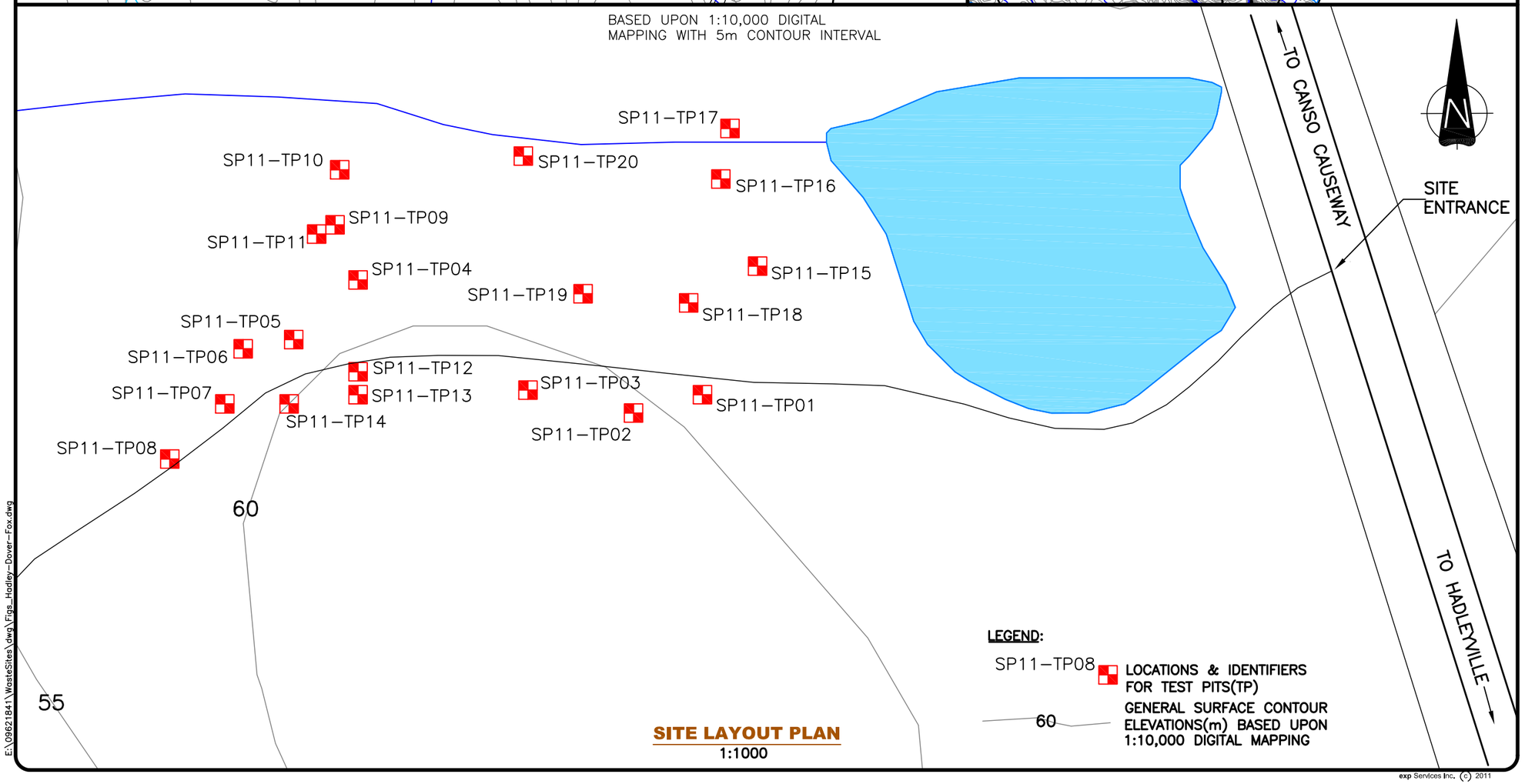

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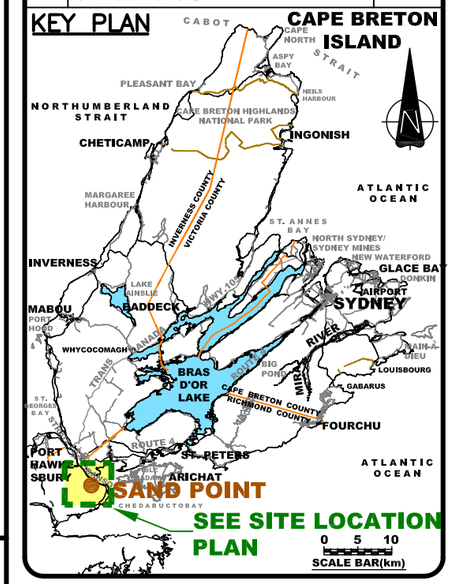

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Project Title

INVESTIGATION INTO OILY WASTE SITES

Dwg. Title

SAND POINT ARROW OILY WASTE DISPOSAL SITE

Project No. SYD–00020401–A0

Dwg. No. **FIGURE 8–1** Rev. No. 0

Scale **AS SHOWN**
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Plate 8-3: Lense of oily waste in test pit SP10-TP12.

Plate 8-4: Formerly intact bag of oily waste rock encountered in SP10-TP18.

3. Test pits with oily wastes terminated on bedrock, suggesting the site was prepared for disposal by excavating down to rock.

4. Water was encountered in test pits SP10-TP01, 02, 03, 05, 06, 14 18 and 19. Water inflow ranged from a trickle to fast flowing and was commonly encountered at the Till/bedrock interface.

5. When present, oily wastes were 0.25 to 0.75 metres below ground surface, suggesting a thin variable cover of loose fill (reworked till) was placed over the wastes.

8.6 Hydrological Setting

8.6.1 Hydrological Region/District

Map DP ME 36 Version 2 (2006), “Surficial Geology Map of the Province of Nova Scotia”, characterizes the regional topography as flat to rolling, few surface boulders; till is think enough to mask bedrock undulations. Soils are characterized as silty, compact, material derived from both local and distant sources.

Nova Scotia Department of Natural Resources, Minerals and Energy Division, “Map ME 2000-1, Geological Map for the Province of Nova Scotia” (2000), indicate that the Subject Property is underlain by the Horton Group Horton Bluff Formation comprised of fluvial lacustrine shale, siltstone, sandstone, conglomerate, breccias, minor dolostone and limestone.

The site hydrogeological setting is best characterized by a three-dimensional block model (Figure 8-2) developed by Baechler, et al (in progress) typifying a Sedimentary Plain Hydrogeological District. It is similar to Hadleyville, but without the thick till sheet. Distinctive features generally include a low relief, gently undulating, bedrock controlled topography, underlain by sedimentary rock, comprised predominantly of argnaceaous beds, interbedded to varying degrees with siltstones and shales. The surface is blanketed by thin to thick continuous silty sand to clayey silt glacial till,

The active groundwater flow field is expected to be governed by the hydrostructural rock domain created in what could be equivalent to the Cumberland HU (Figure 8-2). This is semi-confined by a silty sand Till HU. Ground surface water interaction is expected to be controlled predominantly by

shallow groundwater quick-flow-system operating in the soil and upper weathered portion of the Till HU and shallow bedrock; usually within 1 to 5 metres of ground surface.

Hydrologically the site is positioned within provincial drainage basin 1ER-SO3, locally identified as the Knights Lake watershed, which drains south to discharge into Chedabucto Bay, south of Red Head.

8.6.2 Hydrogeology

The test pit program and recent bedrock geological mapping (Giles et al, 2010) provided some confirmation for the hydrological setting described above. Test pitting indicated a moderate brown silty sand basal Till HU, 1 to 2 metres thick over highly fractured, friable, sandstone bedrock.

As noted above, water was encountered in test pits SP10-TP01, 02, 03, 05, 06, 14, 18 and 19. Water inflow ranged from a trickle to fast flowing and was commonly encountered at the Till/bedrock interface. This proves that the disposal material is buried below the groundwater table.

8.6.3 Hydrology

No defined ephemeral or perennial stream channels were present on-site. No rills or gullies were developed over the former operations area. One broad, natural, heavily vegetated swale was present along the western boundary of the site. Also along the northern site boundary, the forest floor was noted to be somewhat swampy, however, there were no defined channels or flowing water. One man-made lake was present in the abandoned aggregate pit 10 to 20 metres to the northeast of the disposal area.

8.7 Soil Geochemistry

8.7.1 Geochemistry

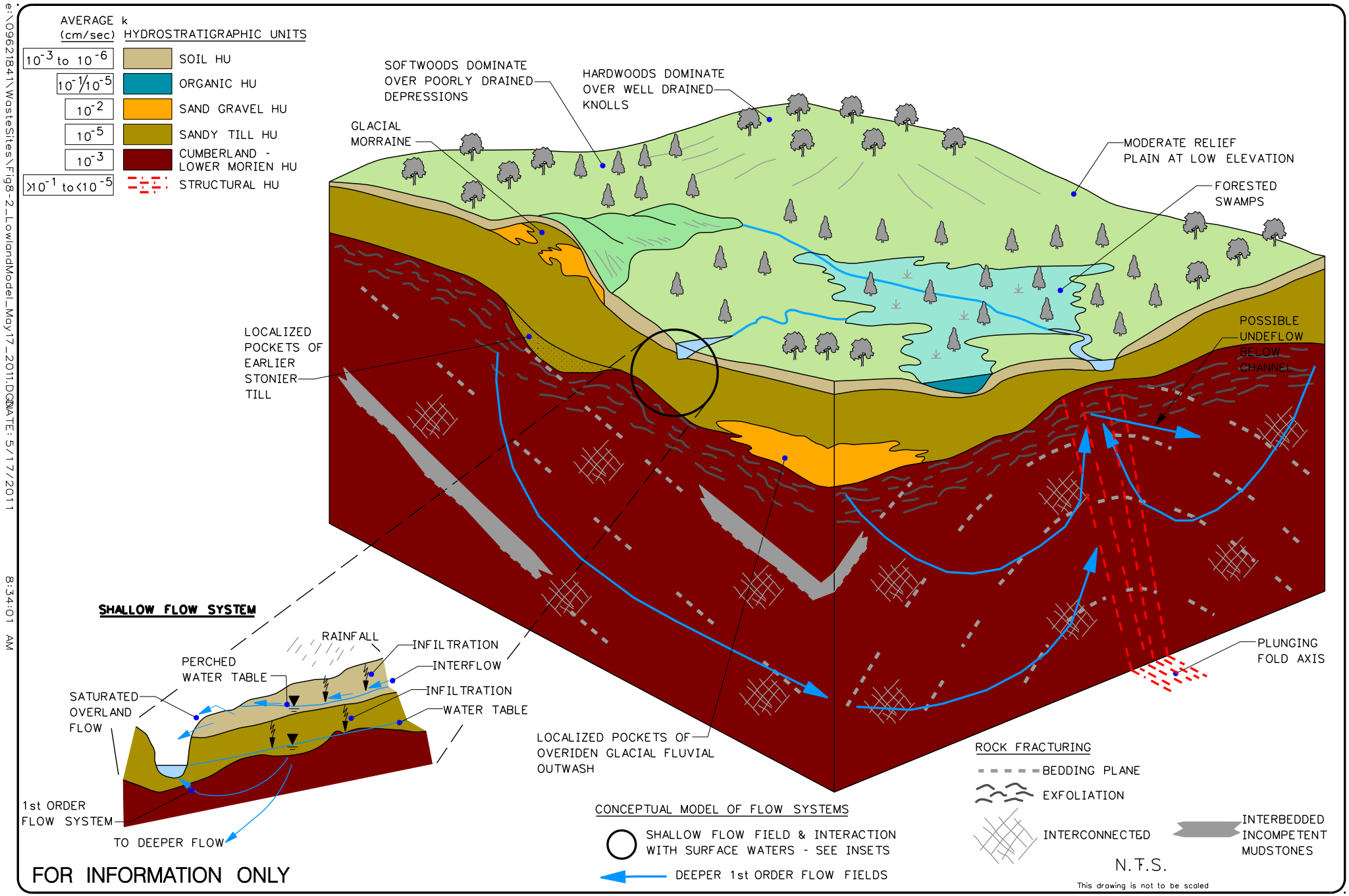
Eight soil samples were collected of visually contaminated soils within the disposal area; one each from test pits SP10-TP02, 05, 06, 09, 12, 15, 18 and 19. Each sample was analyzed for TPH/BTEX, as well as a suite of 32 metals and 19 PAH compounds. Two samples from test pits SP10-TP05 and SP10-TP18 were further analyzed for 35 volatile organics. The results are provided in Appendix D.

Analysis of the data indicated:

1. Modified TPH was detected in seven of eight samples, ranging from 90 to 8700 mg/Kg. Each sample indicated the same breakdown, as expected given the Bunker C nature of the oil. The >C21-<C32 forming the largest concentration (66 to 4500 mg/Kg), followed by >C16-C21 (24 to 3,100 mg/Kg), then >C10-C16 (< 10 to 1,000 mg/Kg), with the lowest concentrations in the C6-C10 (less BTEX) ranging from <3 to 19 mg/Kg and only detectable in sample SP10-TP02.

2. Lighter BTEX components were not detectable in any of the samples analysed.

3. The PAH analysis noted essentially non-detectable compounds except in SP10-TP05 and SP10-TP19. In these two samples 12 and four were detectable, respectively. The two indicators of naphthalene and benzo(a)pyrene noted ranges of <0.1 to < 0.01 mg/Kg and 0.1 to <0.1 mg/Kg, respectively. The highest concentrations (greater than 1 mg/Kg) were present in chrysene (0.01 to 1.3 mg/Kg) and phenanthrene 0.1 to 1.5 mg/Kg.



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INVESTIGATION OF OILY WASTE SITES
(CAPE BRETON WATER RESOURCE MANAGEMENT DATABASE)
(Baechler et al, in Progress)

Dwg.

LOWLAND REGION SEDIMENTARY PLAIN DISTRICT CONCEPTUAL HYDROLOGIC MODEL

Drawn By: NB	Proj. No. SYD-00020401-A0	
Dwg Standards Chk. By:	Dwg. No. **FIGURE 8-2**	
Designed By: FB	Date Last Modified: 28-APR-11	
Dwg. Design Chk. By: FB	Last Modified By: NB	Rev. 0

4. Only one VOC compound was detectable in the two samples tested; 0-Xylene was detected in SP10-TP05.

8.7.2 Quality

There were no elevated soil values for hydrocarbons, metals and VOCs.

PAH compounds were compared to the CCME 2010 Soil Quality Guidelines. There were no PAH compound values elevated above the industrial SQGs. The carcinogenic compounds were converted to Potency Equivalence factors for direct comparison as benzo(a)pyrene. In Table D4 human health is examined where as in Table D5 the index of additive cancer risk of the protection of potable water is calculated by dividing the concentration of each carcinogenic PAH compound by its SQG and summing the results. This exercise shows that the results from sample SP10-TP5 were 3.7 times greater than the protection of potable water (SQG-PW) guideline.

8.8 Preliminary Evaluation of Risk

Domestic dwellings are present within 0.5 km of the site. The site is owned by Provincial Crown, which allows for employing restrictions on land use.

Since the disposal zone is placed near or within the water table, with no under till liner, minimal surface cover, no mounded cover cap and is overgrown with trees the risk for release of oily waste contacted water at this site is qualitatively high (Baechler et al, 1976).

The disposal areas are positioned only 1,000 metres from the sea coast. The near shore coastal zone in this area is known for inshore herring, mackerel and lobster fishery, as well as migration habitat for ducks, cormorants, herons and gulls.

Forestry operations are ongoing in the general area; in the past this has cut into the disposal area.

The site has not been secured with gates nor identified as restricted land use on existing mapping or in the field.

It is unknown whether any recreational use is made of the manmade lake positioned immediately to the northeast.

8.9 Conclusions and Recommendations

The field program for this assignment has confirmed the absence of any appropriate disposal methodology, as would be appropriate by today's standards. The disposal zone is placed near or within the water table, on bedrock, with minimal surface cover, no mounded cover cap and is overgrown with trees. The risk for release is, therefore, qualitatively high.

While organic contaminants were visually noted scattered in discrete zones throughout the disposal area and concentrated in test pits SP10-TP18 and SP10-TP19, lab analyses of product layers did not exceed applicable guidelines with the exception of TP05. There is visual evidence on surface for release of hydrocarbons off-site along the north property boundary.

Potential future development along Highway 344, proximity of the site to the sea coast and ongoing forestry operations suggest consideration be given to:

1. Installation of groundwater monitoring wells between the site and the highway, with appropriate long-term monitoring. Initially this should be on a quarterly basis. An analysis of the data on an annual basis should be carried out to allow for refinements to the program when and where needed.

2. It is recommended that all trees should be cut off the former operations area. Skidders or other heavy equipment should not be utilized to remove trees, to ensure minimal damage to the thin cover seal.

3. A mounded grass cover cap should be constructed over the disposal area. The existing forestry road should be developed around the disposal area.

4. A care and maintenance schedule should be developed for the site to manually keep forest and understory development to a minimum.

5. A permanent gate should be constructed at the entrance to the site access road and a treed buffer zone maintained around the site to ensure access by unauthorized vehicles does not occur.

6. The site should be identified on existing government mapping to ensure no other land use is allowed in the future.

7. Given the site location and relative small volume of waste disposed of consideration could be given to removal of the oily waste and disposal at an approved facility.

9 List of References

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Baechler, F., H. LeBlanc, and O. Quinn Jr., 1976, A Proposed Hydrogeological Investigation of the Arrow Oil Dumpsites, Nova Scotia Department of the Environment, internal report, 119 pages

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Appendix A
Hadleyville

Table A1: HYDROCARBONS IN SOIL RESULTS
Hadleyville Kurdistan Oily Waste Site

Maxxam ID	Units	RBCA Commercial Guideline**	GT6218	GT6290	GT6292	GT6293	GT6294
Sampling Date			3-Aug-10	4-Aug-10	4-Aug-10	4-Aug-10	4-Aug-10
COC Number			ET042310	ET042310	ET042310	ET042310	ET042310
Sample ID			H10-MW01-4	H10-MW02-3	H10-MW03-2	H10-MW04-1	H10-MW04-2
TPH COMPOUNDS							
Benzene	mg/kg	**570**	<0.003	<0.003	<0.003	0.01	<0.003
Toluene	mg/kg	**18000**	<0.03	<0.03	<0.03	0.1	<0.03
Ethylbenzene	mg/kg	**10000**	<0.01	<0.01	<0.01	0.01	<0.01
Xylene (Total)	mg/kg	**180000**	<0.05	<0.05	<0.05	<0.05	<0.05
C6 - C10 (less BTEX)	mg/kg	**13000**	<3	<3	<3	<3	<3
>C10-C21 Hydrocarbons	mg/kg	**7700**	<15	<15	<15	17	<15
>C21-<C32 Hydrocarbons	mg/kg	**12000**	<15	<15	<15	21	<15
Modified TPH (Tier1)	mg/kg		<20	<20	<20	38	<20
Product Identifiecation	na		na	na	na	na	na

Notes:

RDL = Reportable Detection Limit, NG = No guideline

** Atlantic RBCA Version 2.0, Table 8 For Coarse-grained soils on **Commercial** receptor sites with non-potable water use, Soil Ingestion (2003 - update)

(1) Fuel oil / lube oil range.

(2) Fuel oil fraction

(3) Lube oil fraciton. TEH surrogate not within acceptable limits due to sample matrix.

(4) Lube oil fraction

(5) Fuel Oil Fraction and Lube Oil Fraction

*** As per laboratory identified fraction and/or Atlantic RBCA Version 2.0 Table 5, Modified TPH concentration must be compared with appropriate fraction. Shading indicates exceedance of Residential guideline

TABLE A2: METALS IN SOIL RESULTS
Hadleyville Kurdistan Oily Waste Site

Maxxam ID	Units	CCME CEQG Industrial Guideline*	GT6218	GT6290	GT6292	GT6293	GT6294
Sampling Date			3-Aug-10	4-Aug-10	4-Aug-10	4-Aug-10	4-Aug-10
COC Number			ET042310	ET042310	ET042310	ET042310	ET042310
			H10-MW01-4	H10-MW02-3	H10-MW03-2	H10-MW04-1	H10-MW04-2
Elements (ICP-MS)							
Aluminum (Al)	mg/kg	-	9700	9800	9400	10000	12000
Antimony (Sb)	mg/kg	**40**	<1	<1	<1	<1	<1
Arsenic (As)	mg/kg	**12**	5	6	4	5	5
Barium (Ba)	mg/kg	**2000**	130	97	130	180	170
Beryllium (Be)	mg/kg	**8**	<1	<1	<1	<1	1
Boron (B)	mg/kg	-	<7	<7	<7	<7	<7
Cadmium (Cd)	mg/kg	**22**	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium (Ca)	mg/kg	-	9300	15000	10000	10000	9200
Chromium (Cr)	mg/kg	**87**	18	19	18	20	22
Cobalt (Co)	mg/kg	**300**	13	14	12	14	16
Copper (Cu)	mg/kg	**91**	22	21	19	24	29
Iron (Fe)	mg/kg	-	27000	31000	27000	31000	33000
Lead (Pb)	mg/kg	**600**	16	20	18	18	14
Lithium (Li)	mg/kg	-	27	33	26	30	33
Magnesium (Mg)	mg/kg	-	6100	6700	6200	6000	6600
Manganese (Mn)	mg/kg	-	650	750	670	790	560
Mercury (Hg)	mg/kg	**50**	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	**40**	<1	<1	<1	<1	<1
Nickel (Ni)	mg/kg	**50**	27	30	25	30	33
Phosphorus (P)	mg/kg	-	370	380	370	380	400
Potassium (K)	mg/kg	-	1000	1100	1200	1100	1100
Selenium (Se)	mg/kg	**2.9**	<0.6	<0.6	<0.6	<0.6	<0.6
Silver (Ag)	mg/kg	**40**	<1	<1	<1	<1	<1
Sodium (Na)	mg/kg	-	<400	<400	<400	<400	<400
Strontium (Sr)	mg/kg	-	31	42	33	28	29
Sulphur (S)	mg/kg	-	NA	NA	NA	NA	NA
Thallium (Tl)	mg/kg	**1**	<0.7	<0.7	<0.7	<0.7	<0.7
Tin (Sn)	mg/kg	**300**	<10	<10	<10	<10	<10
Titanium (Ti)	mg/kg	-	90	80	130	110	68
Uranium (U)	mg/kg	**300**	<1	<1	<1	<1	<1
Vanadium (V)	mg/kg	**130**	13	12	15	15	14
Zinc (Zn)	mg/kg	**360**	56	54	67	62	52

Notes:

***** CCME Canadian Environmental Quality Guidelines for **Industrial** site land use (September 2007 update)

RDL = Reportable Detection Limit

Exceeds Industrial

Table A3: PAHs IN SOIL RESULTS
Hadleyville Kurdistan Oily Waste Site

Maxxam ID	Units	CCME CEQG Industrial Guideline*	GT6218	GT6290	GT6292	GT6293	GT6294
Sampling Date			3-Aug-10	4-Aug-10	4-Aug-10	4-Aug-10	4-Aug-10
COC Number			ET042310	ET042310	ET042310	ET042310	ET042310
			H10-MW01-4	H10-MW02-3	H10-MW03-2	H10-MW04-1	H10-MW04-2
PAHs							
1-Methylnaphthalene	mg/kg	-	<0.01	<0.01	<0.01	<0.01	<0.01
2-Methylnaphthalene	mg/kg	-	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	-	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	mg/kg	-	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	mg/kg	-	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	mg/kg	10	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	mg/kg	0.7	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	10	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	mg/kg	-	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	10	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	mg/kg	-	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	mg/kg	10	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	mg/kg	-	<0.01	<0.01	<0.01	0.02	<0.01
Fluorene	mg/kg	-	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	10	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	mg/kg	22	<0.01	<0.01	<0.01	<0.01	<0.01
Perylene	mg/kg	-	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	mg/kg	50	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	mg/kg	100	<0.01	<0.01	<0.01	0.02	<0.01

Notes:

* CCME Canadian Environmental Quality Guidelines for **Industrial** site land use (September 2006 update)

RDL = Reportable Detection Limit

Exceeds Industrial

Table A4: PAHs in Soil
Hadleyville Kurdistan Oily Waste Site

Maxxam ID	Units	CCME Direct Contact	CCME PEFs	GT6218	Sample TPE	GT6290	Sample TPE	GT6292	Sample TPE	GT6293	Sample TPE	GT6294	Sample TPE
Sampling Date				3-Aug-10		4-Aug-10		4-Aug-10		4-Aug-10		4-Aug-10	
COC Number				ET042310		ET042310		ET042310		ET042310		ET042310	
				H10-MW01-4		H10-MW02-3		H10-MW03-2		H10-MW04-1		H10-MW04-2	
PAHs													
1-Methylnaphthalene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
2-Methylnaphthalene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Acenaphthene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Acenaphthylene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Anthracene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Benzo(a)anthracene	mg/kg	NV	0.1	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005
Benzo(a)pyrene	mg/kg	NV	1	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Benzo(b)fluoranthene	mg/kg	NV	0.1	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005
Benzo(g,h,i)perylene	mg/kg	NV	0.01	0.005	0.00005	0.005	0.00005	0.005	0.00005	0.005	0.00005	0.005	0.00005
Benzo(k)fluoranthene	mg/kg	NV	0.1	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005
Chrysene	mg/kg	NV	0.01	0.005	0.00005	0.005	0.00005	0.005	0.00005	0.005	0.00005	0.005	0.00005
Dibenzo(a,h)anthracene	mg/kg	NV	1	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Fluoranthene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.02	-	0.005	-
Fluorene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Indeno(1,2,3-cd)pyrene	mg/kg	NV	0.1	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005
Naphthalene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Perylene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Phenanthrene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Pyrene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.02	-	0.005	-
B (a) P TPE	mg/Kg	5.3	-	-	0.0121	-	0.0121	-	0.0121	-	0.0121	-	0.0121
Uncertainty Factor	mg/Kg	3	-	-	0.0363	-	0.0363	-	0.0363	-	0.0363	-	0.0363

Notes:

* CCME Canadian Environmental Quality Guidelines for the Protection of Envrionmental and Human Health (2010)

NV - No Value

PEF - Potency Equivalence Factor

Total Potency Equivalent -

Screening:

Bold - Indicates an exceedance of CCME guidelines

Red indicates value was below the reportable detection limit and half the RDL was used for the calculation.

Table A5: PAHs in Soil
Hadleyville Kurdistan Oily Waste Site

Maxxam ID	Units	CCME Direct Contact	CCME PEFs	GT6218	Sample TPE	GT6290	Sample TPE	GT6292	Sample TPE	GT6293	Sample TPE	GT6294	Sample TPE
Sampling Date				3-Aug-10		4-Aug-10		4-Aug-10		4-Aug-10		4-Aug-10	
COC Number				ET042310		ET042310		ET042310		ET042310		ET042310	
				H10-MW01-4		H10-MW02-3		H10-MW03-2		H10-MW04-1		H10-MW04-2	
PAHs													
1-Methylnaphthalene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
2-Methylnaphthalene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Acenaphthene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Acenaphthylene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Anthracene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Benzo(a)anthracene	mg/kg	NV	0.33	0.005	0.00165	0.005	0.00165	0.005	0.00165	0.005	0.00165	0.005	0.00165
Benzo(a)pyrene	mg/kg	NV	0.37	0.005	0.00185	0.005	0.00185	0.005	0.00185	0.005	0.00185	0.005	0.00185
Benzo(b)fluoranthene	mg/kg	NV	0.16	0.005	0.0008	0.005	0.0008	0.005	0.0008	0.005	0.0008	0.005	0.0008
Benzo(g,h,i)perylene	mg/kg	NV	6.8	0.005	0.034	0.005	0.034	0.005	0.034	0.005	0.034	0.005	0.034
Benzo(k)fluoranthene	mg/kg	NV	0.16	0.005	0.0008	0.005	0.0008	0.005	0.0008	0.005	0.0008	0.005	0.0008
Chrysene	mg/kg	NV	2.1	0.005	0.0105	0.005	0.0105	0.005	0.0105	0.005	0.0105	0.005	0.0105
Dibenzo(a,h)anthracene	mg/kg	NV	0.23	0.005	0.00115	0.005	0.00115	0.005	0.00115	0.005	0.00115	0.005	0.00115
Fluoranthene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.02	-	0.005	-
Fluorene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Indeno(1,2,3-cd)pyrene	mg/kg	NV	2.7	0.005	0.0135	0.005	0.0135	0.005	0.0135	0.005	0.0135	0.005	0.0135
Naphthalene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Perylene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Phenanthrene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
Pyrene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.02	-	0.005	-
SQG PW IACR	mg/Kg	1	-	-	0.06425	-	0.06425	-	0.06425	-	0.06425	-	0.06425

Notes:

Notes:

All values expressed in µg/g unless otherwise indicated

NV - No Value

SQG_{PW} - Soil Quality Guideline for Protection of Potable Water

IACR - Index of Additive Cancer Risk

SQG_{PW} IACR - Index of Additive Cancer Risk for Protection of Potable Water - Calculated by dividing the concentration of each PAH in the sample by its SQG_{PW} and summing the results

Screening:

Bold - Indicates an exceedance of CCME guidelines

Red indicates value was below the reportable detection limit and half the RDL was used for the calculation.

References:

Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Soil Quality Guidelines (CEQG), Last Accessed October 2008 - Commercial land use, coarse textured soil

Table A6: HYDROCARBONS IN WATER RESULTS

Hadleyville Kurdistan Oily Waste Site

Maxxam ID	Units	Guideline 1	HB0454	HB0455	HB0456	HB0457	HB0458	HB0459	HB0460	IC4232	IC4233	IC4234	IC4235	IC4236	IC4237	IC4238
								Duplicate							Duplicate	
Sampling Date			1-Sep-10	1-Sep-10	1-Sep-10	1-Sep-10	1-Sep-10	1-Sep-10	1-Sep-10	7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10
COC Number			B124745	B124745	B124745	B124745	B124745	B124745	B124745	B074912	B074912	B074912	B074912	B074912	B074912	B074912
ADI Sample ID			H10-MW01	H10-MW-02	H10-MW03	H10-MW04	H10-SW01	H10-SW-00	H10-TR02	H10-MW01	H10-MW02	H10-MW03	H10-MW04	H10-MW00	TRENCH #1	H10-SW01
Petroleum Hydrocarbons																
Benzene	mg/L	**NG**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/L	**NG**	<0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ethylbenzene	mg/L	**NG**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.065	<0.001	<0.001	<0.001	<0.001	<0.001	0.046	<0.001
Xylene (Total)	mg/L	**NG**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
C6 - C10 (less BTEX)	mg/L	**NG**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
<C10-C16 Hydrocarbons	mg/L	**NG**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
>C16-C21 Hydrocarbons	mg/L	**NG**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
>C21-<C32 Hydrocarbon	mg/L	**NG**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Modified TPH (Tier1)	mg/L	***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

Guideline 1: Atlantic RBCA Version 2.0, Table 8 For Coarse-grained soils on Commercial receptor sites with Non-potable water use and Ingestion Pathway (September 2003 update).

NG - No Guideline; ND - Not detected

*** As per laboratory identified fraction and/or Atlantic RBCA Version 2.0 Table 7, Modified TPH concentration must be compared with appropriate fraction.

Exceeds Guideline 1

Table A7: INORGANICS and METALS IN WATER RESULTS

Hadleyville Kurdistan Oily Waste Site

Maxxam ID	Units	NS EQS: Groundwater	GT6323	HB0454	Duplicate	IC4232	IC4236	IC4233	IC4234	IC4235	IC4237	NS EQS: Surface Water	HB0458	HB0459	Duplicate	IC4238
Sampling Date			3-Aug-10	1-Sep-10		7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10		1-Sep-10	1-Sep-10		7-Dec-10
COC Number			ET042310	B124745		B074912	B074912	B074912	B074912	B074912	B074912		B124745	B124745		B074912
			Drill Water	H10-MW01		H10-MW01	H10-MW00	H10-MW02	H10-MW03	H10-MW04	TRENCH #1		H10-SW01	H10-SW-00		H10-SW01
RCAP CALCULATIONS																
Anion Sum	me/L	-	0.42	4.1		5.51	5.47	5.47	5.75	8.59	10.2	-	0.17	0.17		0.310
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	<1	138		206	208	172	196	257	459	-	<1	<1		<1
Calculated TDS	mg/L	**500**	31	215		296	296	319	326	486	516	-	15	15		22
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	<1	2		2	3	2	2	3	2	-	<1	<1		<1
Cation Sum	me/L	-	0.57	3.43		5.25	5.34	5.61	5.74	8.58	9.82	-	0.35	0.36		0.460
Hardness (CaCO3)	mg/L	-	10	100		170	170	170	190	320	410	-	5	5		5
Ion Balance (% Difference)	%	-	15.2	8.9		2.42	1.20	1.26	0.0900	0.0600	1.85	-	34.6	35.9		19.5
Langelier Index (@ 20C)	N/A	-	NC	0.314		0.642	0.756	0.582	0.590	0.982	0.862	-	nc	nc		NC
Langelier Index (@ 4C)	N/A	-	NC	0.064		0.393	0.507	0.333	0.341	0.734	0.614	-	nc	nc		NC
Saturation pH (@ 20C)	N/A	-	NC	7.79		7.46	7.44	7.52	7.41	7.12	6.74	-	nc	nc		NC
Saturation pH (@ 4C)	N/A	-	NC	8.04		7.71	7.69	7.77	7.66	7.37	6.99	-	nc	nc		NC
INORGANICS																
Alkalinity (Total as CaCO3)	mg/L	-	<5	140		210	210	170	200	260	460	-	<5	<5		<5
Chloride (Cl)	mg/L	**250**	10	22		16	14	15	12	31	29	-	6	6		11
Colour	TCU	**15**	19	5		<5	<5	6	9	<5	15	**Narrative**	170	190		83
Nitrate (N)	mg/L	**45**	0.09	<0.05		<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	**13**	<0.05	<0.05		<0.06
Nitrite (N)	mg/L	**0**	<0.01	<0.01		<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	-	<0.01	<0.01		<0.06
Nitrite + Nitrate	mg/L	**0.6**	0.09	<0.05		<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	**0.06**	<0.05	<0.05		<0.06
Nitrogen (Ammonia Nitrogen)	mg/L	**0.19**	<0.05	<0.05		0.18	0.13	0.10	0.10	<0.05	1.5	-	<0.05	<0.05		<0.05
Total Organic Carbon (C)	mg/L	-	3.3	5.2		1.8	1.7	2.0	2.9	1.2	7.2	-	15	15		8.5
Orthophosphate (P)	mg/L	-	<0.01	<0.01		<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	-	<0.01	<0.01		<0.3
pH	pH	**0**	6.4	8.1		8.10	8.20	8.10	8.00	8.10	7.60	**6.5 to 9.0**	5.9	5.6		6.10
Silica (SiO2)	mg/L	-	2.5	5		7.5	7.7	9.9	11	12	12	-	<0.1	<0.1		0.8
Sulphate (SO4)	mg/L	**500**	6	34		43	40	75	70	120	7	**100**	<2	<2		<2
Turbidity	NTU	-	3.6	>1000		>1000	>1000	>1000	>1000	>1000	120	-	14	16		4.0
Conductivity	uS/cm	-	59	390		520	530	550	560	850	890	-	31	30		55
Elements (ICP-MS)																
Dissolved Aluminum (Al)	mg/L	**0.05**	NA	0.024		0.03	0.032	0.035	0.035	0.03	0.033	**0.005**	0.088	0.092		0.12
Dissolved Antimony (Sb)	mg/L	**0.006**	NA	<0.0004		<0.0004	0.00046	0.0004	0.0012	0.00097	<0.0004	**0.02**	<0.0004	<0.0004		<0.0004
Dissolved Arsenic (As)	mg/L	**0.01**	NA	0.0013		0.00099	0.001	0.0038	0.0019	0.00088	0.0006	**0.005**	0.00099	0.00099		<0.0006
Dissolved Barium (Ba)	mg/L	**1**	NA	0.083		0.075	0.075	0.053	0.057	0.074	0.59	**1**	0.0087	0.009		0.0086
Dissolved Beryllium (Be)	mg/L	**0.004**	NA	<0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	**0.0053**	<0.0005	<0.0005		<0.0005
Dissolved Bismuth (Bi)	mg/L	-	NA	<0.002		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002		<0.002
Dissolved Boron (B)	mg/L	**5**	NA	<0.1		<0.1	<0.1	<0.1	<0.1	0.11	<0.1	**1.2**	<0.1	<0.1		<0.1
Dissolved Cadmium (Cd)	mg/L	**0.0001**	NA	<0.000017		<0.000017	<0.000017	<0.000017	<0.000017	0.000022	<0.000017	**0.00001**	0.000048	0.000053		0.00011
Dissolved Chromium (Cr)	mg/L	**0.05**	NA	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001		<0.001
Dissolved Cobalt (Co)	mg/L	**0.003**	NA	<0.001		<0.001	<0.001	0.0013	<0.001	0.0017	<0.001	**0.004**	0.0012	0.0012		0.0017
Dissolved Lead (Pb)	mg/L	**0.01**	NA	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.001**	<0.001	<0.001		<0.001
Dissolved Lithium (Li)	mg/L	-	NA	0.011		0.01	0.011	0.013	0.012	0.016	0.0051	-	<0.001	<0.001		<0.001
Total Mercury (Hg)	mg/L	**0.00026**	NA	NA		NA	NA	NA	NA	NA	NA	**0.000026**	NA	NA		NA
Dissolved Molybdenum (Mo)	mg/L	**0.07**	NA	0.13		0.036	0.037	0.021	0.019	0.013	<0.004	**0.073**	<0.004	<0.004		<0.004
Dissolved Nickel (Ni)	mg/L	**0.1**	NA	<0.003		<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	**0.025**	<0.003	<0.003		<0.003
Dissolved Phosphorus (P)	mg/L	-	NA	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1		<0.1
Dissolved Selenium (Se)	mg/L	**0.01**	NA	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.001**	<0.001	<0.001		<0.001
Dissolved Silver (Ag)	mg/L	**0.001**	NA	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**0.0001**	<0.0001	<0.0001		<0.0001
Dissolved Strontium (Sr)	mg/L	**4.4**	NA	0.36		0.68	0.73	0.72	0.86	1.3	0.67	**21**	0.0058	0.0061		0.005
Dissolved Sulphur (S)	mg/L	-	NA	NA		NA	NA	NA	NA	NA	NA	-	NA	NA		NA
Dissolved Thallium (Tl)	mg/L	**0.002**	NA	<0.0008		<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	**0.0008**	<0.0008	<0.0008		<0.0008
Dissolved Tin (Sn)	mg/L	**4.4**	NA	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02		<0.02
Dissolved Titanium (Ti)	mg/L	-	NA	<0.003		<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	<0.003		<0.003
Dissolved Uranium (U)	mg/L	**0.02**	NA	0.0035		0.0035	0.0036	0.0018	0.0039	0.0065	<0.00015	**0.3**	<0.00015	<0.00015		<0.00015
Dissolved Vanadium (V)	mg/L	**0.0062**	NA	<0.002		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	**0.006**	<0.002	<0.002		<0.002
Elements (ICP-OES)																
Dissolved Calcium (Ca)	mg/L	-	2	28		44	45	47	53	87	120	-	0.79	0.77		0.44
Dissolved Copper (Cu)	mg/L	**0.02**	<0.002	<0.002		0.005	<0.002	<0.002	<0.002	0.0032	0.0041	**0.002**	0.0073	0.0076		<0.002
Dissolved Iron (Fe)	mg/L	**0.3**	0.15	<0.1		<0.1	<0.1	0.14	0.23	<0.1	12	**0.3**	0.81	0.7		0.77
Dissolved Magnesium (Mg)	mg/L	-	1.1	6.7		14	14	13	14	25	29	-	0.65	0.68		1
Dissolved Manganese (Mn)	mg/L	**0.05**	0.02	0.24		0.32	0.33	0.48	0.54	0.75	6.1	**0.82**	0.37	0.39		0.3
Dissolved Potassium (K)	mg/L	-	< 0.6	6.2		6	6.2	7.6	6.6	8.3	2.9	-	1.7	1.8		1.2
Dissolved Sodium (Na)	mg/L	**200**	8.4	30		40	41	46	41	46	22	-	4.3	4.3		6.8
Dissolved Zinc (Zn)	mg/L	**0.3**	0.0	<0.005		0.012	0.005	0.011	0.0081	0.016	0.013	**0.03**	0.028	0.02		0.0088

Notes:

Guideline 1: Rationale for the Development of Environmental Quality Standards for Contaminated Sites in Nova Scotia Tier 1: Table A-3 Tier 1

Guideline 2: Rationale for the Development of Environmental Quality Standards for Contaminated Sites in Nova Scotia Tier 1: Table A-4 Tier 1

NM = Not measured due to insufficient water; N/A = Not applicable; NA = Not analysed

AO = Aesthetic Objective

Exceeds NSE EQS: Surface Water

Exceeds NSE EQS: Groundwater

Table A8: PAH IN GROUNDWATER RESULTS
Hadleyville Kurdistan Oily Waste Site

Maxxam ID	Units	NS EQS: Groundwater	HB0457	IC4232	IC4236	IC4233	IC4234	IC4235	IC4237	IC4238
Sampling Date			1-Sep-10	07/12/2010	07/12/2010	07/12/2010	07/12/2010	07/12/2010	07/12/2010	07/12/2010
COC Number			B124745	B074912	B074912	B074912	B074912	B074912	B074912	B074912
ADI Sample ID			H10-MW04	H10-MW01	H10-MW00	H10-MW02	H10-MW03	H10-MW04	TRENCH #2	H10-SW01
Polycyclic Aromatic Hydrocarbons										
1-Methylnaphthalene	ug/L	**20**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.53	<0.05
2-Methylnaphthalene	ug/L	**20**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthene	ug/L	**58**	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01	<0.01
Acenaphthylene	ug/L	**0.45**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	ug/L	**0.12**	<0.01	<0.01	0.02	0.02	<0.01	<0.01	<0.01	0.01
Benzo(a)anthracene	ug/L	**0.18**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	ug/L	**0.15**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	ug/L	**4.8**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	ug/L	**1.7**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	ug/L	**4.8**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	ug/L	**14**	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenz(a,h)anthracene	ug/L	**2.6**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	ug/L	**0.4**	<0.01	0.02	0.06	0.07	0.07	0.05	0.05	0.08
Fluorene	ug/L	**30**	<0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.01
Indeno(1,2,3-cd)pyrene	ug/L	**2.1**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	ug/L	**11**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2
Perylene	ug/L	**-**	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	ug/L	**4**	<0.001	0.03	0.09	0.13	0.13	0.07	0.12	0.14
Pyrene	ug/L	**0.25**	<0.001	0.02	0.03	0.04	0.04	0.03	0.03	0.05

Notes:

Guideline 1: Rationale for the Development of Environmental Quality Standards for Contaminated Sites in Nova Scotia Tier 1: Table A-4 Tier 1 Environmental Quality Standards for Groundwater, January 2011

NG - No Guideline; ND - Not detected

Exceeds Guideline 1

Table A9
Hadleyville groundwater elevations

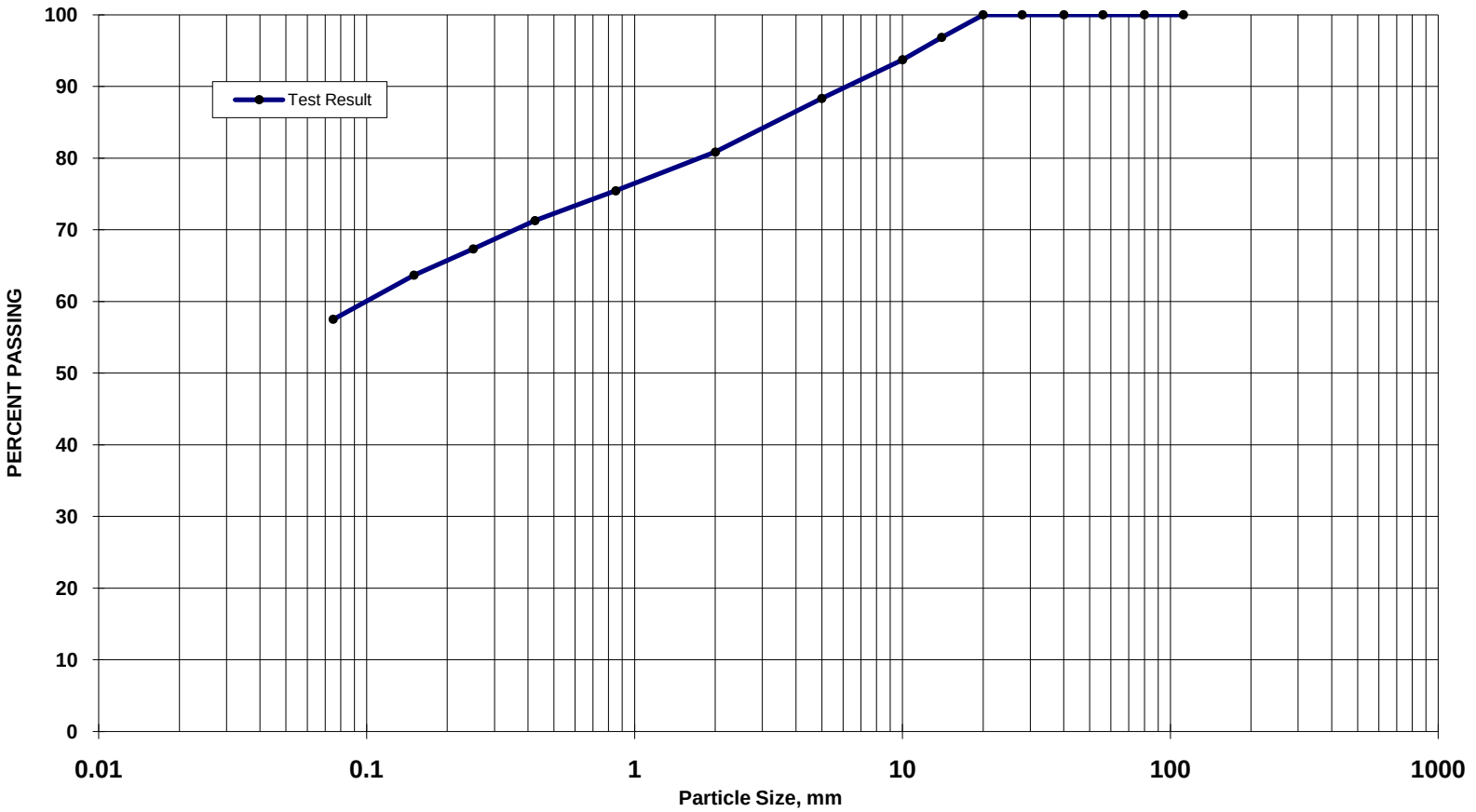
					1-Sep-10		8-Dec-11	
Monitoring Well ID	**Ground level, MASL**	**PVC pipe level, MASL**	**PVC stick up, m**	**Total PVC (well depth), m**	**Water level, m**	**Water elevation, MASL**	**Water level, m**	**Water elevation, MASL**
H10-MW-01	53.5342	53.4238	-0.1104	18.37	2.33	51.0938	2.57	50.8538
H10-MW-02	47.6026	47.4998	-0.1028	7.6	7.13	40.3698	-0.05	47.5498
H10-MW-03	46.5236	46.4637	-0.0599	7.6	7.205	39.2587	-0.05	46.5137
H10-MW-04	45.0935	45.1151	0.0216	7.6	6.93	38.1851	2.57	42.5451

ASTM/USCS Sieve Analysis

SYD-00020401-A0

Oily Waste Sites Guysborough County - Hadleyville

August 3, 2010



TEST DATA	
Sieve Size (mm)	Percent Passing (%)
112	100.0
80	100.0
56	100.0
40	100.0
28	100.0
20	100.0
14	96.8
10	93.7
5	88.3
2	80.8
0.85	75.4
0.425	71.3
0.25	67.3
0.15	63.7
0.075	57.5

Client: NSTIR

Sample: H10-MW01-6

Soil Type: TILL

USCS Soil Name: Sandy Silt

Gravel (%) 11.7

Sand (%) 30.8

Fines (%) 57.5

USCS Symbol: ML

C_u NA

C_c NA

$W_{content}$(%) 10.5

Test By: JWB/KR

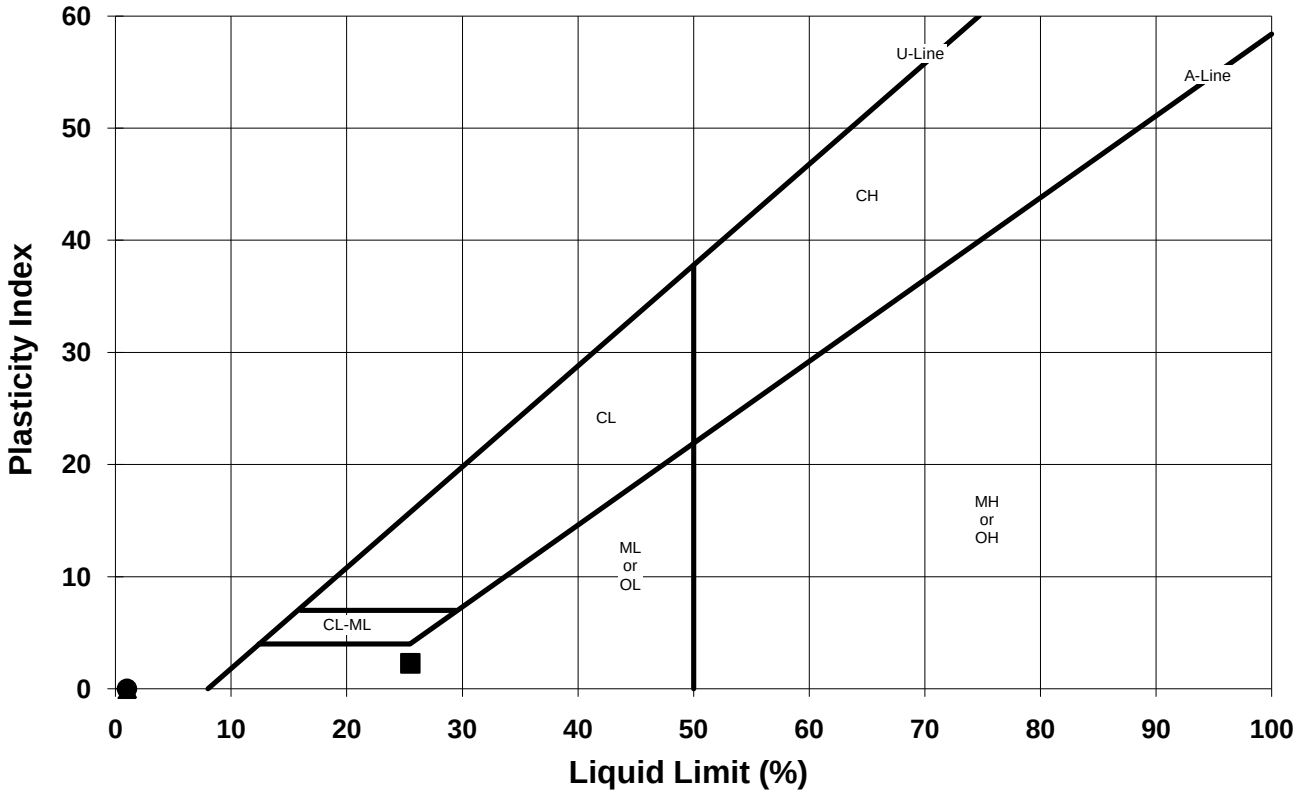
Comment: Fines are classified as ML

Specified Gradational Limits		
Size (mm)	Low Limit % Passing	High Limit % Passing
80		
56		
28		
14		
5		
0.16		
0.08		

exp Services Inc. - Plastic Limits
ASTM D4318

SYD-00020401-A0

August 14, 2010



Client:	NSTIR	Job No:	SYD-00020401-A0
Project:	Kurdistan and Arrow Oily Waste Disposal Sites - Hadleyville	Location:	Hadleyville, NS
Sample Date:	August 3, 2010	Test Date:	August 14, 2010
Sample By:	SS	Test By:	JWB/KR

DATA SUMMARY

Sample #	Liquid Limit	Plastic Limit	Plastic Index	Soil Symbol	Soil Type	Legend
H10-MW01-6	25.5	23.2	2.3	ML or OL	Till	■ ◆ ▲ ●

Comment: Sample was collected for a depth of 6.14 to 9.76 metres

exp Services Inc.
301 Alexandra Street
Sydney, Nova Scotia, B1S 2E8
Telephone: 902-562-2394
Fax: 902-564-5660

WELL NUMBER H10-MW01

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER L09621841
PROJECT LOCATION Hadleyville Kurdistan Oily Waste Site
DATE STARTED 3/8/10 **COMPLETED** 3/8/10
GROUND ELEVATION 53.4 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME 55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
						Casing Top Elev: 53.424 (m) Casing Type: Flush Mount
	SS 1	62	Ground surface was flat, gravel cover. 22		0.10 ORGANICS: Rootlets, some sand and gravel, loose, moist, brown 53.30 FILL: Reworked till, sandy silt, some gravel, loose to compact, moist, reddish brown	
			Small pocket of black beach sand encountered from 1.52 to 1.67 metres depth.		1.52 51.88 TILL: Sandy Silt, some gravel, trace cobble and boulder, compact, dry to moist, moderate brown	
2	SS 2	100	33			Bentonite seal.
	SS 3	100	45			
4						
	SS 4	100	42 Water was not encountered. An occaisional water droplet was noted around the gravel clasts in the till.			
6	SS 5	100	45			
8			Used core barrel to advance from 12.2 metres to termination of borehole. Refusal at 12.2 metres was a boulder.			
	SS 6	100	42			
10						

GENERAL BH / TP / WELL HADLEYVILLE MWS.GPJ GINT STD CANADA LAB.GDT 1/8/12

(Continued Next Page)

exp Services Inc.
301 Alexandra Street
Sydney, Nova Scotia, B1S 2E8
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Fax: 902-564-5660

WELL NUMBER H10-MW01

CLIENT Nova Scotia Transportation and Infrastructure Renewal

PROJECT NAME Hydrogeological Investigation

PROJECT NUMBER L09621841

PROJECT LOCATION Hadleyville Kurdistan Oily Waste Site

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
12	SS 7	200	50/2		TILL: Sandy Silt, some gravel, trace cobble and boulder, compact, dry to moist, moderate brown *(continued)*	Screen in sand.
14	RC 8	20				
16	SS 9	100	41			
18	SS 10	100	51		19.20 Borehole terminated at 19.2 metres depth in Till. Montioring well installed. Bottom of borehole at 19.20 meters.	34.20 End Point.

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Sydney, Nova Scotia, B1S 2E8
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Fax: 902-564-5660

WELL NUMBER H10-MW02

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER L09621841
PROJECT LOCATION Hadleyville Kurdistan Oily Waste Site
DATE STARTED 4/8/10 **COMPLETED** 4/8/10
GROUND ELEVATION 47.5 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME 55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
						Casing Top Elev: 47.4998 (m) Casing Type: Flush Mount
	SS 1	62	Ground surface was uneven. Moss and vegetation ground cover. Drillers cleared some trees to get into drill site. 5		0.10 ORGANICS: 47.40 0.31 Rootlets, some sand and gravel, loose, moist, brown 47.19 FILL: Silt, trace organics (rootlets), loose, moist, yellowish brown FILL: Reworked till, sandy silt, some gravel, loose to compact, moist, moderate brown	Bentonite seal.
2			Water was not encountered.		1.52 45.98 TILL: Sandy silt, some gravel, trace cobble and boulder, compact, dry to moist, reddish brown	
	SS 2	100	32			
4						Screen in sand.
6			Advanced standard augers to 7.62 metres depth.			
	SS 3	100	38		7.62 39.88	End Point.
					Borehole terminated at 7.62 metres depth in Till. Montioring well installed. Bottom of borehole at 7.62 meters.	

GENERAL BH / TP / WELL HADLEYVILLE MWS.GPJ GINT STD CANADA LAB.GDT 1/8/12

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WELL NUMBER H10-MW03

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER L09621841
PROJECT LOCATION Hadleyville Kurdistan Oily Waste Site
DATE STARTED 4/8/10 **COMPLETED** 4/8/10
GROUND ELEVATION 46.5 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME 55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
						Casing Top Elev: 46.4637 (m) Casing Type: Flush Mount
	SS 1	70	Ground surface was uneven. Moss and vegetation ground cover. Drillers cleared some trees to get into drill site. 12		0.31 TOPSOIL: Silt, trace organics (rootlets), loose, moist, yellowish brown 46.19 FILL: Reworked till, sandy silt, some gravel, loose to compact, moist, moderate brown	Bentonite seal.
2			Water was not encountered.		1.52 44.98 TILL: Sandy silt, some gravel, trace cobble and boulder, compact, dry to moist, reddish brown	
	SS 2	100	40			
4						Screen in sand.
6			Advanced standard augers to 7.62 metres depth.			
	SS 3	100	44			
					7.62 38.88	End Point.

Borehole terminated at 7.62 metres depth in Till. Montioring well installed.

Bottom of borehole at 7.62 meters.

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Fax: 902-564-5660

WELL NUMBER H10-MW04

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER L09621841
PROJECT LOCATION Hadleyville Kurdistan Oily Waste Site
DATE STARTED 4/8/10 **COMPLETED** 4/8/10
GROUND ELEVATION 45.1 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME 55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
						Casing Top Elev: 45.1151 (m) Casing Type: Flush Mount
	SS 1	100	Ground surface was gentley sloped. Moss and vegetation ground cover. Drillers cleared some trees to get into drill site. 14		0.31 TOPSOIL: Silt, trace organics (rootlets), loose, moist, yellowish brown 44.79 FILL: Reworked till, sandy silt, some gravel, loose to compact, moist, moderate brown	Bentonite seal.
					1.52 43.58 TILL: Sandy silt, some gravel, trace cobble and boulder, compact, dry to moist, reddish brown	
2			Water was not encountered.			
	SS 2	100	20			
4						Screen in sand.
6			Advanced standard augers to 7.62 metres depth.			
	SS 3	100	32			
					7.62 37.48	End Point.

Borehole terminated at 7.62 metres depth in Till. Montioring well installed.

Bottom of borehole at 7.62 meters.

GENERAL BH / TP / WELL HADLEYVILLE MWS.GPJ GINT STD CANADA LAB.GDT 1/8/12

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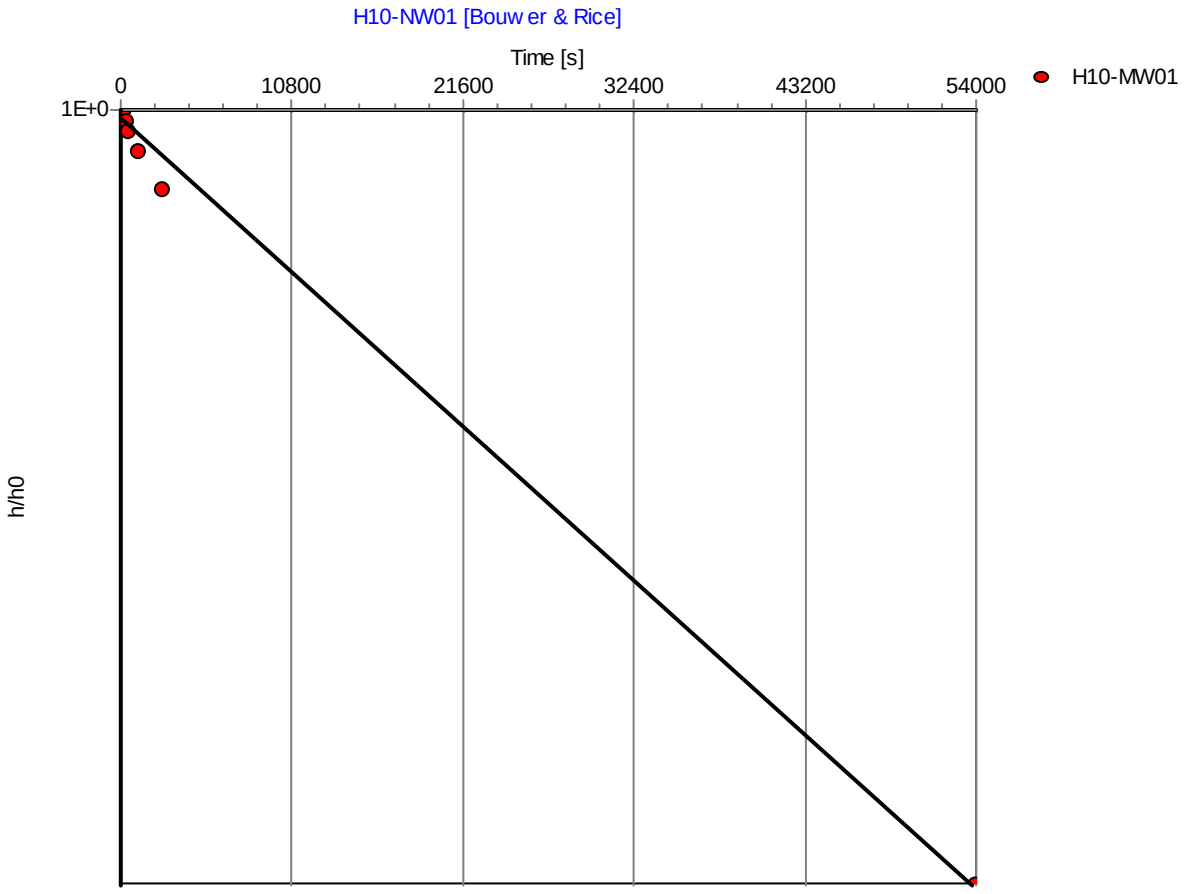
Sydney, NS B1S 2E8
Phone: (902) 562-2394

Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Hadleyville

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **H10-MW01**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 7.15E-9 [cm/s]

Test parameters:

Test Well:	H10-MW01	Aquifer Thickness:	16.87 [m]
Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
Screen length:	15.2 [m]		
Boring radius:	0.0762 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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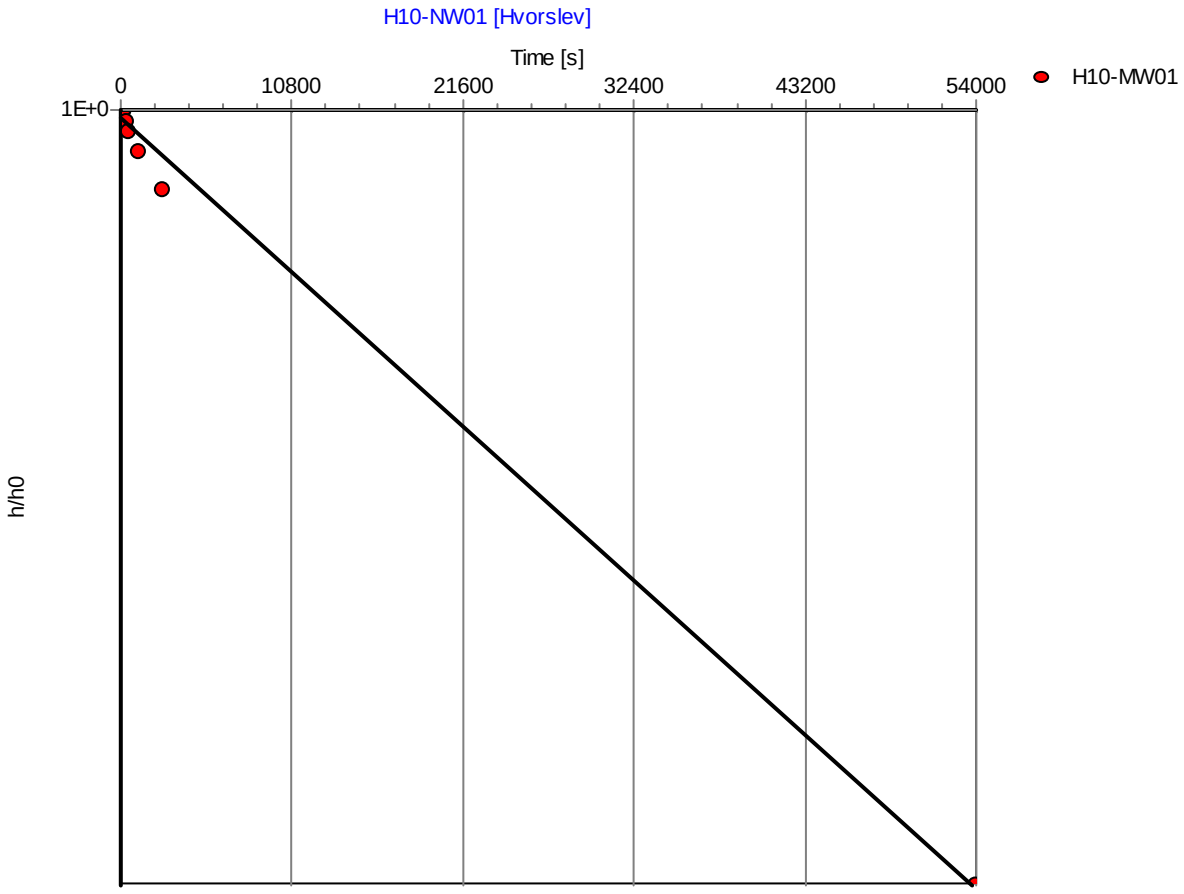
Phone: (902) 562-2394

Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Hadleyville

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **H10-MW01**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 9.00E-9 [cm/s]

Test parameters:

Test Well:	H10-MW01	Aquifer Thickness:	16.87 [m]
Casing radius:	0.0254 [m]		
Screen length:	15.2 [m]		
Boring radius:	0.0762 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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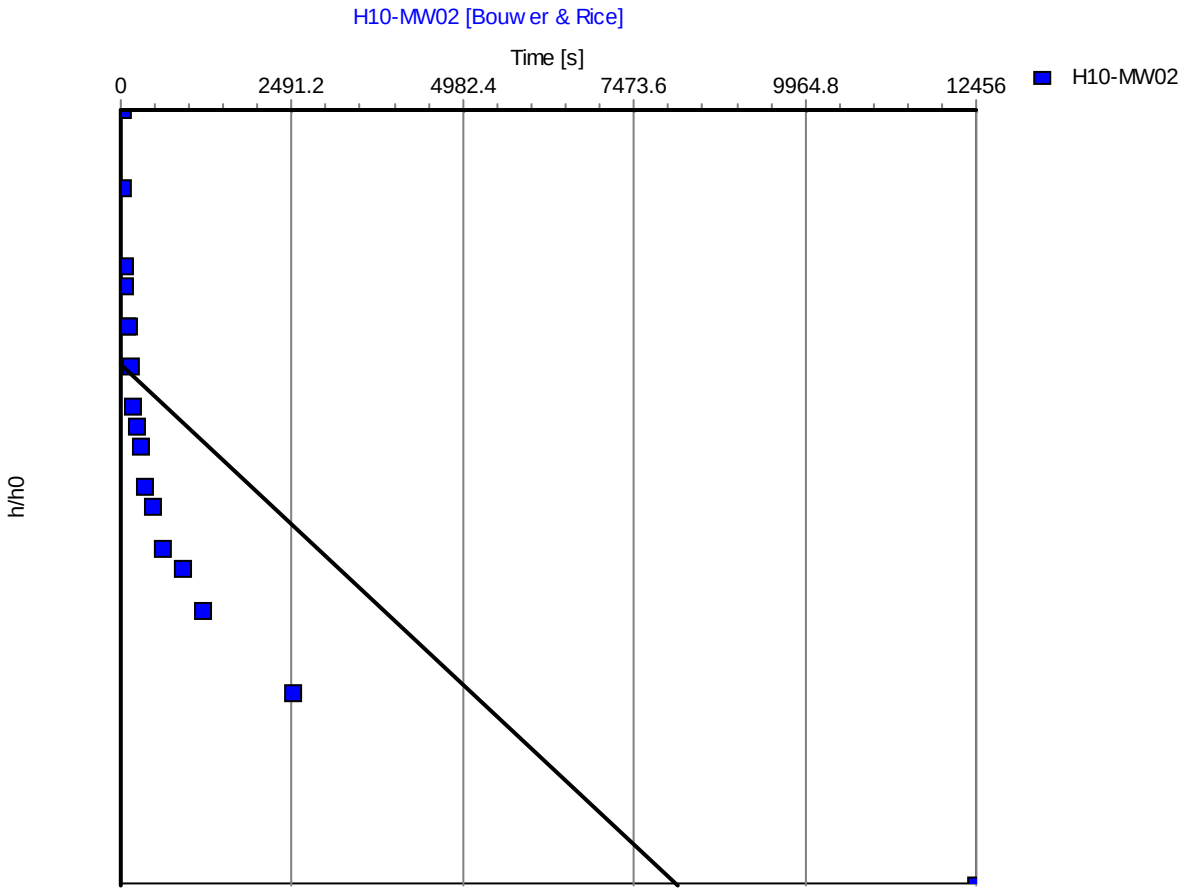
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Hadleyville

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **H10-MW02**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 7.23E-8 [cm/s]

Test parameters:

Test Well:	H10-MW02	Aquifer Thickness:	0.49 [m]
Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
Screen length:	6.22 [m]		
Boring radius:	0.0762 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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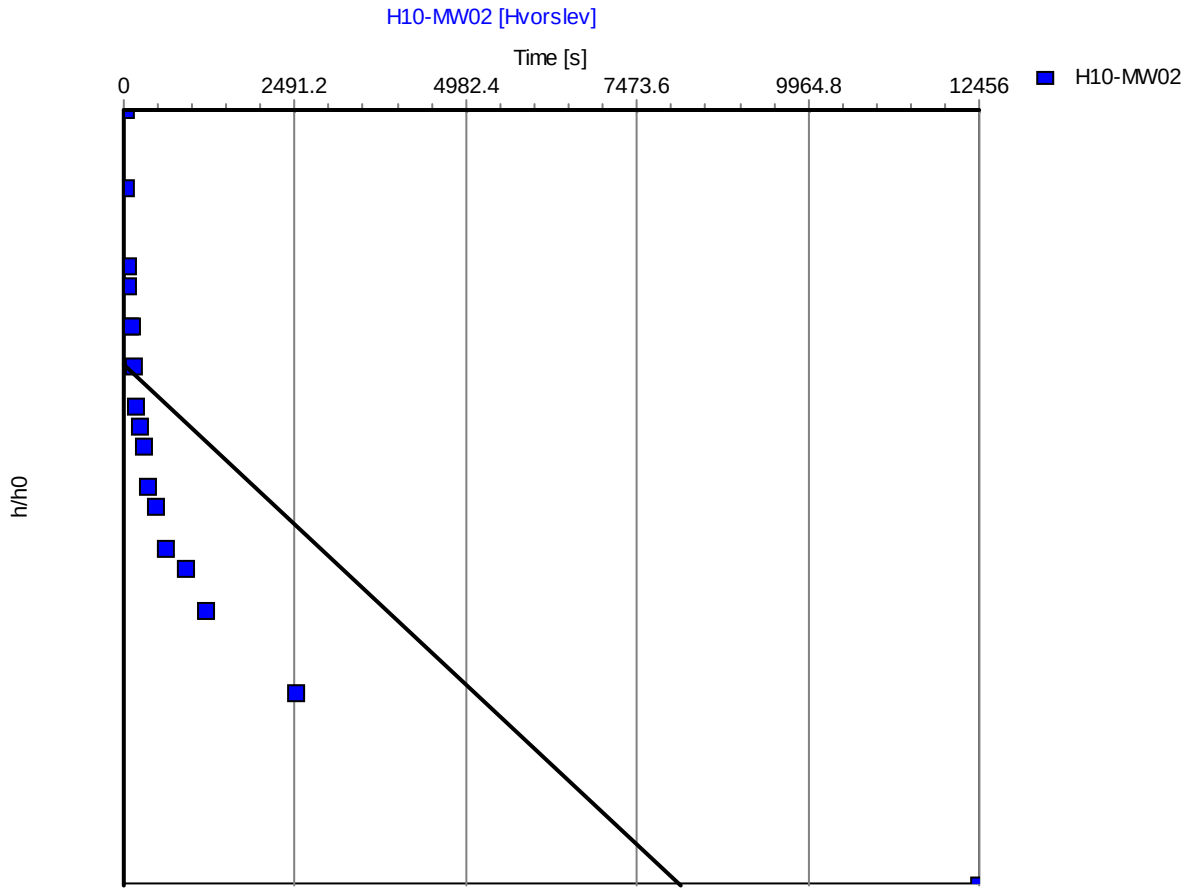
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Hadleyville

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **H10-MW02**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 2.07E-7 [cm/s]

Test parameters:

Test Well:	H10-MW02	Aquifer Thickness:	0.49 [m]
Casing radius:	0.0254 [m]		
Screen length:	6.22 [m]		
Boring radius:	0.0762 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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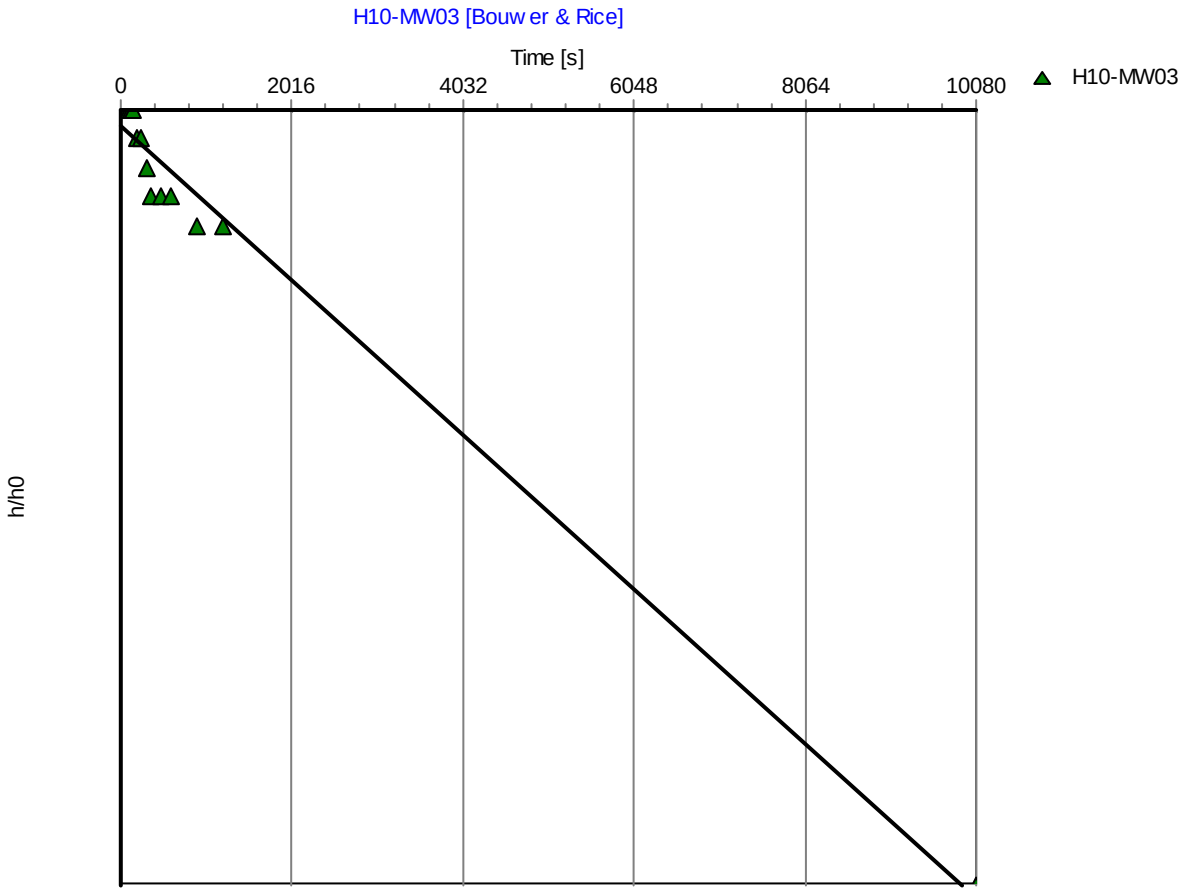
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Hadleyville

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **H10-MW03**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 6.34E-7 [cm/s]

Test parameters:

Test Well:	H10-MW03	Aquifer Thickness:	0.415 [m]
Casing radius:	0.025 [m]	Gravel Pack Porosity (%)	25
Screen length:	0.395 [m]		
Boring radius:	0.0762 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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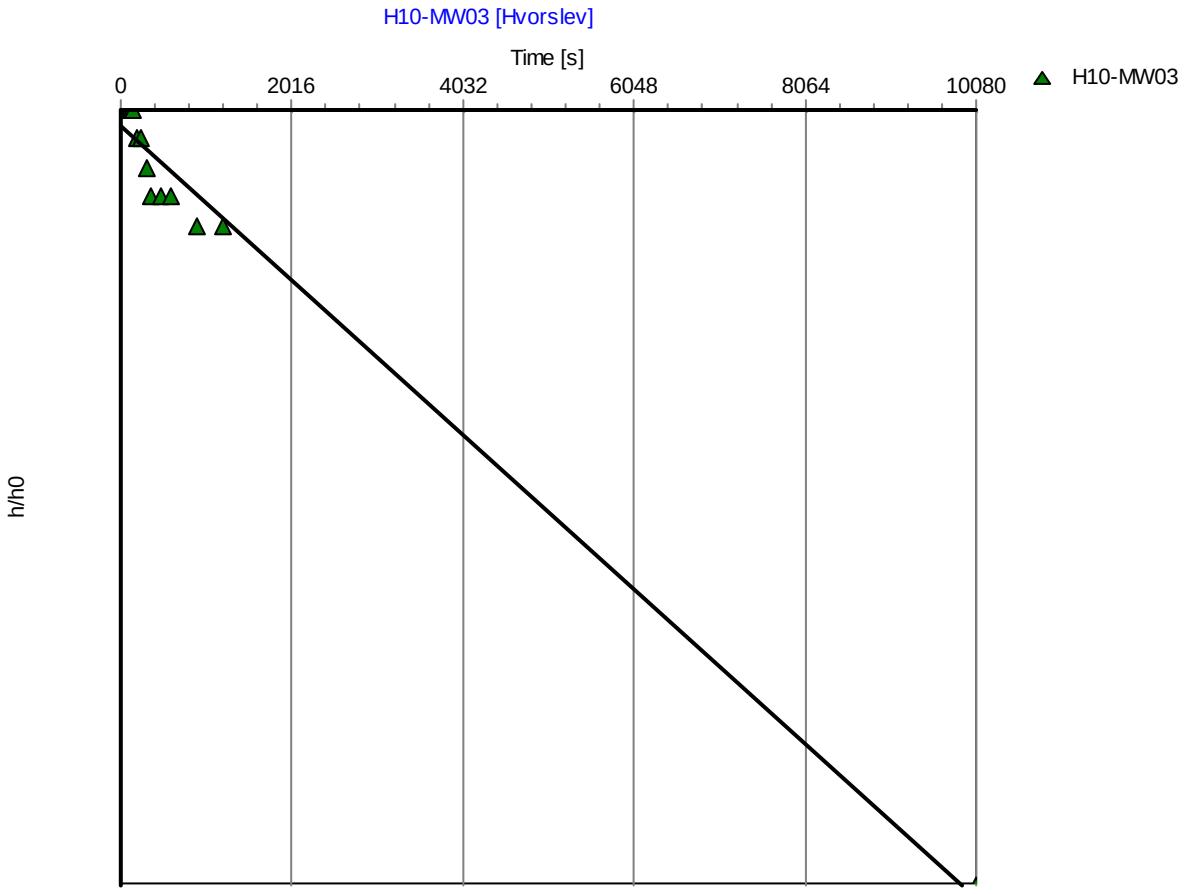
Phone: (902) 562-2394

Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Hadleyville

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **H10-MW03**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 8.89E-7 [cm/s]

Test parameters:

Test Well:	H10-MW03	Aquifer Thickness:	0.415 [m]
Casing radius:	0.025 [m]		
Screen length:	0.395 [m]		
Boring radius:	0.0762 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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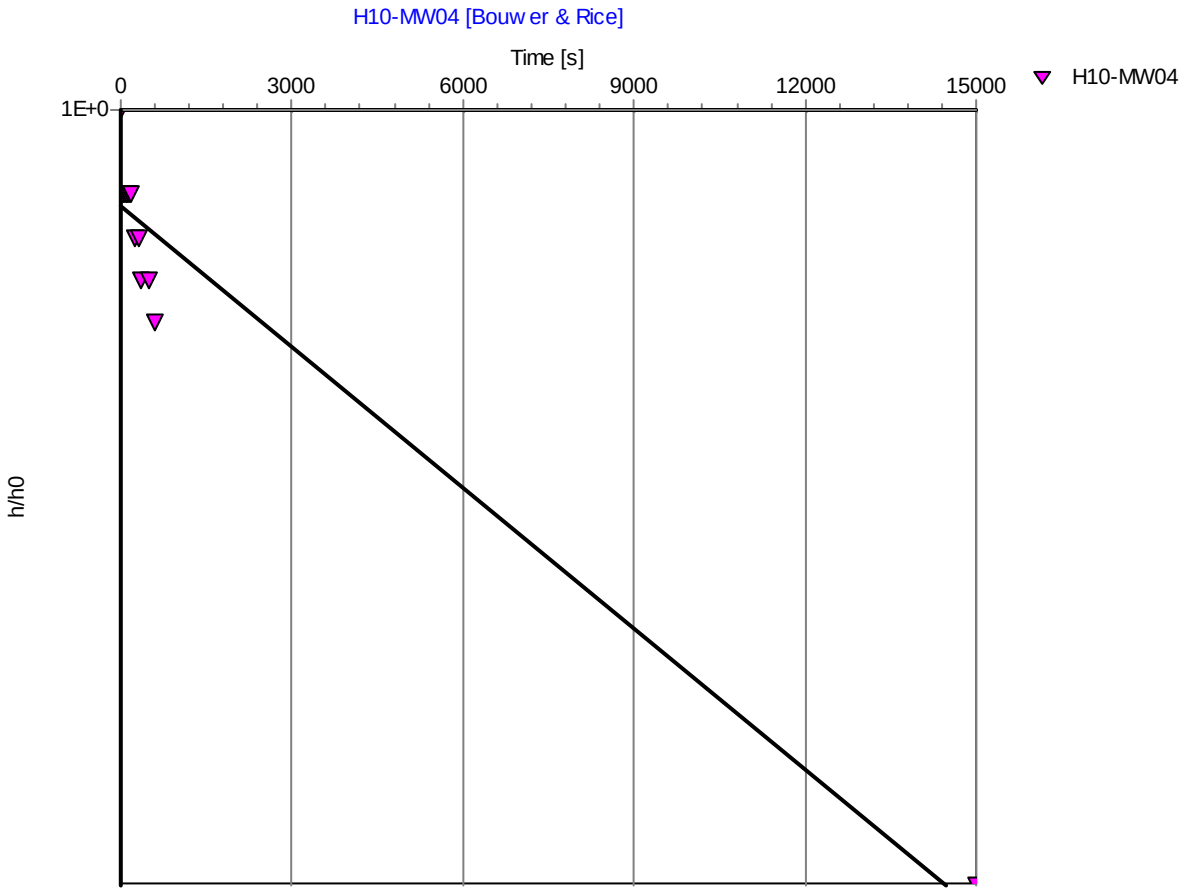
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Hadleyville

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **H10-MW04**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 1.82E-8 [cm/s]

Test parameters:

Test Well:	H10-MW04	Aquifer Thickness:	0.69 [m]
Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
Screen length:	6.22 [m]		
Boring radius:	0.0762 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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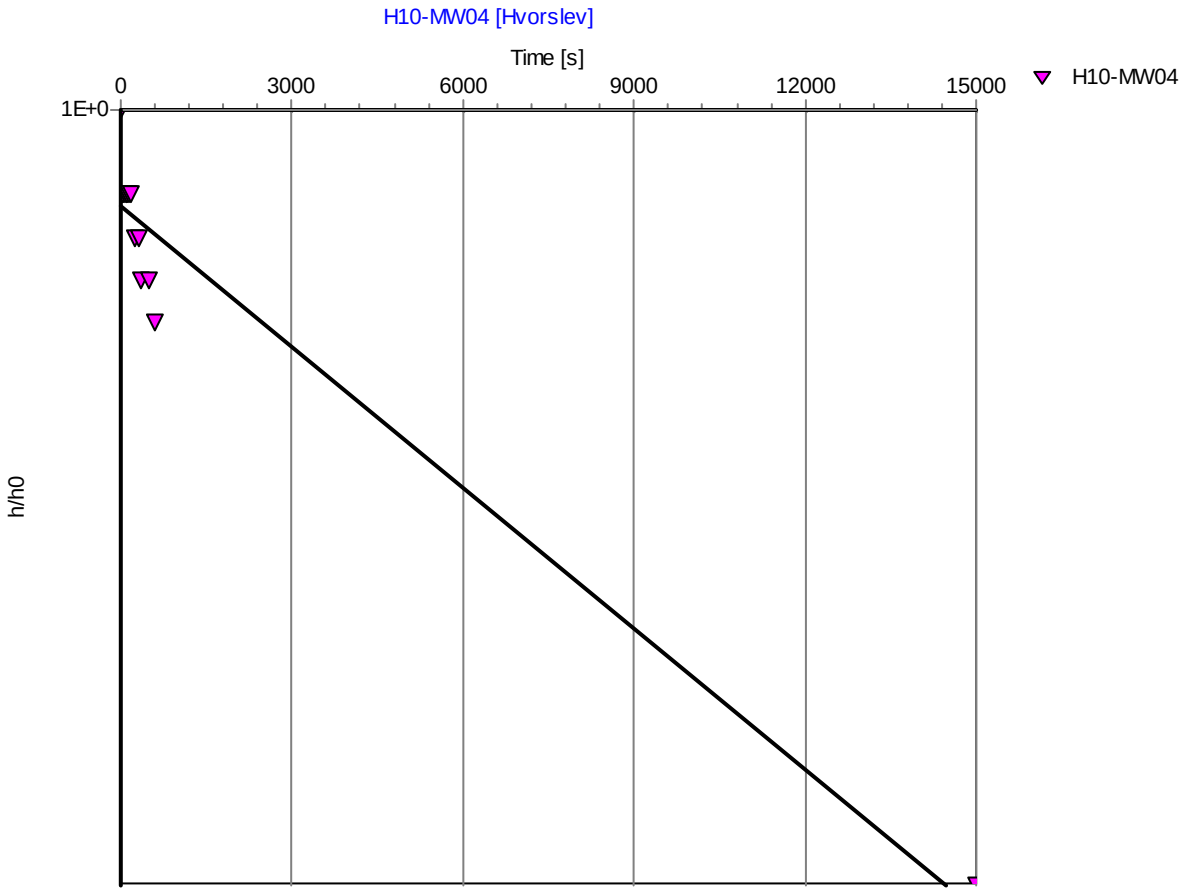
Sydney, NS B1S 2E8
Phone: (902) 562-2394

Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Hadleyville

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **H10-MW04**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 4.39E-8 [cm/s]

Test parameters:

Test Well:	H10-MW04	Aquifer Thickness:	0.69 [m]
Casing radius:	0.0254 [m]		
Screen length:	6.22 [m]		
Boring radius:	0.0762 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

Appendix B
Fox Island

Table B1: HYDROCARBONS IN SOIL RESULTS
Fox Island Arrow Oily Waste Site

Maxxam ID	Units	RBCA Commercial Guideline**	GW9104	GW9155	GW9156	GW9157
Sampling Date			7-Aug-10	7-Aug-10	7-Aug-10	7-Aug-10
COC Number			B124740	B124740	B124740	B124740
Sample ID			FI10-MW02-2 (10-12')	FI10-MW02-3 (15-17')	FI10-MW01-3 (30-32')	FI10-MW01-1 (10-12')
TPH COMPOUNDS						
Benzene	mg/kg	570	<0.003	<0.003	<0.003	<0.003
Toluene	mg/kg	18000	<0.03	<0.03	<0.03	<0.03
Ethylbenzene	mg/kg	10000	<0.01	<0.01	<0.01	<0.01
Xylene (Total)	mg/kg	180000	<0.05	<0.05	<0.05	<0.05
C6 - C10 (less BTEX)	mg/kg	13000	<3	<3	<3	<3
>C10-C21 Hydrocarbons	mg/kg	7700	<10	<10	<10	<10
>C21-<C32 Hydrocarbons	mg/kg	12000	<15	<15	<15	17
Modified TPH (Tier1)	mg/kg	**	<20	<20	<20	<20
Product Identifiecation	na	NG	NA	NA	NA	SEE NOTE (1)

Notes:

RDL = Reportable Detection Limit, NG = No guideline
** Atlantic RBCA Version 2.0, Table 8 For Coarse-grained soils on **Commercial** receptor sites with non-potable water use, Soil ingestion (2009 update)
*** As per laboratory identified fraction and/or Atlantic RBCA Version 2.0 Table 5, Modified TPH concentration must be compared with appropriate fraction. Shading indicates exceedance of Residential guideline
(1) Lube Oil Range

TABLE B2: METALS IN SOIL RESULTS
Fox Island Arrow Oily Waste Site

Maxxam ID	Units	CCME CEQG Industrial Guideline*	GW9104	GW9155	GW9156	GW9157
Sampling Date			7-Aug-10	7-Aug-10	7-Aug-10	7-Aug-10
COC Number			B124740	B124740	B124740	B124740
Sample ID			FI10-MW02-2 (10-12')	FI10-MW02-3 (15-17')	FI10-MW01-3 (30-32')	FI10-MW01-1 (10-12')
Elements (ICP-MS)						
Aluminum (Al)	mg/kg	-	13000	13000	12000	13000
Antimony (Sb)	mg/kg	**40**	<1	<1	<1	<1
Arsenic (As)	mg/kg	**12**	11	9	7	12
Barium (Ba)	mg/kg	**2000**	150	92	95	99
Beryllium (Be)	mg/kg	**8**	<1	<1	<1	<1
Boron (B)	mg/kg	-	<7	<7	<7	<7
Cadmium (Cd)	mg/kg	**22**	<0.2	<0.2	<0.2	<0.2
Calcium (Ca)	mg/kg	-	1300	1600	4700	1200
Chromium (Cr)	mg/kg	**87**	22	21	25	22
Cobalt (Co)	mg/kg	**300**	15	13	13	15
Copper (Cu)	mg/kg	**91**	28	27	27	32
Iron (Fe)	mg/kg	-	29000	27000	27000	31000
Lead (Pb)	mg/kg	**600**	16	16	15	17
Lithium (Li)	mg/kg	-	30	34	33	32
Magnesium (Mg)	mg/kg	-	5900	6200	6700	6200
Manganese (Mn)	mg/kg	-	1400	1200	1100	1200
Mercury (Hg)	mg/kg	**50**	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	**40**	<1	<1	<1	1
Nickel (Ni)	mg/kg	**50**	30	28	27	29
Phosphorus (P)	mg/kg	-	590	570	530	540
Potassium (K)	mg/kg	-	1500	1500	1500	1500
Selenium (Se)	mg/kg	**2.9**	<0.6	0.7	<0.6	0.6
Silver (Ag)	mg/kg	**40**	<1	<1	<1	<1
Sodium (Na)	mg/kg	-	<400	<400	<400	<400
Strontium (Sr)	mg/kg	-	7	7	10	6
Sulphur (S)	mg/kg	-	NA	NA	NA	NA
Thallium (Tl)	mg/kg	**1**	<0.7	<0.7	<0.7	<0.7
Tin (Sn)	mg/kg	**300**	<10	<10	<10	<10
Titanium (Ti)	mg/kg	-	170	160	150	160
Uranium (U)	mg/kg	**300**	<1	<1	<1	1
Vanadium (V)	mg/kg	**130**	23	22	23	23
Zinc (Zn)	mg/kg	**360**	77	76	68	75

Notes:

***** CCME Canadian Environmental Quality Guidelines for **Industrial** site land use (September 2007 update)

RDL = Reportable Detection Limit

Exceeds Industrial

Table B3: PAHs IN SOIL RESULTS
Fox Island Arrow Oily Waste Site

Maxxam ID	Units	CCME CEQG Industrial Guideline*	GW9104	GW9155	GW9156	GW9157
Sampling Date			07/08/2010	40397	40397	40397
COC Number			B124740	B124740	B124740	B124740
Sample ID			FI10-MW02-2 (10-12')	FI10-MW02-3 (15-17')	FI10-MW01-3 (30-32')	FI10-MW01-1 (10-12')
PAHs						
1-Methylnaphthalene	mg/kg	-	<0.01	<0.01	<0.01	<0.01
2-Methylnaphthalene	mg/kg	-	<0.01	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	-	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	mg/kg	-	<0.01	<0.01	<0.01	<0.01
Anthracene	mg/kg	-	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	mg/kg	**10**	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	mg/kg	**0.7**	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	**10**	<0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	mg/kg	-	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	**10**	<0.01	<0.01	<0.01	<0.01
Chrysene	mg/kg	-	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	mg/kg	**10**	<0.01	<0.01	<0.01	<0.01
Fluoranthene	mg/kg	-	<0.01	<0.01	<0.01	<0.01
Fluorene	mg/kg	-	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	**10**	<0.01	<0.01	<0.01	<0.01
Naphthalene	mg/kg	**22**	<0.05 (1)	<0.05 (1)	<0.05 (1)	<0.05 (1)
Perylene	mg/kg	-	<0.01	<0.01	<0.01	<0.01
Phenanthrene	mg/kg	**50**	<0.01	<0.01	<0.01	<0.01
Pyrene	mg/kg	**100**	<0.01	<0.01	<0.01	<0.01

Notes:

(1) PAH RDL(s) elevated due to detection of compound in blank.

***** CCME Canadian Environmental Quality Guidelines for **Industrial** site land use (September 2007 update)

RDL = Reportable Detection Limit

Exceeds Industrial

Table B4: PAHs in Soil
Fox Island Arrow Oily Waste Site

Maxxam ID	Units	CCME Direct Contact	CCME PEFs	GW9104	Sample TPE	GW9155	Sample TPE	GW9156	Sample TPE	GW9157	Sample TPE
Sampling Date				07/08/2010		40397		40397		40397	
COC Number				B124740		B124740		B124740		B124740	
				FI10-MW02-2 (10-12')		FI10-MW02-3 (15-17')		FI10-MW01-3 (30-32')		FI10-MW01-1 (10-12')	
PAHs											
1-Methylnaphthalene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
2-Methylnaphthalene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Acenaphthene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Acenaphthylene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Anthracene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Benzo(a)anthracene	mg/kg	NV	0.1	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005
Benzo(a)pyrene	mg/kg	NV	1	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Benzo(b)fluoranthene	mg/kg	NV	0.1	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005
Benzo(g,h,i)perylene	mg/kg	NV	0.01	0.005	0.00005	0.005	0.00005	0.005	0.00005	0.005	0.00005
Benzo(k)fluoranthene	mg/kg	NV	0.1	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005
Chrysene	mg/kg	NV	0.01	0.005	0.00005	0.005	0.00005	0.005	0.00005	0.005	0.00005
Dibenzo(a,h)anthracene	mg/kg	NV	1	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Fluoranthene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Fluorene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Indeno(1,2,3-cd)pyrene	mg/kg	NV	0.1	0.005	0.0005	0.005	0.0005	0.005	0.0005	0.005	0.0005
Naphthalene	mg/kg	NV	-	0.025	-	0.025	-	0.025	-	0.025	-
Perylene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Phenanthrene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Pyrene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
B (a) P TPE	mg/Kg	5.3	-	-	0.0121	-	0.0121	-	0.0121	-	0.0121
Uncertainty Factor	mg/Kg	3	-	-	0.0363	-	0.0363	-	0.0363	-	0.0363

Notes:

* CCME Canadian Environmental Quality Guidelines for the Protection of Envrionmental and Human Health (2010)

NV - No Value

PEF - Potency Equivalence Factor

B(a)P TPE - Benzo(a)pyrene Total Potency Equivalent - Calculated by multiplying the concentration of each PAH in the sample by its B(a)P PEF factor and summing the product

Screening:

Bold - Indicates an exceedance of CCME guidelines

Red indicates value was below the reportable detection limit and half the RDL was used for the calculation.

References:

Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Soil Quality Guidelines (CEQG), Last Accessed October 2008 - Commercial land use, coarse textured soil

Table B5: PAHs in Soil
Fox Island Arrow Oily Waste Site

Maxxam ID	Units	CCME Direct Contact	CCME PEFs	GW9104	Sample TPE	GW9155	Sample TPE	GW9156	Sample TPE	GW9157	Sample TPE
Sampling Date				07/08/2010		40397		40397		40397	
COC Number				B124740		B124740		B124740		B124740	
				FI10-MW02-2 (10-12')		FI10-MW02-3 (15-17')		FI10-MW01-3 (30-32')		FI10-MW01-1 (10-12')	
PAHs											
1-Methylnaphthalene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
2-Methylnaphthalene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Acenaphthene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Acenaphthylene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Anthracene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Benzo(a)anthracene	mg/kg	NV	0.33	0.005	0.00165	0.005	0.00165	0.005	0.00165	0.005	0.00165
Benzo(a)pyrene	mg/kg	NV	0.37	0.005	0.00185	0.005	0.00185	0.005	0.00185	0.005	0.00185
Benzo(b)fluoranthene	mg/kg	NV	0.16	0.005	0.0008	0.005	0.0008	0.005	0.0008	0.005	0.0008
Benzo(g,h,i)perylene	mg/kg	NV	6.8	0.005	0.034	0.005	0.034	0.005	0.034	0.005	0.034
Benzo(k)fluoranthene	mg/kg	NV	0.16	0.005	0.0008	0.005	0.0008	0.005	0.0008	0.005	0.0008
Chrysene	mg/kg	NV	2.1	0.005	0.0105	0.005	0.0105	0.005	0.0105	0.005	0.0105
Dibenzo(a,h)anthracene	mg/kg	NV	0.23	0.005	0.00115	0.005	0.00115	0.005	0.00115	0.005	0.00115
Fluoranthene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Fluorene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Indeno(1,2,3-cd)pyrene	mg/kg	NV	2.7	0.005	0.0135	0.005	0.0135	0.005	0.0135	0.005	0.0135
Naphthalene	mg/kg	NV	-	0.025	-	0.025	-	0.025	-	0.025	-
Perylene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Phenanthrene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
Pyrene	mg/kg	NV	-	0.005	-	0.005	-	0.005	-	0.005	-
SQG PW IACR	mg/Kg	1	-	-	0.06425	-	0.06425	-	0.06425	-	0.06425

Notes:

Notes:

All values expressed in µg/g unless otherwise indicated

NV - No Value

SQG_{PW} - Soil Quality Guideline for Protection of Potable Water

IACR - Index of Additive Cancer Risk

SQG_{PW} IACR - Index of Additive Cancer Risk for Protection of Potable Water - Calculated by dividing the concentration of each PAH in the sample by its SQG_{PW} and summing the results

Screening:

Bold - Indicates an exceedance of CCME guidelines

Red indicates value was below the reportable detection limit and half the RDL was used for the calculation.

References:

Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Soil Quality Guidelines (CEQG), Last Accessed October 2008 - Commercial land use, coarse textured soil

Fox Island Water

Table B6: HYDROCARBONS IN WATER RESULTS

							Duplicate					Duplicate
Maxxam ID	**Units**	**Guideline 1**	HB0449	HB0441	HB0450	HB0451	HB0452	IC3310	IC3323	IC3324	IC3325	IC3326
Sampling Date			1-Sep-10	1-Sep-10	1-Sep-10	1-Sep-10	1-Sep-10	7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10
COC Number			B124744	B124744	B124744	B124744	B124744	B074915	B074915	B074915	B074915	B074915
ADI Sample ID			**FI10-MW01**	**FI10-MW02**	**FI10-MW03**	**FI10-SW01**	**FI10-SW00**	**F10-MW01**	**F10-MW02**	**F10-MW03**	**F10-MW00**	**F10-SW01**
Petroleum Hydrocarbons												
Benzene	mg/L	**NG**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/L	**NG**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ethylbenzene	mg/L	**NG**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L	**NG**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
C6 - C10 (less BTEX)	mg/L	**NG**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<C10-C16 Hydrocarbons	mg/L	**NG**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
>C16-C21 Hydrocarbons	mg/L	**NG**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
>C21-<C32 Hydrocarbons	mg/L	**NG**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Modified TPH (Tier1)	mg/L	***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

Guideline 1: Atlantic RBCA Version 2.0, Table 8 For Coarse-grained soils on Commercial receptor sites with Non-potable water use and Ingestion Pathway (September 2003 update).

NG - No Guideline; ND - Not detected

*** As per laboratory identified fraction and/or Atlantic RBCA Version 2.0 Table 7, Modified TPH concentration must be compared with appropriate fraction.

Exceeds Guideline 1

Fox Island Water

Table B7: INORGANICS and METALS IN WATER RESULTS

											Duplicate			Duplicate
Maxxam ID	**Units**	**NS EQS: Groundwater**	**GT5634**	**HB0449**	**HB0441**	**HB0450**	**IC3310**	**IC3323**	**IC3324**	**IC3325**	**NS EQS: Surface Water**	**HB0451**	**HB0452**	**IC3326**
Sampling Date			**07-Aug-10**	**1-Sep-10**	**1-Sep-10**	**1-Sep-10**	**7-Dec-10**	**7-Dec-10**	**7-Dec-10**	**7-Dec-10**		**1-Sep-10**	**1-Sep-10**	**7-Dec-10**
COC Number			**ET042510**	**B124744**	**B124744**	**B124744**	**B074915**	**B074915**	**B074915**	**B074915**		**B124744**	**B124744**	**B074915**
			Drill Water	**FI10-MW01**	**FI10-MW02**	**FI10-MW03**	**F10-MW01**	**F10-MW02**	**F10-MW03**	**F10-MW00**		**FI10-SW01**	**FI10-SW00**	**F10-SW01**
RCAP CALCULATIONS														
Anion Sum	me/L	-	0.370	2.54	2.27	1.2	2.35	1.26	1.13	1.16	-	0.4	0.4	0.500
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	<1	61	79	16	71	21	14	15	-	<1	<1	<1
Calculated TDS	mg/L	**500**	26	144	126	73	134	79	79	80	-	24	24	34
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	<1	<1	<1	<1	1	<1	<1	<1	-	<1	<1	<1
Cation Sum	me/L	-	0.530	2.28	2.09	0.99	2.24	1.23	1.24	1.24	-	0.46	0.48	0.610
Hardness (CaCO3)	mg/L	-	5	74	73	22	73	17	22	21	-	4	4	7
Ion Balance (% Difference)	%	-	17.8	5.39	4.13	9.59	2.40	1.20	4.64	3.33	-	6.98	9.09	9.91
Langelier Index (@ 20C)	N/A	-	NC	-0.388	-0.682	-2.88	0.0860	-2.63	-2.90	-2.77	-	NC	NC	NC
Langelier Index (@ 4C)	N/A	-	NC	-0.638	-0.933	-3.13	-0.164	-2.88	-3.15	-3.02	-	NC	NC	NC
Saturation pH (@ 20C)	N/A	-	NC	8.29	8.28	9.48	8.21	9.43	9.50	9.47	-	NC	NC	NC
Saturation pH (@ 4C)	N/A	-	NC	8.54	8.53	9.73	8.46	9.68	9.75	9.72	-	NC	NC	NC
INORGANICS														
Alkalinity (Total as CaCO3)	mg/L	-	<5	62	79	16	72	21	14	15	-	<5	<5	<5
Chloride (Cl)	mg/L	**250**	13	23	15	21	19	25	20	20	-	14	14	16
Colour	TCU	**15**	310	11	6	<5	7	94	<5	<5	**Narrative**	250	240	190
Nitrate (N)	mg/L	**45**	0.06	<0.05	0.1	0.87	0.09	<0.06	0.54	0.56	**13**	<0.05	<0.05	<0.06
Nitrite (N)	mg/L	**0**	<0.01	0.12	<0.01	<0.01	<0.06	<0.06	<0.06	<0.06	-	<0.01	<0.01	<0.06
Nitrite + Nitrate	mg/L	**0.6**	0.06	0.16	0.1	0.87	0.09	<0.06	0.54	0.56	**0.06**	<0.05	<0.05	<0.06
Nitrogen (Ammonia Nitrogen)	mg/L	**0.19**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	0.05	-	<0.05	<0.05	<0.05
Total Organic Carbon (C)	mg/L	-	16	<0.5	<0.5	<0.5	1.2	9.2	0.6	<0.5	-	15	15	16
Orthophosphate (P)	mg/L	-	<0.01	0.02	<0.01	0.01	<0.3	<0.3	<0.3	<0.3	-	<0.01	<0.01	<0.3
pH	pH	**0**	4.80	7.9	7.6	6.6	8.30	6.80	6.60	6.70	**6.5 to 9.0**	4.9	4.7	4.90
Silica (SiO2)	mg/L	-	1.3	7.6	11	7.3	8.9	7.6	8.1	8.2	-	<0.1	<0.1	2.6
Sulphate (SO4)	mg/L	**500**	<2	30	12	10	18	6	12	12	**100**	<2	<2	3
Turbidity	NTU	-	11	460	610	>1000	>1000	>1000	340	320	-	2	2.2	1.6
Conductivity	uS/cm	-	58	250	220	120	240	140	130	130	-	64	62	82
Elements (ICP-MS)														
Dissolved Aluminum (Al)	mg/L	**0.05**	NA	0.11	0.081	0.055	0.049	0.27	0.056	0.052	**0.005**	0.43	0.43	0.51
Dissolved Antimony (Sb)	mg/L	**0.006**	NA	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	**0.02**	<0.0004	<0.0004	<0.0004
Dissolved Arsenic (As)	mg/L	**0.01**	NA	0.0013	<0.0006	<0.0006	0.0015	0.00072	0.0016	0.0016	**0.005**	<0.0006	<0.0006	<0.0006
Dissolved Barium (Ba)	mg/L	**1**	NA	0.014	0.039	0.031	0.018	0.028	0.021	0.02	**1**	0.0053	0.0051	0.0068
Dissolved Beryllium (Be)	mg/L	**0.004**	NA	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	**0.0053**	<0.0005	<0.0005	<0.0005
Dissolved Bismuth (Bi)	mg/L	-	NA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002
Dissolved Boron (B)	mg/L	**5**	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**1.2**	<0.1	<0.1	<0.1
Dissolved Cadmium (Cd)	mg/L	**0.0001**	NA	<0.000017	<0.000017	0.00016	<0.000017	0.000067	0.00002	0.000026	**0.00001**	<0.000017	<0.000017	<0.000017
Dissolved Chromium (Cr)	mg/L	**0.05**	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Dissolved Cobalt (Co)	mg/L	**0.003**	NA	<0.001	<0.001	<0.001	<0.001	0.0014	0.0022	0.0022	**0.004**	<0.001	<0.001	<0.001
Dissolved Lead (Pb)	mg/L	**0.01**	NA	<0.001	<0.001	<0.001	<0.001	0.0031	<0.001	<0.001	**0.001**	<0.001	<0.001	<0.001
Dissolved Lithium (Li)	mg/L	-	NA	0.0062	0.01	0.0027	0.0059	0.0078	0.0037	0.0037	-	<0.001	<0.001	<0.001
Total Mercury (Hg)	mg/L	**0.00026**	NA	NA	NA	NA	NA	NA	NA	NA	**0.000026**	NA	NA	
Dissolved Molybdenum (Mo)	mg/L	**0.07**	NA	0.0054	<0.004	<0.004	0.011	<0.004	<0.004	<0.004	**0.073**	<0.004	<0.004	<0.004
Dissolved Nickel (Ni)	mg/L	**0.1**	NA	<0.003	<0.003	<0.003	<0.003	0.0047	0.0045	0.0	**0.025**	<0.003	<0.003	<0.003
Dissolved Phosphorus (P)	mg/L	-	NA	<0.1	<0.1	<0.1	<0.1	<0.1	0.76	0.76	-	<0.1	<0.1	<0.1
Dissolved Selenium (Se)	mg/L	**0.01**	NA	<0.1	<0.1	<0.1	<0.001	<0.001	<0.001	<0.001	**0.001**	<0.1	<0.1	<0.001
Dissolved Silver (Ag)	mg/L	**0.001**	NA	<0.0001	<0.0001	0.00012	<0.0001	<0.0001	<0.0001	<0.0001	**0.0001**	<0.0001	<0.0001	<0.0001
Dissolved Strontium (Sr)	mg/L	**4.4**	NA	0.074	0.049	0.026	0.072	0.017	0.026	0.026	**21**	0.0062	0.0062	0.0091
Dissolved Sulphur (S)	mg/L	-	NA	NA	NA	NA	NA	NA	NA	NA	-	NA	NA	NA
Dissolved Thallium (Tl)	mg/L	**0.002**	NA	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	**0.0008**	<0.0008	<0.0008	<0.0008
Dissolved Tin (Sn)	mg/L	**4.4**	NA	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02
Dissolved Titanium (Ti)	mg/L	-	NA	0.0052	0.004	0.0031	<0.003	<0.003	<0.003	<0.003	-	0.0045	0.0038	0.0034
Dissolved Uranium (U)	mg/L	**0.02**	NA	0.0015	0.00021	<0.00015	0.0015	0.00038	<0.00015	<0.00015	**0.3**	<0.00015	<0.00015	<0.00015
Dissolved Vanadium (V)	mg/L	**0.0062**	NA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	**0.006**	<0.002	<0.002	<0.002
Elements (ICP-OES)														
Dissolved Calcium (Ca)	mg/L	-	0.66	19	15	4.3	20	3.7	4.8	4.8	-	0.56	0.58	0.74
Dissolved Copper (Cu)	mg/L	**0.02**	<0.002	<0.002	<0.002	0.0028	0.0025	0.022	0.0037	0.0029	**0.002**	<0.002	<0.002	<0.002
Dissolved Iron (Fe)	mg/L	**0.3**	1.1	<0.1	<0.1	<0.1	<0.1	0.35	0.27	0.28	**0.3**	0.77	0.77	0.57
Dissolved Magnesium (Mg)	mg/L	-	0.75	6.1	8.7	2.6	5.8	1.8	2.3	2.3	-	0.7	0.71	1.1
Dissolved Manganese (Mn)	mg/L	**0.05**	0.053	0.25	0.15	0.088	0.31	0.32	0.51	0.55	**0.82**	0.053	0.053	0.072
Dissolved Potassium (K)	mg/L	-	< 0.6	1.9	3.4	1.3	2.2	2.7	5.6	5.6	-	<600	<600	<0.6
Dissolved Sodium (Na)	mg/L	**200**	8.6	17	12	12	16	19	15	15	-	7.8	7.9	10
Dissolved Zinc (Zn)	mg/L	**0.3**	0.0091	<0.005	0.0061	0.02	0.012	2.2	0.044	0.041	**0.03**	0.006	0.006	0.0093

Notes:

Guideline 1: Rationale for the Development of Environmental Quality Standards for Contaminated

Guideline 2: Rationale for the Development of Environmental Quality Standards for Contaminated

NM = Not measured due to insufficient water; N/A = Not applicable; NA = Not analysed

AO = Aesthetic Objective

Exceeds NSE EQS: Surface Water

Exceeds NS EQS:Groundwater

Fox Island Water

Table B8: PAH IN GROUNDWATER RESULTS

Maxxam ID	Units	NS EQS: Surface Water	NS EQS: Groundwater	HB0441	IC3310	IC3323	IC3324	IC3325	IC3326
Sampling Date				1-Sep-10	7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10	7-Dec-10
COC Number				B124744	B074915	B074915	B074915	B074915	B074915
ADI Sample ID				FI10-MW02	F10-MW01	F10-MW02	F10-MW03	F10-MW00	F10-SW01
Polycyclic Aromatic Hydrocarbons									
1-Methylnaphthalene	ug/L	**2**	**20**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
2-Methylnaphthalene	ug/L	**2**	**20**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthene	ug/L	**5.8**	**58**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	ug/L	**4.6**	**0.45**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	ug/L	**0.012**	**0.12**	<0.01	0.01	<0.01	<0.01	0.01	<0.01
Benzo(a)anthracene	ug/L	**0.018**	**0.18**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	ug/L	**0.015**	**0.15**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	ug/L	**0.48**	**4.8**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	ug/L	**0.17**	**1.7**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	ug/L	**0.48**	**4.8**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	ug/L	**1.4**	**14**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenz(a,h)anthracene	ug/L	**0.26**	**2.6**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	ug/L	**0.04**	**0.4**	<0.01	0.05	0.07	0.06	0.05	0.03
Fluorene	ug/L	**3**	**30**	<0.01	0.01	0.01	0.01	0.01	<0.01
Indeno(1,2,3-cd)pyrene	ug/L	**0.21**	**2.1**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	ug/L	**1.1**	**11**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Perylene	ug/L	**-**	**-**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	ug/L	**0.4**	**4**	<0.01	0.07	0.12	0.11	0.08	0.06
Pyrene	ug/L	**0.025**	**0.25**	<0.01	0.03	0.04	0.03	0.03	0.02

Notes:

Guideline 1: Rationale for the Development of Environmental Quality Standards for Contaminated Sites in Nova Scotia Tier 1: Table A-3 Tier 1 Environmental Quality Standards for Surface Water, Fresh Water, January 2011

Guideline 2: Rationale for the Development of Environmental Quality Standards for Contaminated Sites in Nova Scotia Tier 1: Table A-4 Tier 1 Environmental Quality Standards for Groundwater, January 2011

NG - No Guideline; ND - Not detected

Exceeds Guideline 1

Exceeds Guideline 2

Exceeds Guideline 1 and 2

Table B9
Fox Island groundwater elevations

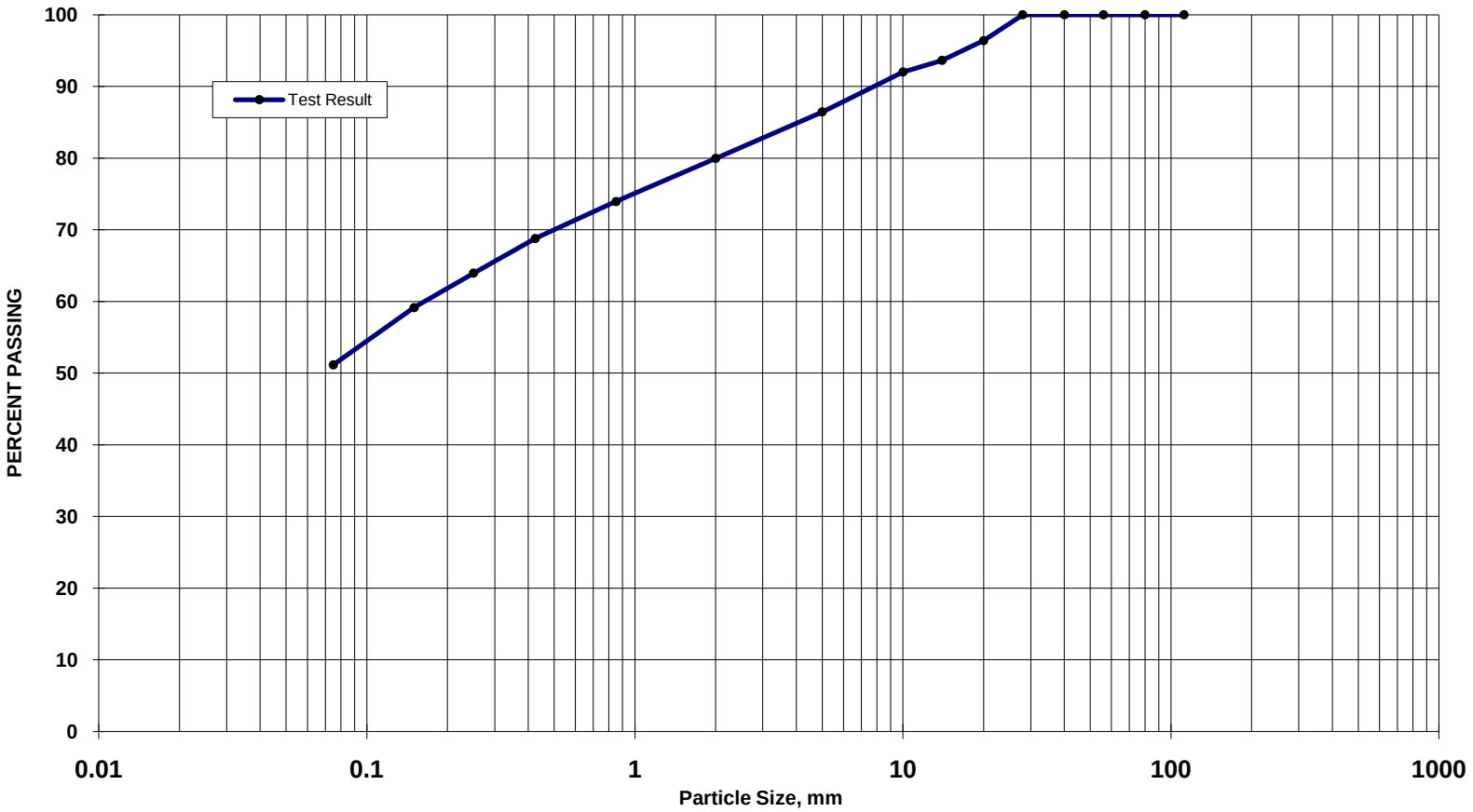
					1-Sep-10		7-Dec-11	
Monitoring Well ID	**Ground level, MASL**	**PVC pipe level, MASL**	**PVC stick up, m**	**Total PVC (well depth), m**	**Water level, m**	**Water elevation, MASL**	**Water level, m**	**Water elevation, MASL**
FI10-MW-01	39.1251	39.142	-0.0169	12.33	2.992	36.15	2.45	36.692
FI10-MW-02	36.1393	36.195	-0.0557	7.8	1.08	35.115	0.1	36.095
FI10-MW-03	28.6223	28.5453	-0.077	4.91	0.795	27.7503	0.26	28.2853

ASTM/USCS Sieve Analysis

SYD-00020401-A0

Oily Waste Sites Guysborough County - Fox Island

August 7, 2010



TEST DATA	
Sieve Size (mm)	Percent Passing (%)
112	100.0
80	100.0
56	100.0
40	100.0
28	100.0
20	96.4
14	93.6
10	92.0
5	86.4
2	80.0
0.85	74.0
0.425	68.8
0.25	64.0
0.15	59.1
0.075	51.2

Client: NSTIR

Sample: FI10-MW01-2

Soil Type: TILL

USCS Soil Name: Sandy Lean Clay

Gravel (%) 13.6

Sand (%) 35.3

Fines (%) 51.2

USCS Symbol: CL

C_u NA

C_c NA

$W_{content}$(%) 14.9

Test By: JWB/KR

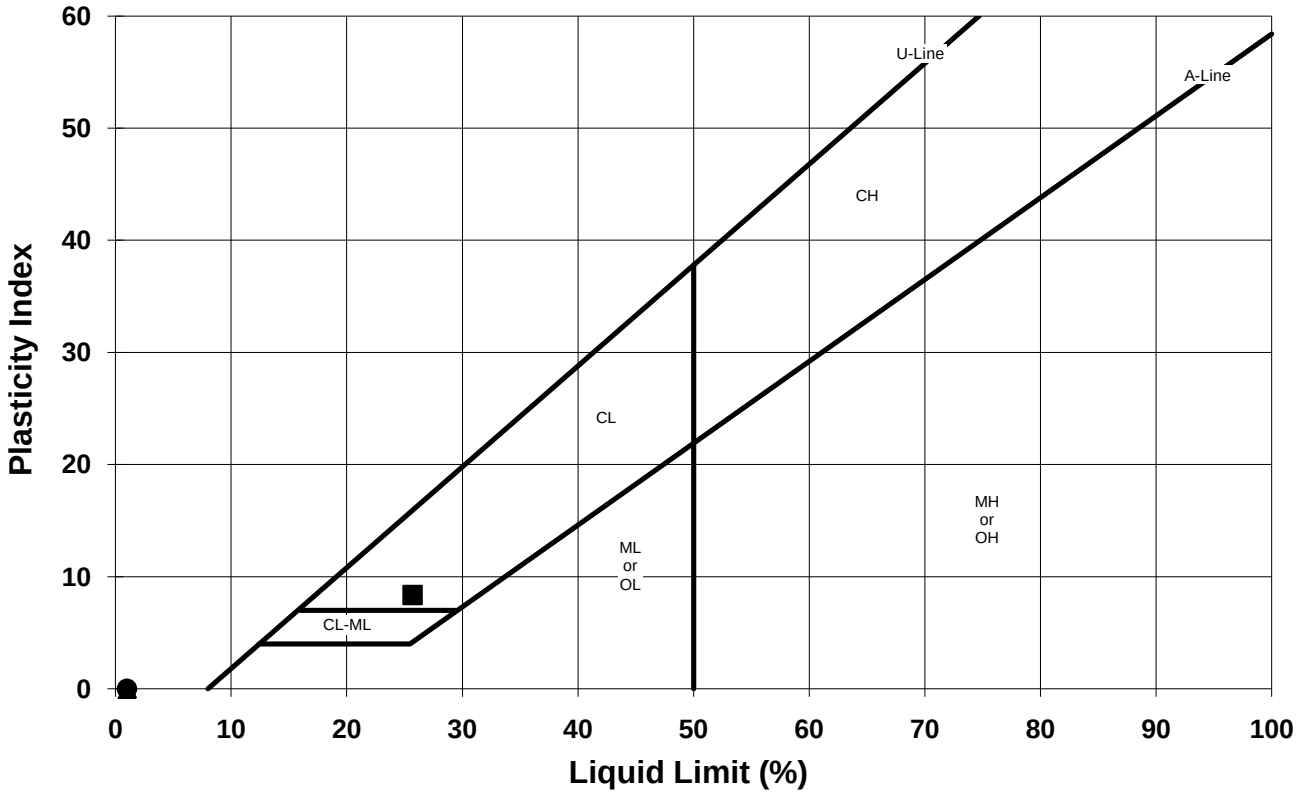
Comment: Fines are classified as CL

Specified Gradational Limits		
Size (mm)	Low Limit % Passing	High Limit % Passing
80		
56		
28		
14		
5		
0.16		
0.08		

exp Services Inc. - Plastic Limits
ASTM D4318

SYD-00020401-A0

August 14, 2010



Client:	NSTIR	Job No:	SYD-00020401-A0
Project:	Kurdistan and Arrow Oily Waste Disposal Sites - Fox Island	Location:	Fox Island, NS
Sample Date:	August 7, 2010	Test Date:	August 14, 2010
Sample By:	SS	Test By:	JWB/KR

DATA SUMMARY

Sample #	Liquid Limit	Plastic Limit	Plastic Index	Soil Symbol	Soil Type	Legend
FI10-MW01-2	25.7	17.3	8.4	CL	Till	■

Comment: Sample was collected for a depth of 6.1 to 6.7 metres

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WELL NUMBER FI10-MW01

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Fox Island Arrow Oily Waste Site
DATE STARTED 7/8/10 **COMPLETED** 7/8/10
GROUND ELEVATION 36.2 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
			Ground surface was flat. Moss and vegetation ground cover. Drillers cleared some trees to get into drill site.		TOPSOIL: Silt, trace organics (rootlets), loose, moist, yellowish brown	Casing Top Elev: 36.195 (m) Casing Type: Flush Mount
					0.31	Bentonite seal at surface.
					TILL: Sandy silt, some gravel, compact, moist, greyish brown	
1						
2						
3			No odours observed.			
	SS 1	100	25			
4						
5						Solid PVC in sand.
6					35.89	

GENERAL BH / TP / WELL FOX ISLAND MWS.GPJ GINT STD CANADA LAB.GDT 1/8/12

(Continued Next Page)

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WELL NUMBER FI10-MW01

CLIENT Nova Scotia Transportation and Infrastructure Renewal **PROJECT NAME** Hydrogeological Investigation

PROJECT NUMBER SYD-00020401-A0 **PROJECT LOCATION** Fox Island Arrow Oily Waste Site

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
	SS 2	100	23		TILL: Sandy silt, some gravel, compact, moist, greyish brown *(continued)*	
7						
8			Black film and sheen noted on return water near 9 metres depth.			
9			Iron staining observed on most fracture faces.			
	SS 3	4	40		9.75	Bentonite seal.
10	RC 4	100 (39)			BEDROCK: Fine Sandstone, grey, highly fractured, iron staining observed on fracture faces.	
	RC 5	76 (18)				Solid PVS in Sand.
11						
	RC 6	100 (54)				Screen in sand.
12					12.50	End Point.
					26.45	
					23.70	

Borehole terminated at 12.5 metres depth in Bedrock.
Montioring well installed.
Bottom of borehole at 12.50 meters.

GENERAL BH / TP / WELL FOX ISLAND MWS.GPJ GINT STD CANADA LAB.GDT 1/8/12

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WELL NUMBER FI10-MW02

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Fox Island Arrow Oily Waste Site
DATE STARTED 7/8/10 **COMPLETED** 7/8/10
GROUND ELEVATION 39.1 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
			Ground surface was flat. Moss and vegetation ground cover. Drillers cleared some trees to get into drill site.		TOPSOIL: Silt, trace organics (rootlets), loose, moist, yellowish brown	Casing Top Elev: 39.142 (m) Casing Type: Flush Mount; Bentonite seal at surface.
					0.31	
1					TILL: Sandy silt, some gravel, compact, moist, greyish brown	
2	SS 1		20 Iron staining observed on most fracture faces.			Solid PVC in sand.
3			No odours observed.			
4	SS 2		34			
5	SS 3	16-22-50 (72)			4.88 BEDROCK: Fine Sandstone, grey, highly fractured 5.49 to 5.79, remainder was horizontal and sub horizontal fractures, iron staining observed on fracture faces. 34.22	Bentonite seal.
6						Solid PVS in Sand.

GENERAL BH / TP / WELL FOX ISLAND MWS.GPJ GINT STD CANADA LAB.GDT 1/8/12

(Continued Next Page)

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WELL NUMBER FI10-MW02

CLIENT Nova Scotia Transportation and Infrastructure Renewal

PROJECT NAME Hydrogeological Investigation

PROJECT NUMBER SYD-00020401-A0

PROJECT LOCATION Fox Island Arrow Oily Waste Site

DEPTH (m)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS AND REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
7					BEDROCK: Fine Sandstone, grey, highly fractured 5.49 to 5.79, remainder was horizontal and sub horizontal fractures, iron staining observed on fracture faces. *(continued)*	Screen in sand.
7.77					31.33	End Point.

Borehole terminated at 7.77 metres depth in Bedrock.
Montioring well installed.
Bottom of borehole at 7.77 meters.

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WELL NUMBER FI10-MW03

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Fox Island Arrow Oily Waste Site
DATE STARTED 7/8/10 **COMPLETED** 7/8/10
GROUND ELEVATION 28.5 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
			Ground surface was flat. Located in a topographic low. Moss and vegetation ground cover. Drillers cleared some trees to get into drill site. Iron staining observed on most fracture faces.		TOPSOIL: Silt, trace organics (rootlets), loose, moist, yellowish brown — 0.31 — 28.19	Casing Top Elev: 28.545 (m) Casing Type: Flush Mount; Bentonite seal at surface.
1					TILL: Sandy silt, some gravel, compact, moist, greyish brown — 1.52 — 26.98	Solid PVC in sand.
2	RC 1	65 (0)			BEDROCK: Fine Sandstone, grey, highly fractured, iron staining observed on fracture faces.	Bentonite seal.
	RC 2	100 (0)				
3	RC 3	99 (38)	No odours observed.			Solid PVS in Sand.
4	RC 4	100 (90)			4.88 — 23.62	Screen in sand.
						End Point.

Borehole terminated at 4.88 metres depth in Bedrock.
Montioring well installed.
Bottom of borehole at 4.88 meters.

GENERAL BH / TP / WELL FOX ISLAND MWS.GPJ GINT STD CANADA LAB.GDT 1/8/12

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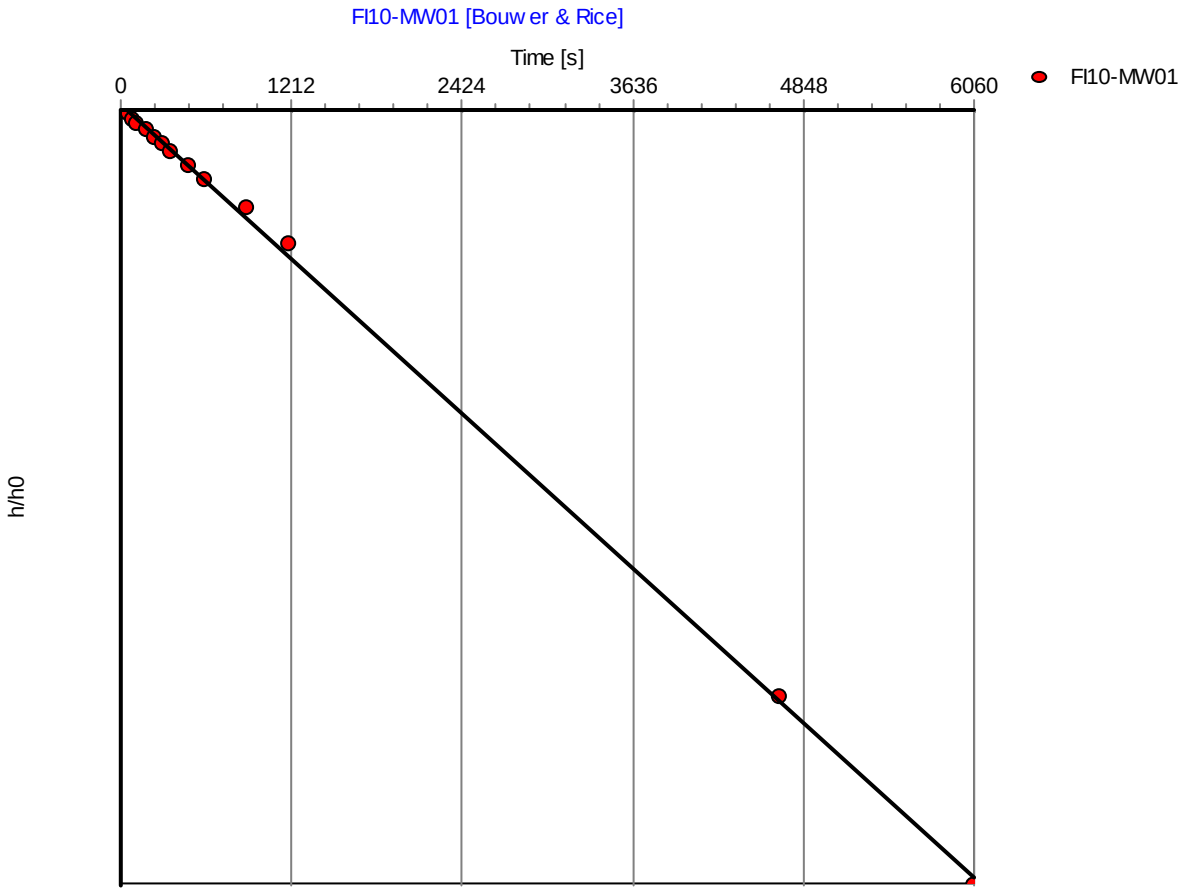
Sydney, NS B1S 2E8
Phone: (902) 562-2394

Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Fox Island

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **FI10-MW01**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 4.18E-6 [cm/s]

Test parameters:

Test Well:	FI10-MW01	Aquifer Thickness:	9.508 [m]
Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
Screen length:	1.43 [m]		
Boring radius:	0.076 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 4/18/2011

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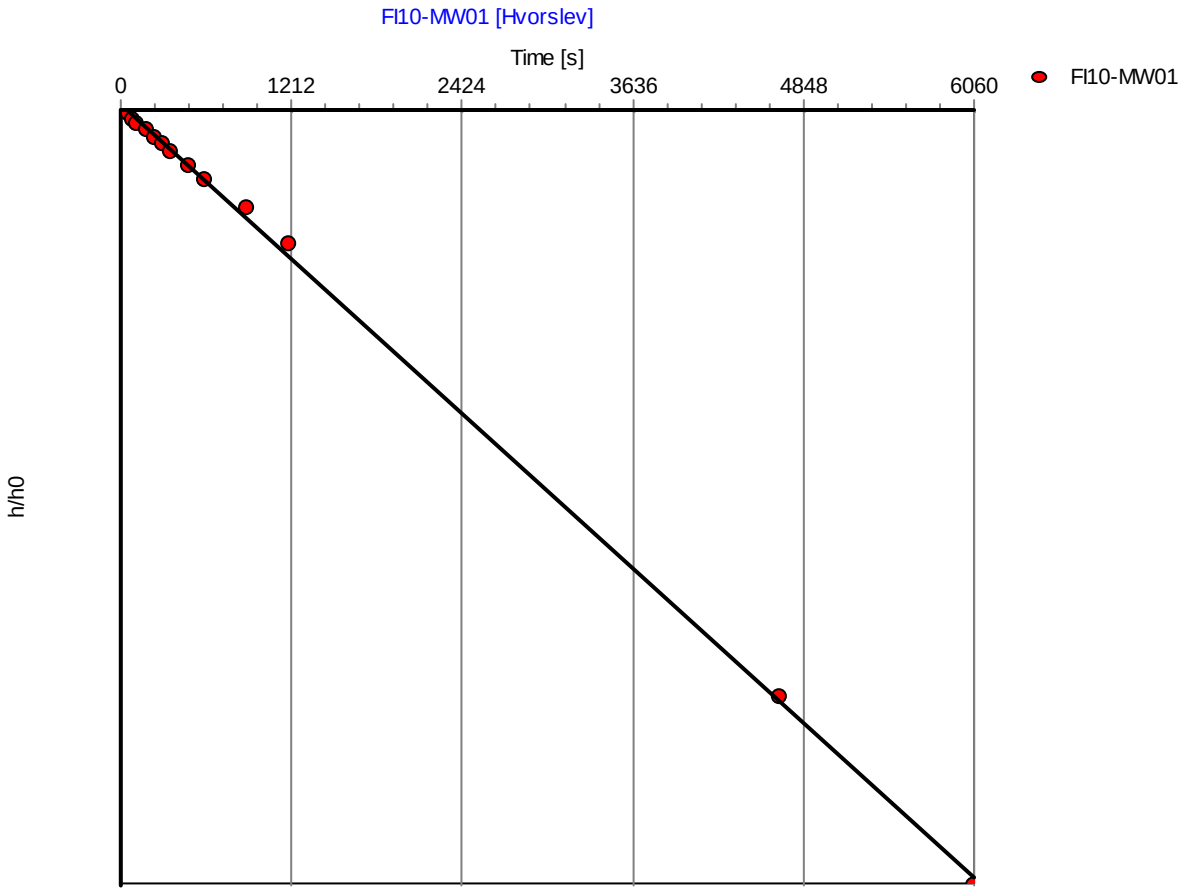
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Fox Island

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **FI10-MW01**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 3.78E-6 [cm/s]

Test parameters:

Test Well:	FI10-MW01	Aquifer Thickness:	9.508 [m]
Casing radius:	0.0254 [m]		
Screen length:	1.43 [m]		
Boring radius:	0.076 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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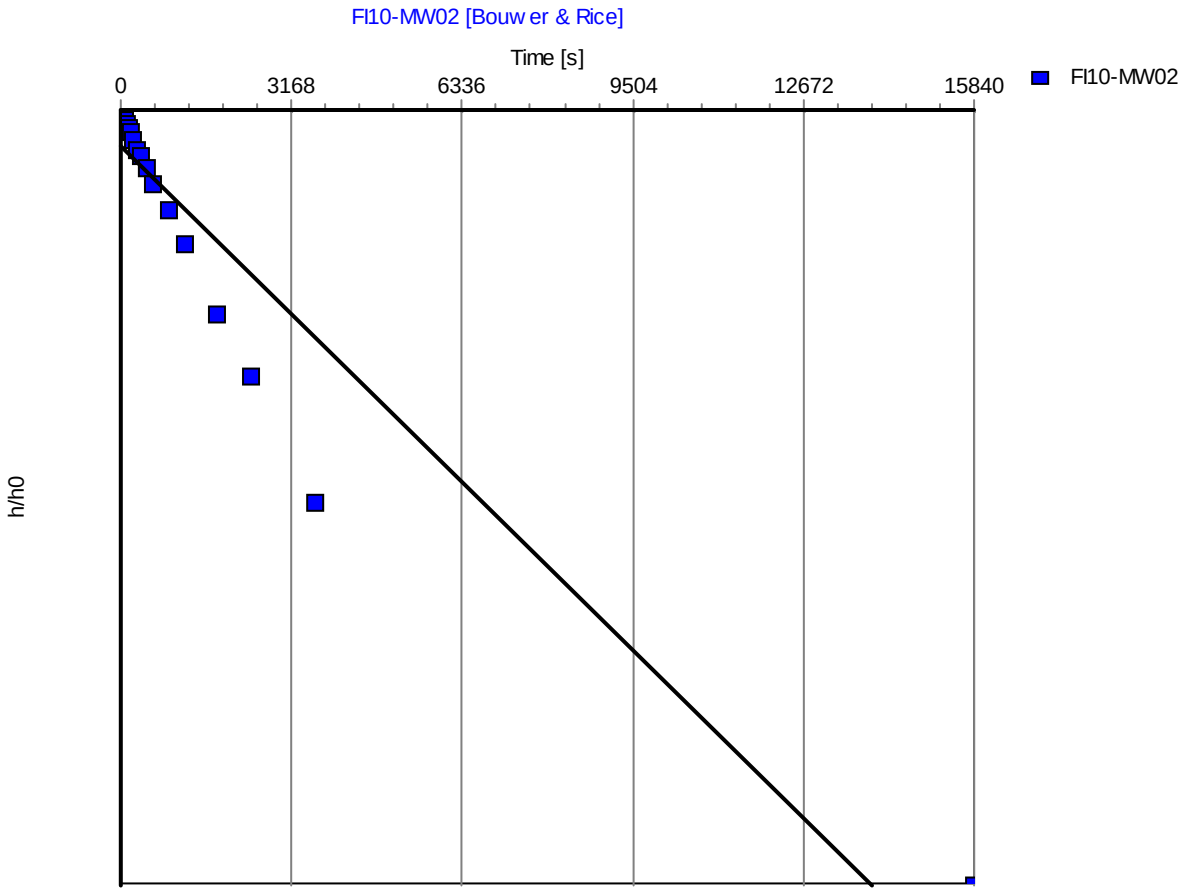
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Fox Island

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **FI10-MW02**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 4.41E-6 [cm/s]

Test parameters:

Test Well:	FI10-MW02	Aquifer Thickness:	6.72 [m]
Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
Screen length:	1.57 [m]		
Boring radius:	0.076 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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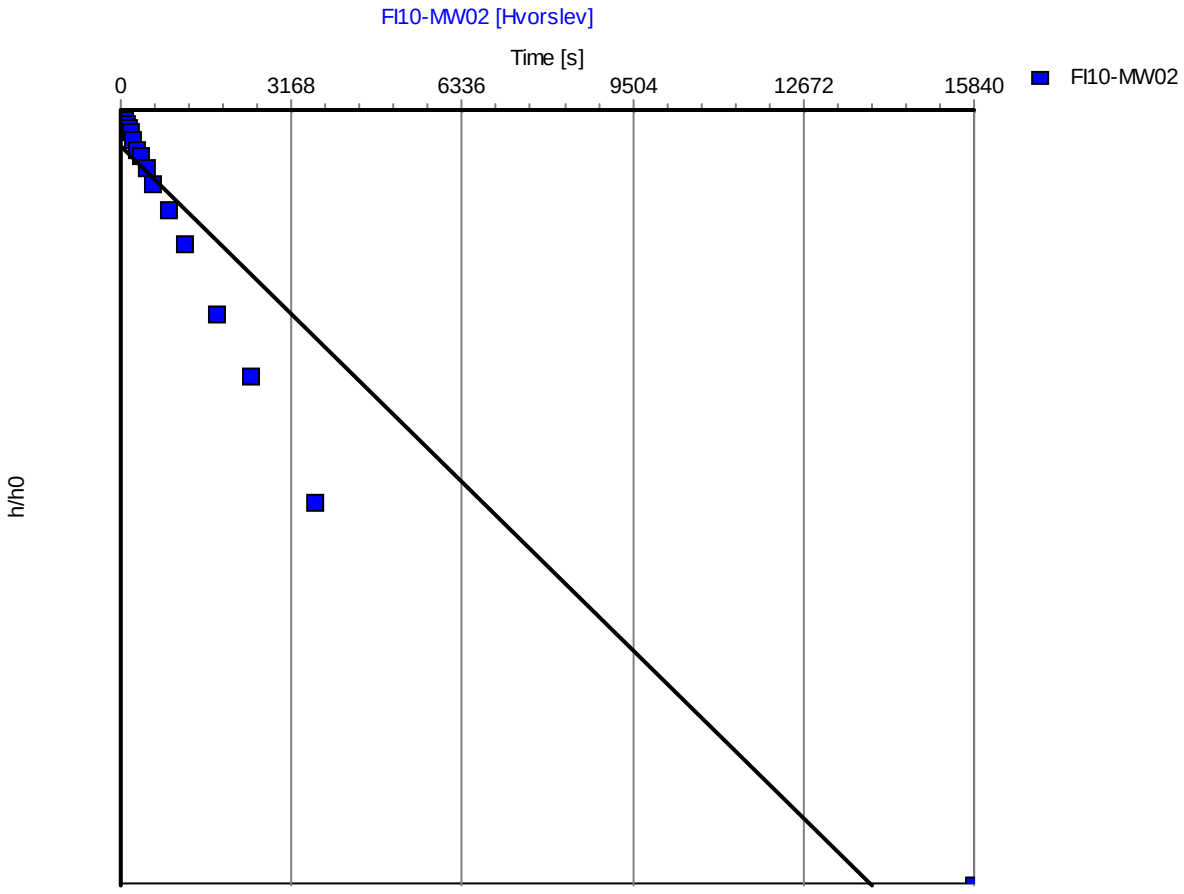
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Fox Island

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **FI10-MW02**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 4.29E-6 [cm/s]

Test parameters:

Test Well:	FI10-MW02	Aquifer Thickness:	6.72 [m]
Casing radius:	0.0254 [m]		
Screen length:	1.57 [m]		
Boring radius:	0.076 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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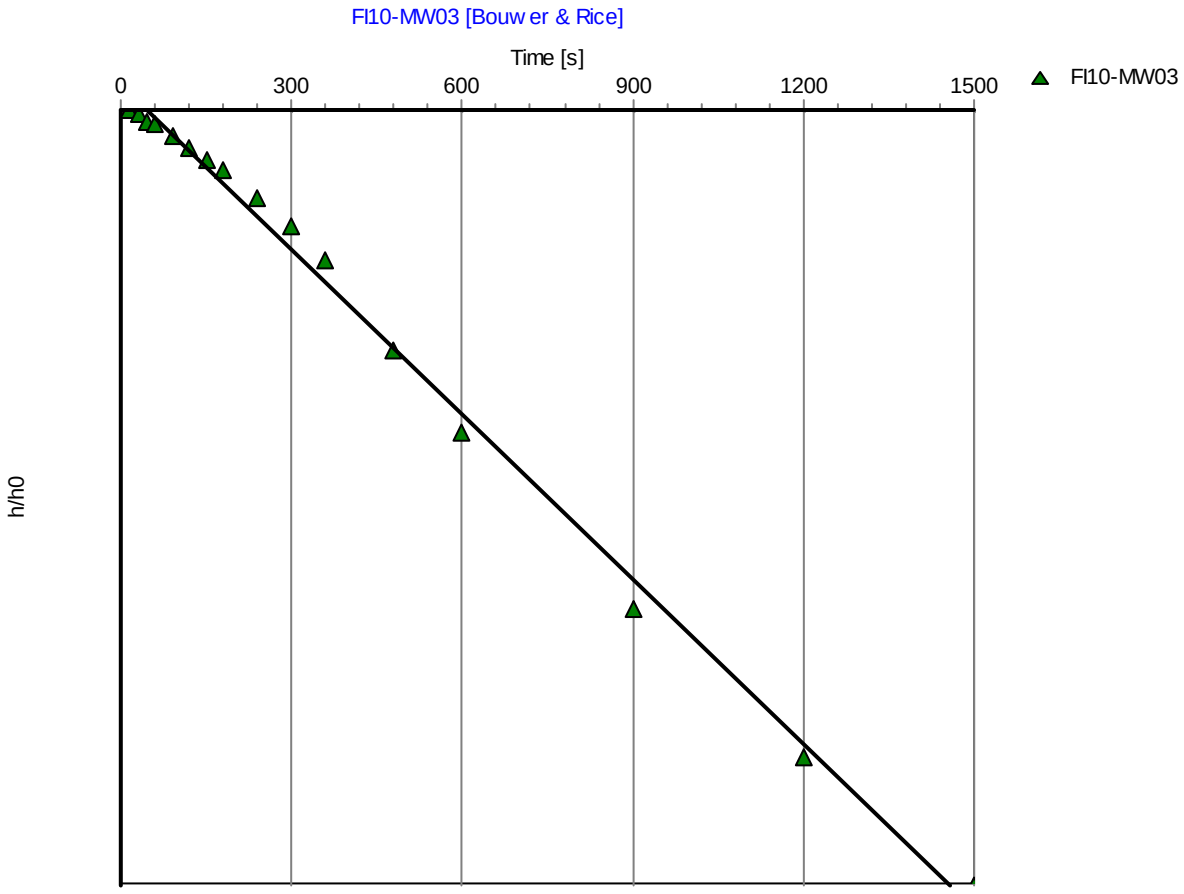
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Fox Island

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **FI10-MW03**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 6.33E-5 [cm/s]

Test parameters:

Test Well:	FI10-MW03	Aquifer Thickness:	4.115 [m]
Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
Screen length:	1.68 [m]		
Boring radius:	0.076 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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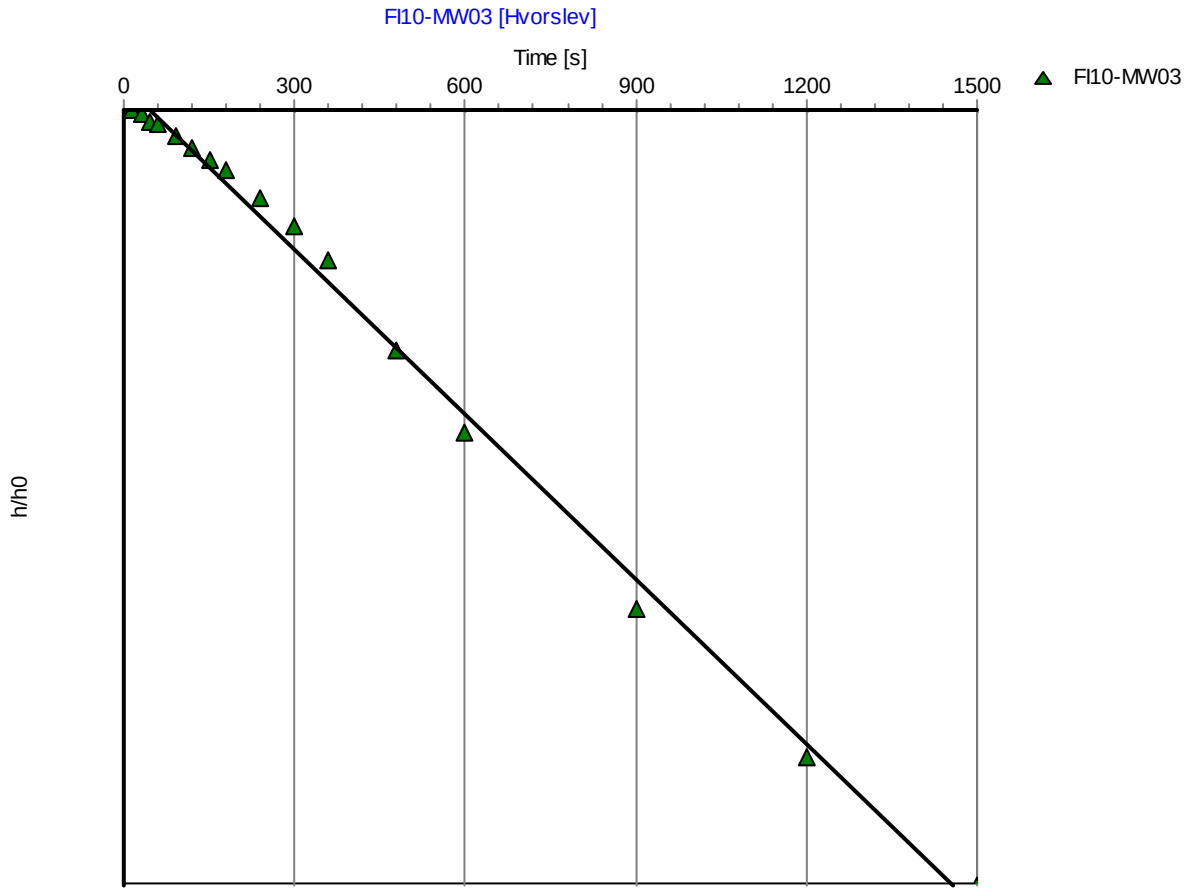
Sydney, NS B1S 2E8
Phone: (902) 562-2394

Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Fox Island

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **FI10-MW03**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 6.88E-5 [cm/s]

Test parameters:

Test Well:	FI10-MW03	Aquifer Thickness:	4.115 [m]
Casing radius:	0.0254 [m]		
Screen length:	1.68 [m]		
Boring radius:	0.076 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

Appendix C
Little Dover

Table C1: HYDROCARBONS IN SOIL RESULTS
Little Dover Arrow Oily Waste Site

Maxxam ID	**Units**	**RBCA Commercial Guideline****	**GT6938**
Sampling Date			**5-Aug-10**
COC Number			**ET042410**
Sample ID			**LD10-MW03-1**
TPH COMPOUNDS			
Benzene	mg/kg	**570**	<0.003
Toluene	mg/kg	**18000**	<0.03
Ethylbenzene	mg/kg	**10000**	<0.01
Xylene (Total)	mg/kg	**180000**	<0.05
C6 - C10 (less BTEX)	mg/kg	**13000**	<3
>C10-C21 Hydrocarbons	mg/kg	**7700**	<15
>C21-<C32 Hydrocarbons	mg/kg	**12000**	<15
Modified TPH (Tier1)	mg/kg	**	<20
Product Identifiecation	na	NG	na

Notes:

RDL = Reportable Detection Limit, NG = No guideline

** Atlantic RBCA Version 2.0, Table 8 For Coarse-grained soils on **Commercial** receptor sites with non-potable water use, Soil Ingestion (2003 update)

(1) Fuel oil / lube oil range.

(2) Fuel oil fraction

(3) Lube oil fraciton. TEH surrogate not within acceptable limits due to sample matrix.

(4) Lube oil fraction

(5) Fuel Oil Fraction and Lube Oil Fraction

*** As per laboratory identified fraction and/or Atlantic RBCA Version 2.0 Table 5, Modified TPH concentration must be compared with appropriate fraction. Shading indicates exceedance of Residential guideline

TABLE C2: METALS IN SOIL RESULTS
Little Dover Arrow Oily Waste Site

Maxxam ID	Units	CCME CEQG Industrial Guideline*	GT6938
Sampling Date			5-Aug-10
COC Number			ET042410
			LD10-MW03-1
Elements (ICP-MS)			
Aluminum (Al)	mg/kg	-	13000
Antimony (Sb)	mg/kg	**40**	<1
Arsenic (As)	mg/kg	**12**	6
Barium (Ba)	mg/kg	**2000**	19
Beryllium (Be)	mg/kg	**8**	<1
Boron (B)	mg/kg	-	<7
Cadmium (Cd)	mg/kg	**22**	<0.2
Calcium (Ca)	mg/kg	-	380
Chromium (Cr)	mg/kg	**87**	19
Cobalt (Co)	mg/kg	**300**	6
Copper (Cu)	mg/kg	**91**	16
Iron (Fe)	mg/kg	-	22000
Lead (Pb)	mg/kg	**600**	15
Lithium (Li)	mg/kg	-	39
Magnesium (Mg)	mg/kg	-	4400
Manganese (Mn)	mg/kg	-	440
Mercury (Hg)	mg/kg	**50**	<0.1
Molybdenum (Mo)	mg/kg	**40**	<1
Nickel (Ni)	mg/kg	**50**	16
Phosphorus (P)	mg/kg	-	220
Potassium (K)	mg/kg	-	550
Selenium (Se)	mg/kg	**2.9**	<0.6
Silver (Ag)	mg/kg	**40**	<1
Sodium (Na)	mg/kg	-	<400
Strontium (Sr)	mg/kg	-	4
Sulphur (S)	mg/kg	-	
Thallium (Tl)	mg/kg	**1**	<0.7
Tin (Sn)	mg/kg	**300**	<10
Titanium (Ti)	mg/kg	-	170
Uranium (U)	mg/kg	**300**	2
Vanadium (V)	mg/kg	**130**	12
Zinc (Zn)	mg/kg	**360**	<50

Notes:

***** CCME Canadian Environmental Quality Guidelines for **Industrial** site land use (September 2007 update)

RDL = Reportable Detection Limit

Exceeds Industrial

Table C3: PAHs IN SOIL RESULTS
Little Dover Arrow Oily Waste Site

Maxxam ID	Units	CCME CEQG Commercial Guideline*	GT6938
Sampling Date			5-Aug-10
COC Number			ET042410
			LD10-MW03-1
PAHs			
1-Methylnaphthalene	mg/kg	**NG**	<0.01
2-Methylnaphthalene	mg/kg	**NG**	<0.01
Acenaphthene	mg/kg	**NG**	<0.01
Acenaphthylene	mg/kg	**NG**	<0.01
Anthracene	mg/kg	**NG**	<0.01
Benzo(a)anthracene	mg/kg	**10**	<0.01
Benzo(a)pyrene	mg/kg	**0.7**	<0.01
Benzo(b)fluoranthene	mg/kg	**10**	<0.01
Benzo(g,h,i)perylene	mg/kg	**NG**	<0.01
Benzo(k)fluoranthene	mg/kg	**10**	<0.01
Chrysene	mg/kg	**NG**	<0.01
Dibenzo(a,h)anthracene	mg/kg	**10**	<0.01
Fluoranthene	mg/kg	**NG**	<0.01
Fluorene	mg/kg	**NG**	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	**10**	<0.01
Naphthalene	mg/kg	**22**	<0.01
Perylene	mg/kg	**NG**	<0.01
Phenanthrene	mg/kg	**50**	<0.01
Pyrene	mg/kg	**100**	<0.01

Notes:

* CCME Canadian Environmental Quality Guidelines for **Industrial** site land use (September 2006 update)

RDL = Reportable Detection Limit

Exceeds Industrial

Table C4: PAHs in Soil
Little Dover For Soils
Little Dover Arrow Oily Waste Site

Maxxam ID	Units	CCME Direct Contact	CCME PEFs	GT6938	Sample TPE
Sampling Date				5-Aug-10	
COC Number				ET042410	
				LD10-MW03-1	
PAHs					
1-Methylnaphthalene	mg/kg	NV	-	0.005	-
2-Methylnaphthalene	mg/kg	NV	-	0.005	-
Acenaphthene	mg/kg	NV	-	0.005	-
Acenaphthylene	mg/kg	NV	-	0.005	-
Anthracene	mg/kg	NV	-	0.005	-
Benzo(a)anthracene	mg/kg	NV	0.1	0.005	0.0005
Benzo(a)pyrene	mg/kg	NV	1	0.005	0.005
Benzo(b)fluoranthene	mg/kg	NV	0.1	0.005	0.0005
Benzo(g,h,i)perylene	mg/kg	NV	0.01	0.005	0.00005
Benzo(k)fluoranthene	mg/kg	NV	0.1	0.005	0.0005
Chrysene	mg/kg	NV	0.01	0.005	0.00005
Dibenzo(a,h)anthracene	mg/kg	NV	1	0.005	0.005
Fluoranthene	mg/kg	NV	-	0.005	-
Fluorene	mg/kg	NV	-	0.005	-
Indeno(1,2,3-cd)pyrene	mg/kg	NV	0.1	0.005	0.0005
Naphthalene	mg/kg	NV	-	0.005	-
Perylene	mg/kg	NV	-	0.005	-
Phenanthrene	mg/kg	NV	-	0.005	-
Pyrene	mg/kg	NV	-	0.005	-
B (a) P TPE	mg/Kg	**5.3**	-	-	0.0121
Uncertainty Factor	mg/Kg	**3**	-	-	0.0363

Notes:

* CCME Canadian Environmental Quality Guidelines for the Protection of Envrionmental and Human Health (2010)

NV - No Value

PEF - Potency Equivalence Factor

Total Potency Equivalent -

Screening:

Bold - Indicates an exceedance of CCME guidelines

Red indicates value was below the reportable detection limit and half the RDL was used for the calculation.

Table C5: PAHs in Soil
Little Dover For Soils
Little Dover Arrow Oily Waste Site

Maxxam ID	Units	CCME Direct Contact	CCME PEFs	GT6938	Sample TPE
Sampling Date				5-Aug-10	
COC Number				ET042410	
				LD10-MW03-1	
PAHs					
1-Methylnaphthalene	mg/kg	NV	-	0.005	-
2-Methylnaphthalene	mg/kg	NV	-	0.005	-
Acenaphthene	mg/kg	NV	-	0.005	-
Acenaphthylene	mg/kg	NV	-	0.005	-
Anthracene	mg/kg	NV	-	0.005	-
Benzo(a)anthracene	mg/kg	NV	0.33	0.005	0.00165
Benzo(a)pyrene	mg/kg	NV	0.37	0.005	0.00185
Benzo(b)fluoranthene	mg/kg	NV	0.16	0.005	0.0008
Benzo(g,h,i)perylene	mg/kg	NV	6.8	0.005	0.034
Benzo(k)fluoranthene	mg/kg	NV	0.16	0.005	0.0008
Chrysene	mg/kg	NV	2.1	0.005	0.0105
Dibenzo(a,h)anthracene	mg/kg	NV	0.23	0.005	0.00115
Fluoranthene	mg/kg	NV	-	0.005	-
Fluorene	mg/kg	NV	-	0.005	-
Indeno(1,2,3-cd)pyrene	mg/kg	NV	2.7	0.005	0.0135
Naphthalene	mg/kg	NV	-	0.005	-
Perylene	mg/kg	NV	-	0.005	-
Phenanthrene	mg/kg	NV	-	0.005	-
Pyrene	mg/kg	NV	-	0.005	-
SQG PW IACR	mg/Kg	**1**	-	-	0.06425

Notes:

Notes:

All values expressed in µg/g unless otherwise indicated

NV - No Value

SQG_{PW} - Soil Quality Guideline for Protection of Potable Water

IACR - Index of Additive Cancer Risk

SQG_{PW} IACR - Index of Additive Cancer Risk for Protection of Potable Water - Calculated by dividing the concentration of each PAH in the sample by its SQG_{PW} and summing the results

Screening:

Bold - Indicates an exceedance of CCME guidelines

Red indicates value was below the reportable detection limit and half the RDL was used for the calcul

References:

Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Soil Quality Guidelines (CEQG), Last Accessed October 2008 - Commercial land use, coarse

Table C6: HYDROCARBONS IN GROUNDWATER RESULTS

Little Dover Arrow Oily Waste Site

Maxxam ID	Units	Guideline 1	HB0368	HB0369	HB0370	HB0371	HB0372	HB0374	HB0373	IC4239	IC4240	IC4241	IC4242	IC4243	IC4244	IC4245
														Duplicate		Duplicate
Sampling Date			2-Sep-10	2-Sep-10	2-Sep-10	2-Sep-10	2-Sep-10	2-Sep-10	2-Sep-10	8-Dec-10	8-Dec-10	8-Dec-10	8-Dec-10	8-Dec-10	8-Dec-10	8-Dec-10
COC Number			B124743	B124743	B124743	B124743	B124743	B124743	B124743	B074916	B074916	B074916	B074916	B074916	B074916	B074916
ADI Sample ID			LD10-SW01	LD10-SW-2	LD10-MW01	LD10-MW02	LD10-MW03	LD10-MW00	LD10-MW04	LD10-MW01	LD10-MW02	LD10-MW03	LD10-MW04	LD10-MW00	LD10-SW01	LD10-SW02
TPH COMPOUNDS																
Benzene	mg/L	**NG**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/L	**NG**	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ethylbenzene	mg/L	**NG**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L	**NG**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
C6 - C10 (less BTEX)	mg/L	**NG**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L	**NG**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
>C16 - C21 Hydrocarbons	mg/L	**NG**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
>C21-<C32 Hydrocarbons	mg/L	**NG**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Modified TPH (Tier1)	mg/L	***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

Guideline 1: Atlantic RBCA Version 2.0, Table 8 For Coarse-grained soils on Commercial receptor sites with Non-potable water use and Ingestion Pathway (September 2003 update).

NG - No Guideline; ND - Not detected

*** As per laboratory identified fraction and/or Atlantic RBCA Version 2.0 Table 7, Modified TPH concentration must be compared with appropriate fraction.

Exceeds Guideline 1

Table C7: INORGANICS and METALS IN GROUNDWATER RESULTS
Little Dover Arrow Oily Waste Site

							Duplicate										Duplicate	
Maxxam ID	**Units**	**NS EQS: Groundwater**	**GT6903**	**HB0370**	**HB0371**	**HB0372**	**HB0374**	**HB0373**	**IC4239**	**IC4240**	**IC4241**	**IC4243**	**IC4242**	**NS EQS: Surface Water**	**HB0368**	**HB0369**	**IC4244**	**IC4245**
Sampling Date			**05/08/2010**	**2-Sep-10**	**2-Sep-10**	**2-Sep-10**	**2-Sep-10**	**2-Sep-10**	**8-Dec-10**	**8-Dec-10**	**8-Dec-10**	**8-Dec-10**	**8-Dec-10**		**2-Sep-10**	**2-Sep-10**	**8-Dec-10**	**8-Dec-10**
COC Number			**ET042410**	**B124743**	**B124743**	**B124743**	**B124743**	**B124743**	**B074916**	**B074916**	**B074916**	**B074916**	**B074916**		**B124743**	**B124743**	**B074916**	**B074916**
			Drill Water	**LD10-MW01**	**LD10-MW02**	**LD10-MW03**	**LD10-MW00**	**LD10-MW04**	**LD10-MW01**	**LD10-MW02**	**LD10-MW03**	**LD10-MW00**	**LD10-MW04**		**LD10-SW01**	**LD10-SW02**	**LD10-SW01**	**LD10-SW02**
RCAP CALCULATIONS																		
Anion Sum	me/L	-	0.7	1.04	0.41	0.65	0.62	1.66	0.870	0.710	0.760	0.750	1.78	-	0.35	1.08	0.500	0.520
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	<1	19	6	13	13	50	9	6	15	16	40	-	<1	<1	<1	<1
Calculated TDS	mg/L	**500**	48	67	30	53	52	104	58	47	57	57	112	-	22	65	34	35
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1
Cation Sum	me/L	-	0.8	0.99	0.45	0.97	0.96	1.78	0.830	0.700	0.890	0.950	1.96	-	0.46	1.12	0.520	0.650
Hardness (CaCO3)	mg/L	-	10	25	6	12	12	52	19	10	14	14	65	-	3	6	5	5
Ion Balance (% Difference)	%	-	6.67	2.46	4.65	19.8	21.5	3.49	2.35	0.710	7.88	11.8	4.81	-	13.6	1.82	1.96	11.1
Langelier Index (@ 20C)	N/A	-	NC	-2.06	-4.73	-3.9	-3.91	-1.63	-3.48	-4.48	-3.53	-3.39	-1.79	-	NC	NC	NC	NC
Langelier Index (@ 4C)	N/A	-	NC	-2.32	-4.99	-4.16	-4.16	-1.88	-3.73	-4.73	-3.78	-3.64	-2.04	-	NC	NC	NC	NC
Saturation pH (@ 20C)	N/A	-	NC	9.16	10.4	9.9	9.91	8.43	9.58	10.4	9.73	9.69	8.39	-	NC	NC	NC	NC
Saturation pH (@ 4C)	N/A	-	NC	9.42	10.7	10.2	10.2	8.68	9.83	10.6	9.98	9.94	8.64	-	NC	NC	NC	NC
INORGANICS																		
Alkalinity (Total as CaCO3)	mg/L	-	<5	19	6	13	13	50	9	6	15	16	40	-	<5 (1)	<5	<5	<5
Chloride (Cl)	mg/L	**250**	24	17	10	12	12	13	17	19	12	12	18	-	12	38	16	16
Colour	TCU	**15**	300	43	51	100	98	62	36	55	100	31	75	**Narrative**	100	330	54	190
Nitrate (N)	mg/L	**45**	0.13	0.1	<0.05	<0.05	0.06	0.05	0.12	<0.06	<0.06	<0.06	<0.06	**13**	<0.05	<0.05	<0.06	<0.06
Nitrite (N)	mg/L	**0**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.06	<0.06	<0.06	<0.06	<0.06	-	<0.01	<0.01	<0.06	<0.06
Nitrite + Nitrate	mg/L	**0.6**	0.13	0.1	<0.05	<0.05	0.06	0.05	0.12	<0.06	<0.06	<0.06	<0.06	**0.06**	<0.05	<0.05	<0.06	<0.06
Nitrogen (Ammonia Nitrogen)	mg/L	**0.19**	0.11	<0.05	0.06	0.14	0.14	0.36	<0.05	<0.05	0.09	0.09	0.26	-	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon (C)	mg/L	-	17	8.8	7.10	9	8.8	16	12	9.7	12	12	22	-	22	21	10	22
Orthophosphate (P)	mg/L	-	0.02	0.01	0.02	0.07	0.07	<0.01	<0.3	<0.3	<0.3	<0.3	<0.3	-	<0.01	<0.01	<0.3	<0.3
pH	pH	**0**	6	7.1	5.7	6.0	6.0	6.8	6.10	5.90	6.20	6.30	6.60	**6.5 to 9.0**	4.3	4.4	4.50	4.10
Silica (SiO2)	mg/L	-	5	8.7	6.1	7.8	8.3	7.3	8.2	7.1	9.6	9.4	5.2	-	<0.1	2.7	5.3	4.0
Sulphate (SO4)	mg/L	**500**	<2	8	<2	2	<2	14	10	3	5	4	22	**100**	<2	<2	3	3
Turbidity	NTU	-	5.9	>1000	66	77	81	>1000	>1000	31	260	410	>1000	-	74	2.2	3.1	1.3
Conductivity	uS/cm	-	94	100	52	67	68	160	100	87	82	85	180	-	62	140	77	95
Elements (ICP-MS)																		
Dissolved Aluminum (Al)	mg/L	**0.05**	NA	0.22	0.52	0.24	0.25	0.22	0.53	0.69	0.27	0.27	0.41	**0.005**	0.36	0.6	0.42	0.6
Dissolved Antimony (Sb)	mg/L	**0.006**	NA	<0.0004	<0.0004	0.00066	<0.0004	0.00047	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	**0.02**	<0.0004	<0.0004	0.00078	0.00045
Dissolved Arsenic (As)	mg/L	**0.01**	NA	0.00087	0.0013	0.0061	0.0062	0.0049	<0.0006	<0.0006	0.005	0.0049	0.0028	**0.005**	<0.0006	0.00061	<0.0006	<0.0006
Dissolved Barium (Ba)	mg/L	**1**	NA	0.018	0.0073	0.0066	0.0069	0.018	0.01	0.011	0.0064	0.0065	0.011	**1**	0.0017	0.0071	0.0031	0.0035
Dissolved Beryllium (Be)	mg/L	**0.004**	NA	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	**0.0053**	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Bismuth (Bi)	mg/L	-	NA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002
Dissolved Boron (B)	mg/L	**5**	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**1.2**	<0.1	<0.1	<0.1	<0.1
Dissolved Cadmium (Cd)	mg/L	**0.0001**	NA	0.00011	<0.000017	<0.000017	<0.000017	0.000048	0.00013	<0.000017	<0.000017	<0.000017	<0.000017	**0.00001**	<0.000017	<0.000017	0.000051	0.000023
Dissolved Chromium (Cr)	mg/L	**0.05**	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	0.0021	0.0015	<0.001	<0.001
Dissolved Cobalt (Co)	mg/L	**0.003**	NA	0.002	0.0012	0.0026	0.0027	0.0034	<0.001	<0.001	0.0023	0.0023	0.0011	**0.004**	<0.001	<0.001	<0.001	<0.001
Dissolved Lead (Pb)	mg/L	**0.01**	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.001**	<0.001	0.0012	<0.001	0.0011
Dissolved Lithium (Li)	mg/L	-	NA	0.0062	0.0025	<0.001	0.0011	0.0037	0.0041	0.0033	0.0011	0.0011	0.0011	-	0.0015	0.0018	0.0035	0.0015
Total Mercury (Hg)	mg/L	**0.00026**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**0.000026**	NA	NA	NA	NA
Dissolved Molybdenum (Mo)	mg/L	**0.07**	NA	0.0064	<0.004	<0.004	<0.004	0.0045	<0.004	<0.004	<0.004	<0.004	<0.004	**0.073**	<0.004	<0.004	<0.004	<0.004
Dissolved Nickel (Ni)	mg/L	**0.1**	NA	0.0092	<0.003	<0.003	<0.003	0.012	<0.003	<0.003	<0.003	<0.003	0.0036	**0.025**	<0.003	<0.003	<0.003	<0.003
Dissolved Phosphorus (P)	mg/L	-	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.12	0.12	<0.1	-	<0.1	<0.1	<0.1	<0.1
Dissolved Selenium (Se)	mg/L	**0.01**	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.001**	<0.001	<0.001	<0.001	<0.001
Dissolved Silver (Ag)	mg/L	**0.001**	NA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**0.0001**	<0.0001	<0.0001	<0.0001	<0.0001
Dissolved Strontium (Sr)	mg/L	**4.4**	NA	0.027	0.0091	0.017	0.017	0.085	0.023	0.011	0.018	0.019	0.1	**21**	0.0056	0.0087	0.0086	0.0064
Dissolved Sulphur (S)	mg/L	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-	NA	NA	NA	NA
Dissolved Thallium (Tl)	mg/L	**0.002**	NA	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	**0.0008**	<0.0008	<0.0008	<0.0008	<0.0008
Dissolved Tin (Sn)	mg/L	**4.4**	NA	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02
Dissolved Titanium (Ti)	mg/L	-	NA	0.0048	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	-	<0.003	0.0033	<0.003	<0.003
Dissolved Uranium (U)	mg/L	**0.02**	NA	0.0017	0.00081	0.0038	0.0038	0.0037	0.001	0.00034	0.0029	0.003	0.003	**0.3**	<0.00015	<0.00015	<0.00015	<0.00015
Dissolved Vanadium (V)	mg/L	**0.0062**	NA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	**0.006**	<0.002	<0.002	<0.002	<0.002
Elements (ICP-OES)																		
Dissolved Calcium (Ca)	mg/L	-	1.7	7.5	1.1	2	1.9	17	5.9	1.5	2.5	2.6	23	-	0.39	0.91	0.5	0.43
Dissolved Copper (Cu)	mg/L	**0.02**	0.0036	0.016	<0.002	0.0023	<0.002	0.0054	0.0072	<0.002	<0.002	0.002	0.003	**0.002**	<0.002	<0.002	<0.002	<0.002
Dissolved Iron (Fe)	mg/L	**0.3**	1.2	0.62	1.1	9.8	10	5.5	0.29	1.1	7.7	7.8	7.3	**0.3**	0.65	1.8	0.42	0.58
Dissolved Magnesium (Mg)	mg/L	-	1.3	1.6	0.86	1.7	1.7	2.4	1	1.4	1.8	1.8	2.1	-	0.6	0.83	1	0.91
Dissolved Manganese (Mn)	mg/L	**0.05**	0.036	0.39	0.15	0.7	0.71	1.3	0.14	0.12	0.59	0.6	0.69	**0.82**	0.055	0.17	0.036	0.041
Dissolved Potassium (K)	mg/L	-	0.69	1.4	<0.6	0.68	0.67	2.2	<0.6	<0.6	0.62	0.62	1.5	-	1.9	<0.6	<0.6	<0.6
Dissolved Sodium (Na)	mg/L	**200**	12	10	6.5	7.5	7.6	11	10	11	7.5	8.6	7.9	-	6.1	21	8.5	10
Dissolved Zinc (Zn)	mg/L	**0.3**	0.0079	0.051	0.011	0.013	0.013	0.068	0.056	0.018	0.0072	0.01	0.017	**0.03**	0.0061	0.01	0.0089	0.0077

Notes:

Guideline 1: Rationale for the Development of Environmental Quality Standards for Contaminated Sites in Nova Scotia Tier 1: Table A-3 Tier 1

Guideline 2: Rationale for the Development of Environmental Quality Standards for Contaminated Sites in Nova Scotia Tier 1: Table A-4 Tier 1

NM = Not measured due to insufficient water; N/A = Not applicable; NA = Not analyzed

AO = Aesthetic Objective

Exceeds NS EQS:Surface Water

Exceeds NS EQS:Groundwater

Table C8: PAH IN GROUNDWATER RESULTS
Little Dover Arrow Oily Waste Site

Maxxam ID	Units	NS EQS: Groundwater	HB0373	IC4239	IC4240	IC4241	IC4243	IC4242	NS EQS: Surface Water	IC4244	IC4245
Sampling Date			2-Sep-10	8-Dec-10	8-Dec-10	8-Dec-10	8-Dec-10	8-Dec-10		8-Dec-10	8-Dec-10
COC Number			B124743	B074916	B074916	B074916	B074916	B074916		B074916	B074916
ADI Sample ID			LD10-MW04	LD10-MW01	LD10-MW02	LD10-MW03	LD10-MW00	LD10-MW04		LD10-SW01	LD10-SW02
Polycyclic Aromatic Hydrocarbons											
1-Methylnaphthalene	ug/L	**20**	<0.05	<0.05	<0.05	0.19	0.17	<0.05	**2**	<0.05	<0.05
2-Methylnaphthalene	ug/L	**20**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**2**	<0.05	<0.05
Acenaphthene	ug/L	**58**	0.02	<0.01	<0.01	0.03	0.03	0.02	**5.8**	<0.01	<0.01
Acenaphthylene	ug/L	**0.45**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**4.6**	<0.01	<0.01
Anthracene	ug/L	**0.12**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.012**	<0.01	<0.01
Benzo(a)anthracene	ug/L	**0.18**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.018**	<0.01	<0.01
Benzo(a)pyrene	ug/L	**0.15**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.015**	<0.01	<0.01
Benzo(b)fluoranthene	ug/L	**4.8**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.48**	<0.01	<0.01
Benzo(g,h,i)perylene	ug/L	**1.7**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.17**	<0.01	<0.01
Benzo(k)fluoranthene	ug/L	**4.8**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.48**	<0.01	<0.01
Chrysene	ug/L	**14**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**1.4**	<0.01	<0.01
Dibenz(a,h)anthracene	ug/L	**2.6**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.26**	<0.01	<0.01
Fluoranthene	ug/L	**0.4**	0.04	<0.01	0.03	0.05	<0.01	0.02	**0.04**	0.01	<0.01
Fluorene	ug/L	**30**	0.02	<0.01	<0.01	0.06	0.05	0.02	**3**	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	ug/L	**2.1**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.21**	<0.01	<0.01
Naphthalene	ug/L	**11**	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	**1.1**	<0.2	<0.2
Perylene	ug/L	**-**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**-**	<0.01	<0.01
Phenanthrene	ug/L	**4**	0.04	<0.01	0.06	0.11	0.03	0.04	**0.4**	0.02	<0.01
Pyrene	ug/L	**0.25**	0.03	<0.01	0.02	0.03	<0.01	0.02	**0.025**	<0.01	<0.01

Duplicate

Notes:

Guideline 1: Rationale for the Development of Environmental Quality Standards for Contaminated Sites in Nova Scotia Tier 1: Table A-3 Tier 1 Environmental Quality Standards for Surface Water, Fresh Water, January 2011

Guideline 2: Rationale for the Development of Environmental Quality Standards for Contaminated Sites in Nova Scotia Tier 1: Table A-4 Tier 1 Environmental Quality Standards for Groundwater, January 2011

NG - No Guideline; ND - Not detected

Exceeds NSE EQS: Surface Water

Exceeds NSE EQS: Groundwater

Table C9
Little Dover Groundwater Elevations

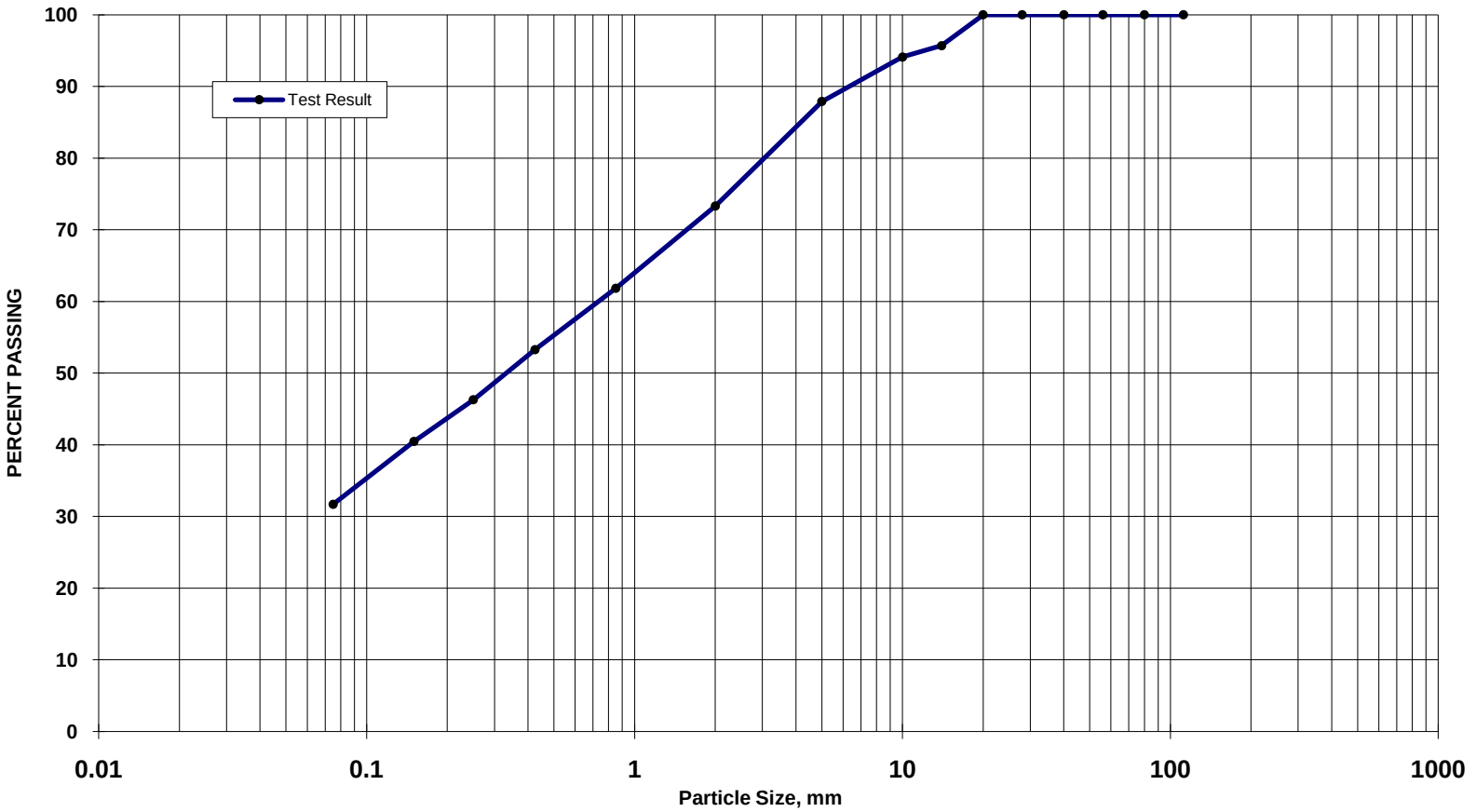
					2-Sep-10		7-Dec-11	
Monitoring Well ID	**Ground level, MASL**	**PVC pipe level, MASL**	**PVC stick up, m**	**Total PVC (well depth), m**	**Water level, m**	**Water elevation, MASL**	**Water level, m**	**Water elevation, MASL**
LD10-MW01	23.57	23.558	-0.012	4.57	3.62	19.938	3.38	20.178
LD10-MW02	22.38	22.3347	-0.0453	3.62	0.2	22.1347	flowing	flowing
LD10-MW03	17.4644	17.4184	-0.046	4.71	0.75	16.6684	0.355	17.0634
LD10-MW04	19.8942	19.8689	-0.0253	4.6	1.42	18.4489	0.585	19.2839

ASTM/USCS Sieve Analysis

SYD-00020401-A0

Oily Waste Sites Guysborough County - Little Dover

August 5, 2010



TEST DATA	
Sieve Size (mm)	Percent Passing (%)
112	100.0
80	100.0
56	100.0
40	100.0
28	100.0
20	100.0
14	95.7
10	94.1
5	87.9
2	73.3
0.85	61.8
0.425	53.3
0.25	46.3
0.15	40.5
0.075	31.7

Client: NSTIR

Sample: LD10-MW03-1

Soil Type: TILL

USCS Soil Name: Silty Sand

Gravel (%) 12.1

Sand (%) 56.2

Fines (%) 31.7

USCS Symbol: SM

C_u NA

C_c NA

$W_{content}$(%) 27.4

Test By: JWB/KR

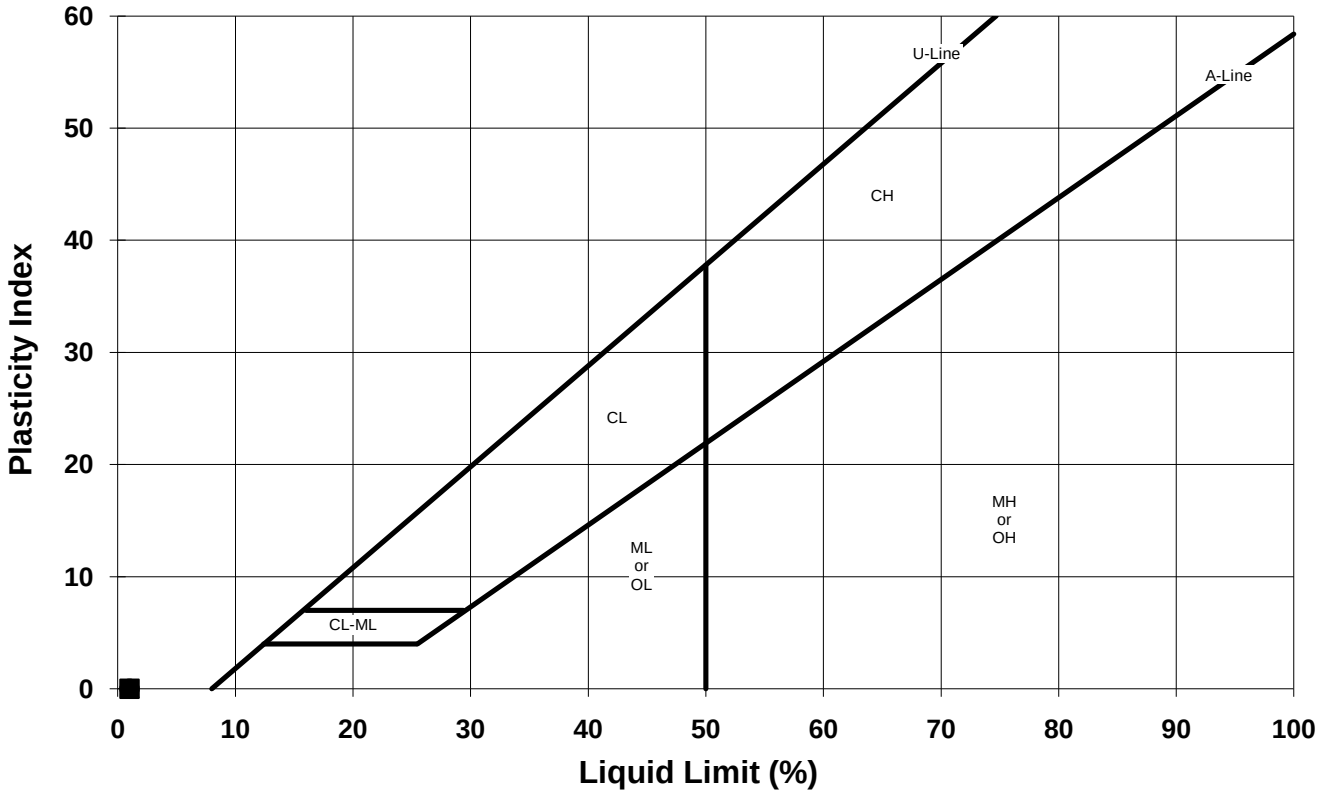
Comment: Fines are assumed to be classified as ML

Specified Gradational Limits		
Size (mm)	Low Limit % Passing	High Limit % Passing
80		
56		
28		
14		
5		
0.16		
0.08		

exp Services Inc. - Plastic Limits
ASTM D4318

SYD-00020401-A0

August 14, 2010



Client: NSTIR

Job No: SYD-00020401-A0

Project: Kurdistan and Arrow Oily Waste Disposal Sites - Little Dover

Location: Little Dover,NS

Sample Date: August 5, 2010

Test Date: August 14, 2010

Sample By: SS

Test By: JWB/KR

DATA SUMMARY

Sample #	Liquid Limit	Plastic Limit	Plastic Index	Soil Symbol	Soil Type	Legend
LD10-MW03-1	NA	NA	NA	ML	Till	■

Comment: Sample was collected for a depth of 0.61 to 1.22metres. Sample was not suitalbe for testing.

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WELL NUMBER LD10-MW01

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Little Dover Arrow Oily Waste Site
DATE STARTED 6/8/10 **COMPLETED** 6/8/10
GROUND ELEVATION 23.6 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME 55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
			Ground surface was flat. Rock at surface. Used standard auger to start borehole.		BEDROCK: Granite, white and grey, quartz encountered at 3.35 to 4.26 metres depth, verticle fractures from 0 to 1.22 metres, highly fractured from 1.22 to 1.82 metres depth, horizontal and sub-horizontal from 1.82 to 4.57 metres, iron staining on fracture faces	Casing Top Elev: 23.56 (m) Casing Type: Flush Mount
	RC 1	100 (0)	Water was not encountered. Staining noted on fracture faces. No odours observed.			Bentonite seal.
1	RC 2	100 (0)				
	RC 3	100 (0)	Advanced core barrel only, no case pipe.			
2	RC 4	100 (0)				
	RC 5	100 (0)				Screen in sand.
3						
	RC 6	100 (27)				
4						
	RC 7	10 (10)				
					4.57	19.03 End Point.

Borehole terminated at 4.57 metres depth in Bedrock.
Monitoring well installed.
Bottom of borehole at 4.57 meters.

GENERAL BH / TP / WELL LITTLE DOVER MWS.GPJ GINT STD CANADA LAB.GDT 1/8/12

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WELL NUMBER LD10-MW02

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Little Dover Arrow Oily Waste Site
DATE STARTED 6/8/10 **COMPLETED** 6/8/10
GROUND ELEVATION 22.3 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME 55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
			Ground surface was flat. Rock at surface. Used standard auger to start borehole.		BEDROCK: Granite, white and grey, mostly horizontal fractures, one vertical fracture at 3.05 to 3.35 metres depth, iron staining on fracture faces	Casing Top Elev: 22.33 (m) Casing Type: Flush Mount Bentonite seal.
1	RC 1	100 (75)	Water was not encountered. Staining noted on fracture faces. No odours observed.			
	RC 2	100 (68)				Screen in sand.
2	RC 3	100 (100)	Advanced core barrel only, no case pipe.			
	RC 4	100 (100)				
3	RC 5	93 (54)			3.36	18.94 End Point.

Borehole terminated at 3.36 metres depth in Bedrock.
Monitoring well installed.
Bottom of borehole at 3.36 meters.

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WELL NUMBER LD10-MW03

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Little Dover Arrow Oily Waste Site
DATE STARTED 5/8/10 **COMPLETED** 5/8/10
GROUND ELEVATION 17.4 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME 55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
			Ground surface was uneven. Moss and vegetation ground cover. Area had to be cut at time of drilling for access. Water was not encountered. Staining noted on fracture faces. No odours observed.		TOPSOIL: Silt, sand and organics (rootlets), loose, moist, black (0.31 / 17.09)	Casing Top Elev: 17.42 (m) Casing Type: Flush Mount
					TILL: Sandy silt, trace gravel, loose, moist, moderate brown (1.22 / 16.18)	Bentonite seal.
1	RC 1	65 (43)			BEDROCK: Granite, white and grey, trace mica on fracture faces, horizontal and sub-horizontal from 1.22 to 4.72 metres, black and orange staining on fracture faces, verticle fractures at 1.67 to 1.98 and from 2.43 to 3.05 metres depth	
2	RC 2	100 (59)				
3						Screen in sand.
4	RC 3	100 (83)			(4.72 / 12.68)	End Point.
					Borehole terminated at 4.72 metres depth in Bedrock. Monitoring well installed. Bottom of borehole at 4.72 meters.	

GENERAL BH / TP / WELL LITTLE DOVER MWS.GPJ GINT STD CANADA LAB.GDT 1/8/12

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WELL NUMBER LD10-MW04

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigation
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Little Dover Arrow Oily Waste Site
DATE STARTED 5/8/10 **COMPLETED** 5/8/10
GROUND ELEVATION 19.9 m Geodetic
DRILLING CONTRACTOR Boart Longyear
GROUND WATER LEVELS:
DRILLING METHOD CME 55
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
			Ground surface was uneven. Moss and vegetation ground cover.		TOPSOIL: Silt, sand and organics (rootlets), loose, moist, black	Casing Top Elev: 19.87 (m) Casing Type: Flush Mount
					0.31	
	RC 1	100 (22)			BEDROCK: Granite, white and grey, verticle fractures from 0.31 to 1.22 metres, horizontal and sub-horizontal from 1.22 to 4.72 metres, black staining on fracture faces	Bentonite seal.
1						
	RC 2	79 (0)				
	RC 3	100 (70)	Water was not encountered. Staining noted on fracture faces. No odours observed.			
2						
3	RC 4	100 (23)	Advanced core barrel only, no case pipe.			Screen in sand.
4	RC 5	100 (29)				
					4.72	15.18 End Point.
					Borehole terminated at 4.72 metres depth in Bedrock. Monitoring well installed. Bottom of borehole at 4.72 meters.	

GENERAL BH / TP / WELL LITTLE DOVER MWS.GPJ GINT STD CANADA LAB.GDT 1/8/12

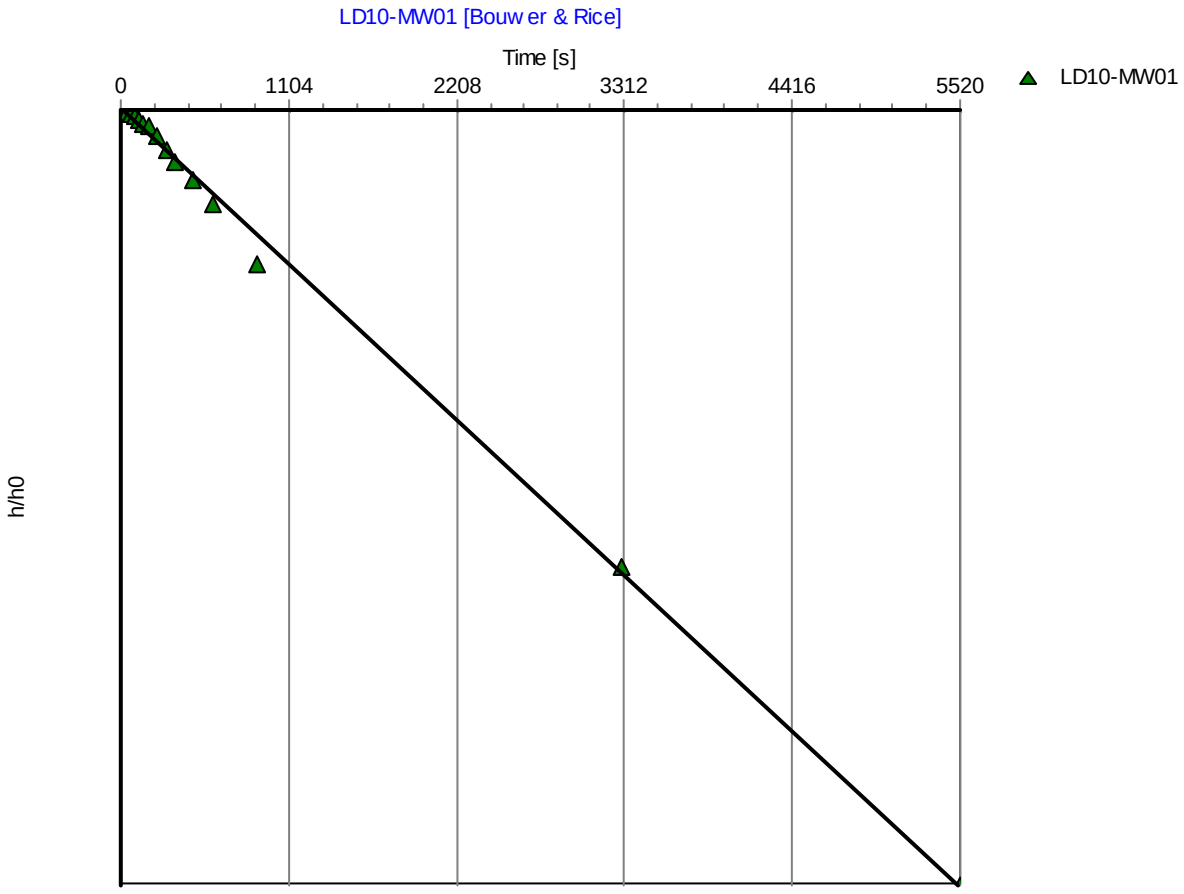
exp Services Inc.
301 Alexandra Street
Sydney, NS B1S 2E8
Phone: (902) 562-2394

Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Little Dover

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **LD10-MW01**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 1.46E-6 [cm/s]

Test parameters:

Test Well:	LD10-MW01	Aquifer Thickness:	0.95 [m]
Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
Screen length:	3 [m]		
Boring radius:	0.076 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

exp Services Inc.
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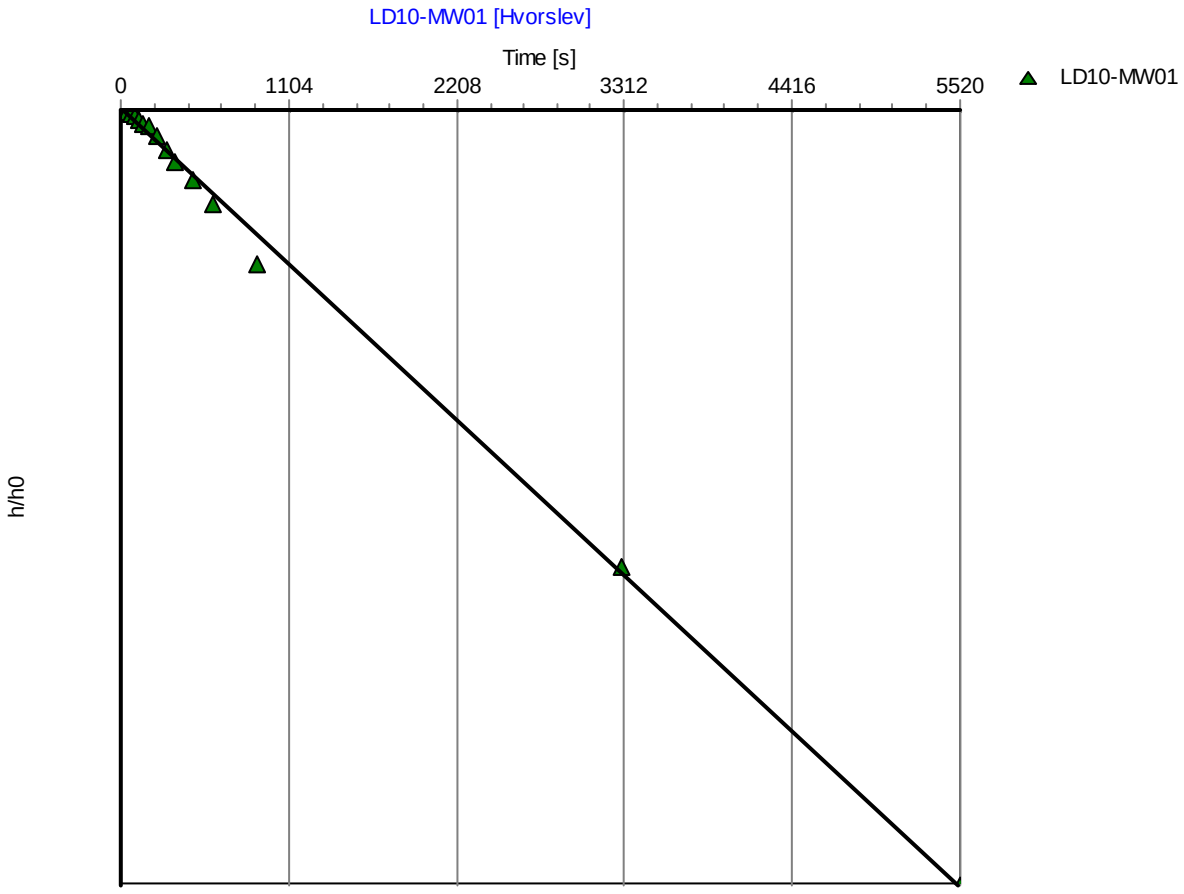
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Little Dover

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **LD10-MW01**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 2.73E-6 [cm/s]

Test parameters:

Test Well:	LD10-MW01	Aquifer Thickness:	0.95 [m]
Casing radius:	0.0254 [m]		
Screen length:	3 [m]		
Boring radius:	0.076 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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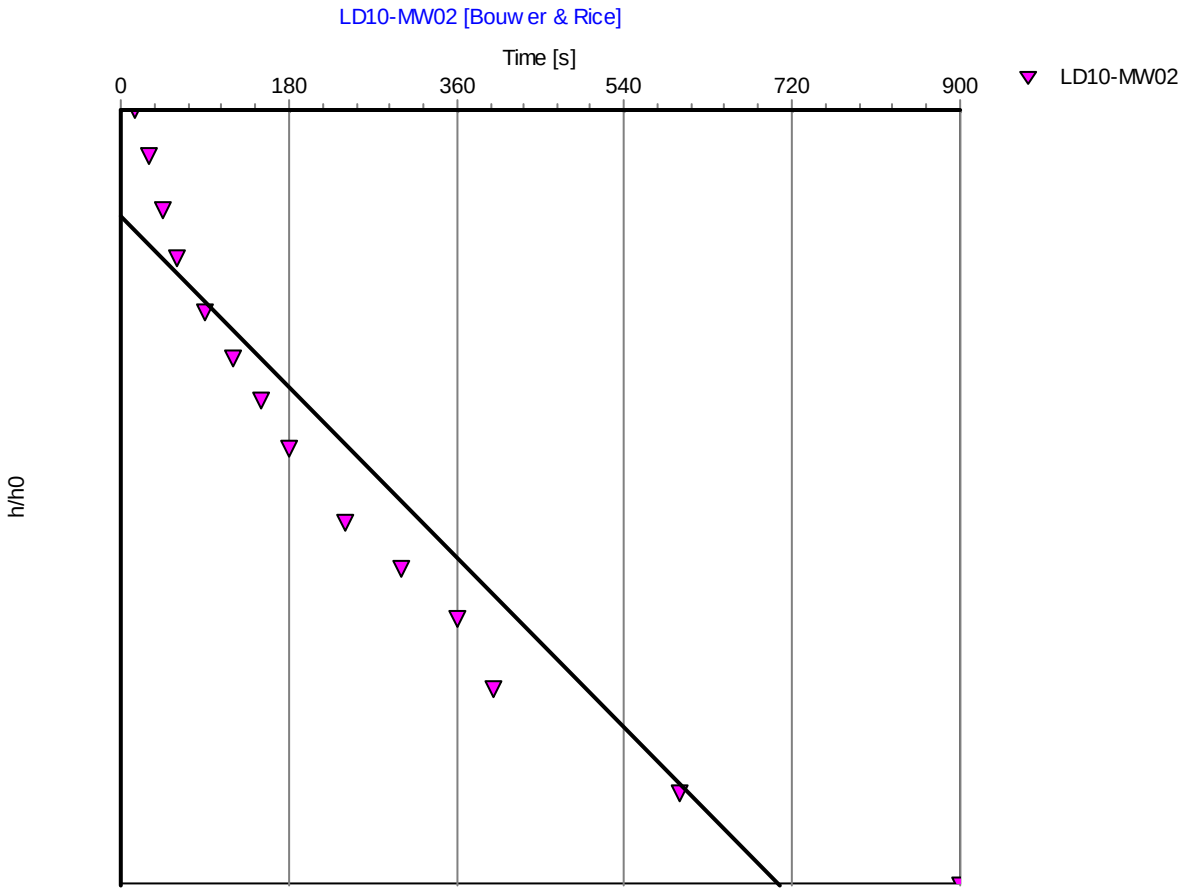
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Little Dover

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **LD10-MW02**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 6.84E-5 [cm/s]

Test parameters:

Test Well:	LD10-MW02	Aquifer Thickness:	3.16 [m]
Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
Screen length:	3 [m]		
Boring radius:	0.076 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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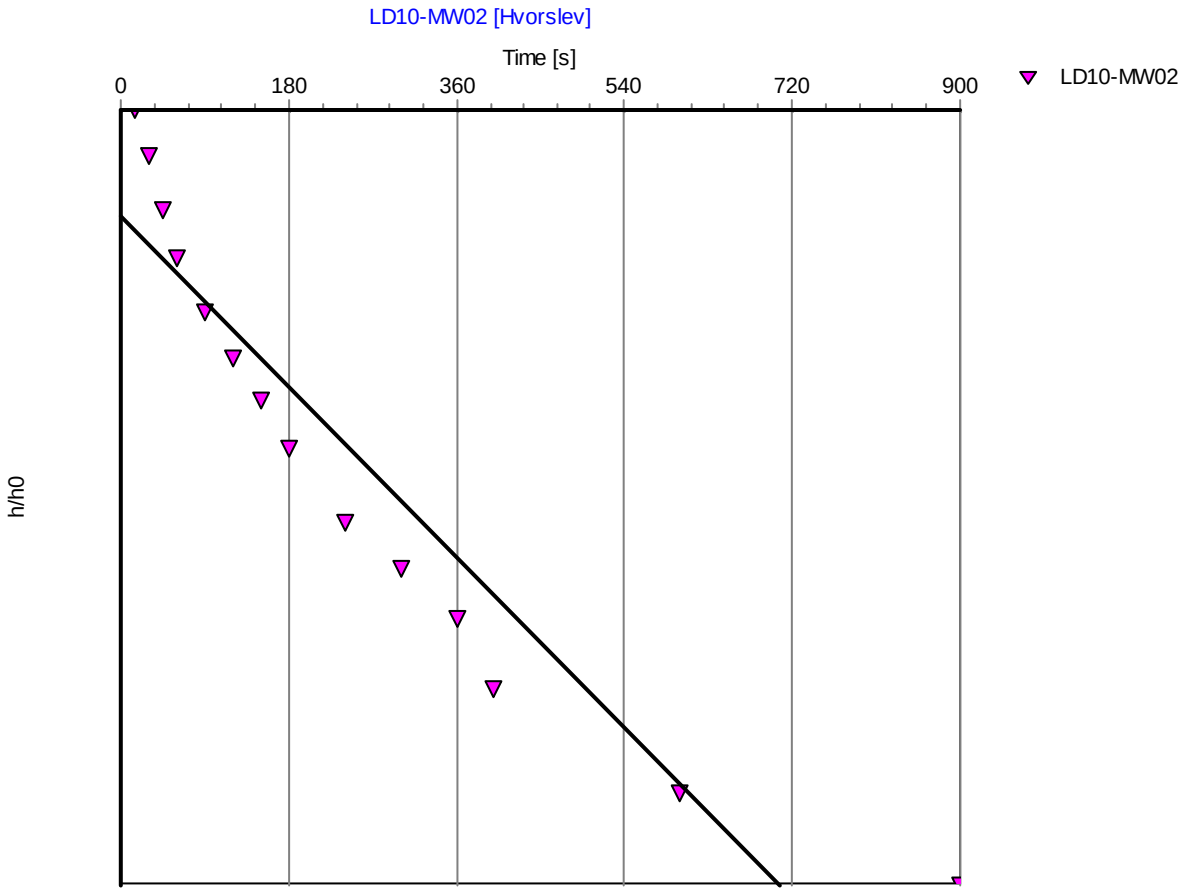
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Little Dover

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **LD10-MW02**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 8.90E-5 [cm/s]

Test parameters:

Test Well:	LD10-MW02	Aquifer Thickness:	3.16 [m]
Casing radius:	0.0254 [m]		
Screen length:	3 [m]		
Boring radius:	0.076 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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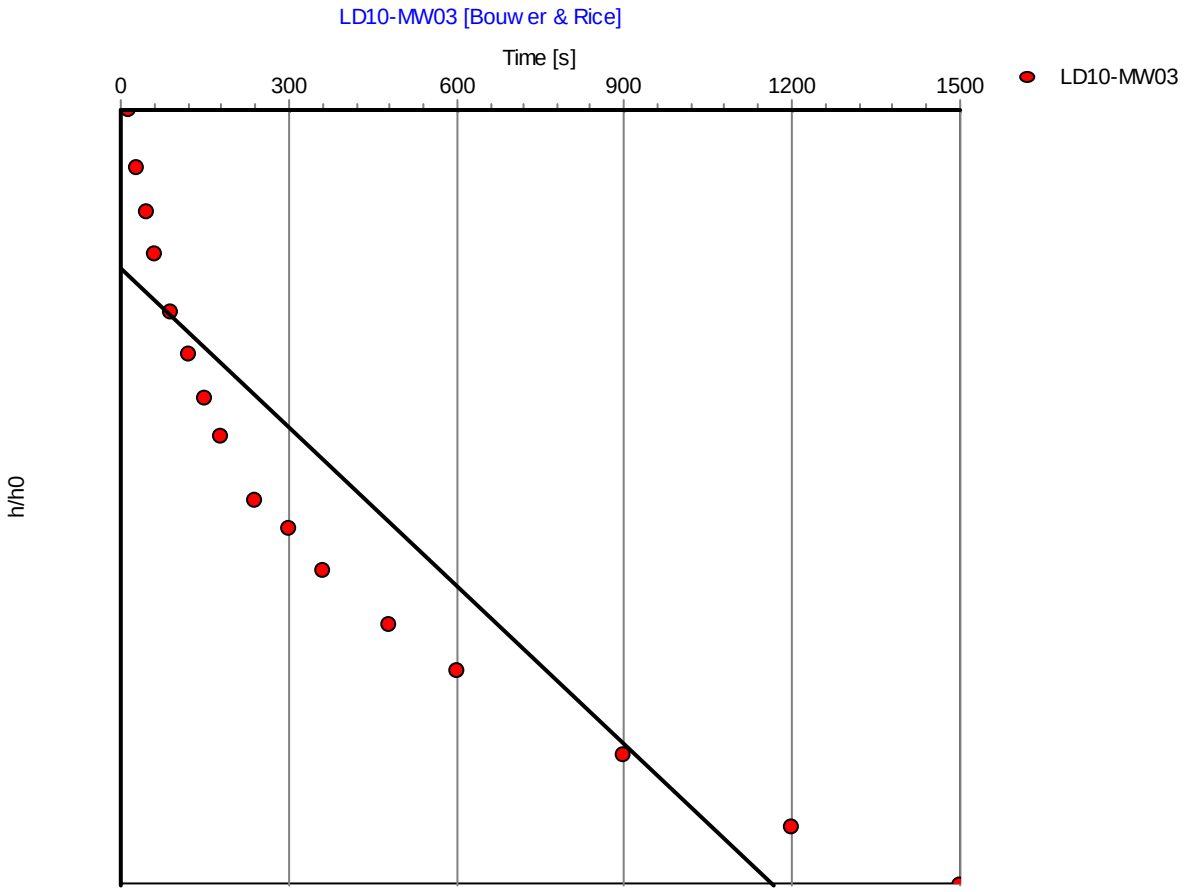
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Little Dover

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **LD10-MW03**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 4.07E-5 [cm/s]

Test parameters:

Test Well:	LD10-MW03	Aquifer Thickness:	3.97 [m]
Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
Screen length:	3 [m]		
Boring radius:	0.076 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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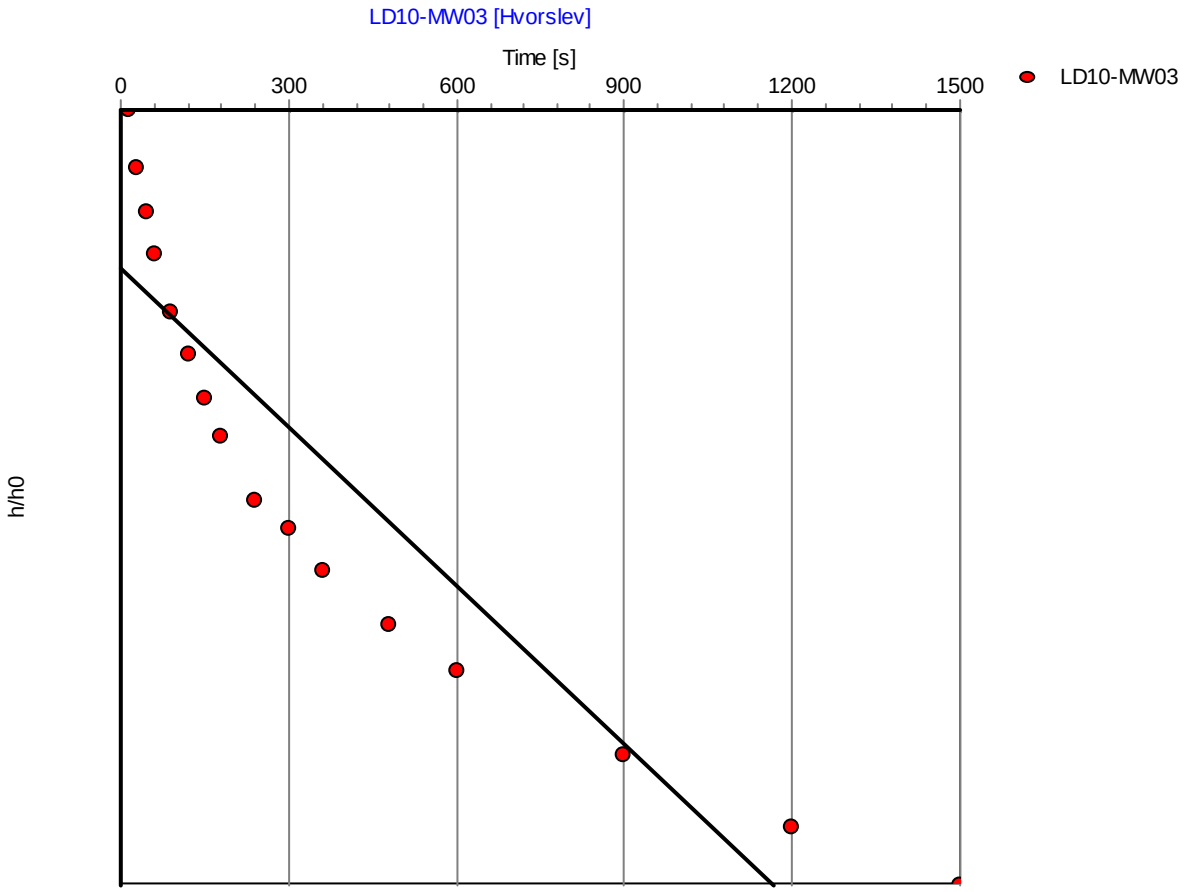
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Little Dover

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **LD10-MW03**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 5.05E-5 [cm/s]

Test parameters:

Test Well:	LD10-MW03	Aquifer Thickness:	3.97 [m]
Casing radius:	0.0254 [m]		
Screen length:	3 [m]		
Boring radius:	0.076 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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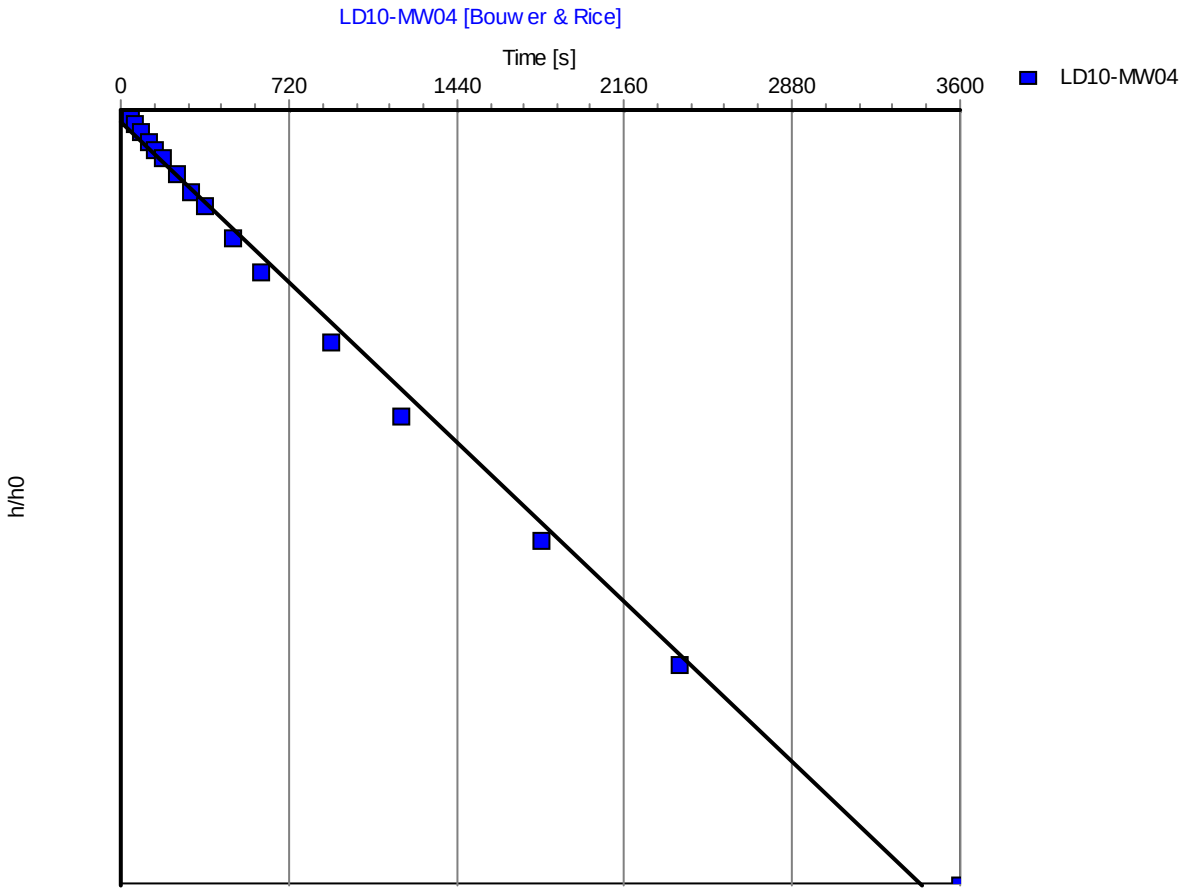
Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Little Dover

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **LD10-MW04**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 5.63E-6 [cm/s]

Test parameters:

Test Well:	LD10-MW04	Aquifer Thickness:	3.3 [m]
Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
Screen length:	3 [m]		
Boring radius:	0.076 [m]		
r(eff):	0.044 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

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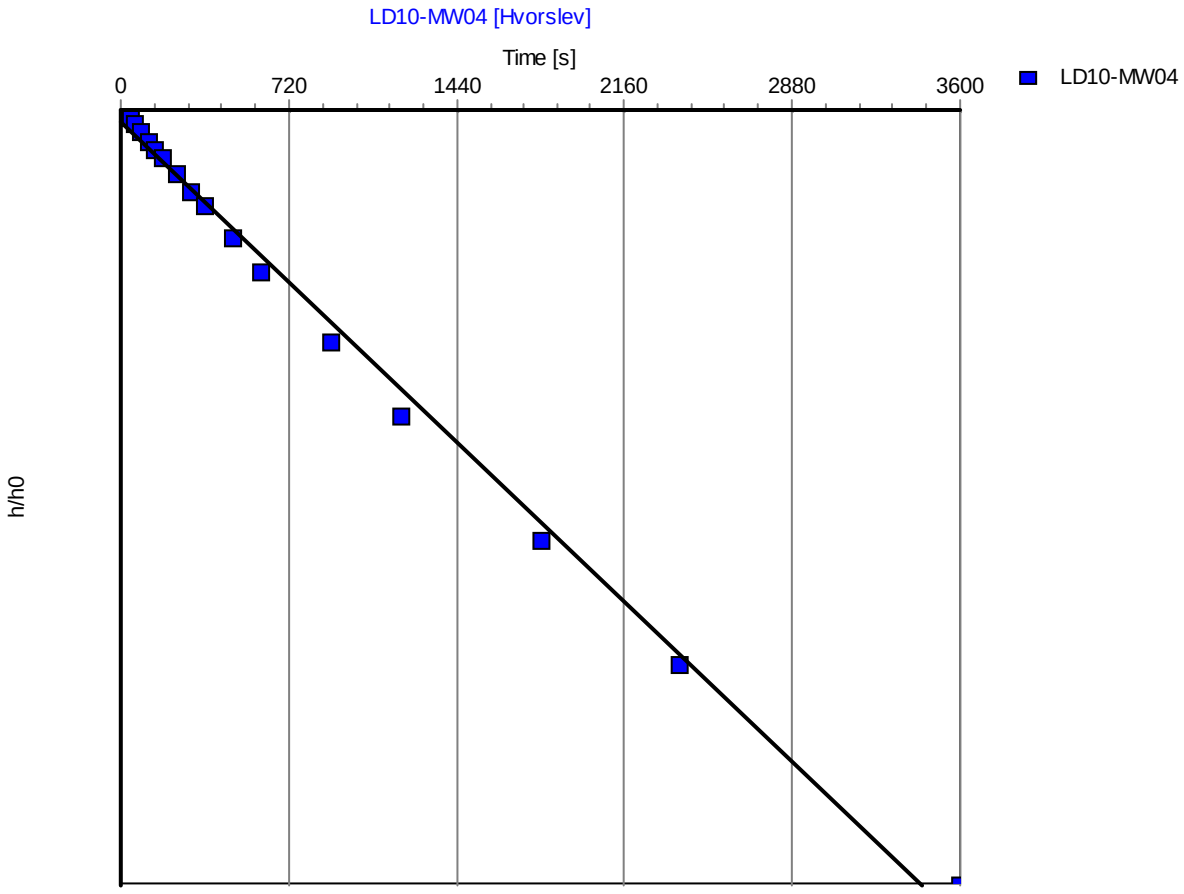
Sydney, NS B1S 2E8
Phone: (902) 562-2394

Slug Test Analysis Report

Project: Kurdistan Oily Waste Sites Little Dover

Number: SYD-00020401-A0

Client: NSTIR



Slug Test: **LD10-MW04**

Analysis Method: **Hvorslev**

Analysis Results:

Conductivity: 7.28E-6 [cm/s]

Test parameters:

Test Well:	LD10-MW04	Aquifer Thickness:	3.3 [m]
Casing radius:	0.0254 [m]		
Screen length:	3 [m]		
Boring radius:	0.076 [m]		

Comments:

Evaluated by: AEP

Evaluation Date: 9/17/2010

Appendix D
Sand Point

Table D1: HYDROCARBONS IN SOIL RESULTS
Sand Point Kurdistan Oily Waste Disposal Site

Maxxam ID	Units	RBCA Commercial Guideline**	IA9915	IA9918	IA9921	IA9922	IA9923	IA9924	IA9925	IA9929
Sampling Date			1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10
COC Number			B124762	B124762	B124762	B124762	B124762	B124762	B124762	B124762
Sample ID			SPA10-TP02	SPA10-TP05	SPA10-TP06	SPA10-TP09	SPA10-TP12	SPA10-TP15	SPA10-TP18	SPA10-TP19
TPH COMPOUNDS										
Benzene	mg/kg	**570**	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Toluene	mg/kg	**18000**	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Ethylbenzene	mg/kg	**10000**	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01
Xylene (Total)	mg/kg	**180000**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C6 - C10 (less BTEX)	mg/kg	**13000**	<3	19	<3	<3	<3	<3	<3	<3
>C10-C16 Hydrocarbons	mg/kg	**7700**	17	1000	29	<10	<10	13	15	<10
>C16-C21 Hydrocarbons	mg/kg		110	3100	170	<10	40	81	79	24
>C21-<C32 Hydrocarbons	mg/kg	**12000**	360	4500	470	19	200	270	160	66
Modified TPH (Tier1)	mg/kg	***	500	8700	670	<20	240	360	250	90
Product Identification	na	NG	na	na	na	na	na	na	na	na

Notes:

RDL = Reportable Detection Limit, NG = No guideline

** Atlantic RBCA Version 2.0, Table 8 For Coarse-grained soils on **Commercial** receptor sites with non-potable water use, Soil

(1) Fuel oil / lube oil range.

(2) Fuel oil fraction

(3) Lube oil fraciton. TEH surrogate not within acceptable limits due to sample matrix.

(4) Lube oil fraction

(5) Fuel Oil Fraction and Lube Oil Fraction

*** As per laboratory identified fraction and/or Atlantic RBCA Version 2.0 Table 5, Modified TPH concentration must be compared with appropriate fraction. Shading indicates exceedance of

TABLE D2: METALS IN SOIL RESULTS
Sand Point Kurdistan Oily Waste Disposal Site

Maxxam ID	Units	CCME CEQG Industrial Guideline*	IA9915	IA9918	IA9921	IA9922	IA9923	IA9924	IA9925	IA9929
Sampling Date			1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10
COC Number			B124762	B124762	B124762	B124762	B124762	B124762	B124762	B124762
Sample ID			SPA10-TP02	SPA10-TP05	SPA10-TP06	SPA10-TP09	SPA10-TP12	SPA10-TP15	SPA10-TP18	SPA10-TP19
Elements (ICP-MS)										
Aluminum (Al)	mg/kg	-	8500	930	5200	44000	5200	6000	10000	14000
Antimony (Sb)	mg/kg	**40**	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic (As)	mg/kg	**12**	4	<1	4	19	3	2	4	7
Barium (Ba)	mg/kg	**2000**	32	<10	21	130	21	14	30	110
Beryllium (Be)	mg/kg	**8**	<1	<1	<1	1	<1	<1	<1	<1
Boron (B)	mg/kg	-	<7	<7	<7	<7	<7	<7	<7	<7
Cadmium (Cd)	mg/kg	**22**	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2
Calcium (Ca)	mg/kg	-	1400	520	1800	5000	1300	1400	4300	910
Chromium (Cr)	mg/kg	**87**	13	1	8	64	8	10	17	24
Cobalt (Co)	mg/kg	**300**	8	<1	5	240	5	6	11	13
Copper (Cu)	mg/kg	**91**	13	<10	<10	16	<10	14	18	20
Iron (Fe)	mg/kg	-	18000	1900	12000	91000	12000	15000	23000	29000
Lead (Pb)	mg/kg	**600**	7	<1	5	38	5	6	5	17
Lithium (Li)	mg/kg	-	19	2	12	28	13	15	31	27
Magnesium (Mg)	mg/kg	-	4900	570	3300	2900	3200	3500	5600	4700
Manganese (Mn)	mg/kg	-	320	39	380	34000	410	240	400	470
Mercury (Hg)	mg/kg	**50**	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	**40**	<1	<1	<1	4	<1	<1	<1	<1
Nickel (Ni)	mg/kg	**50**	15	2	10	16	10	13	23	25
Phosphorus (P)	mg/kg	-	420	71	260	1200	270	310	370	250
Potassium (K)	mg/kg	-	<400	<400	<400	700	<400	<400	<400	760
Selenium (Se)	mg/kg	**2.9**	<0.6	<0.6	<0.6	8.0	<0.6	<0.6	<0.6	0.6
Silver (Ag)	mg/kg	**40**	<1	<1	<1	<1	<1	<1	<1	<1
Sodium (Na)	mg/kg	-	<400	<400	<400	<400	<400	<400	<400	<400
Strontium (Sr)	mg/kg	-	5	<2	5	26	4	7	14	7
Sulphur (S)	mg/kg	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium (Tl)	mg/kg	**1**	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
Tin (Sn)	mg/kg	**300**	<10	<10	<10	<10	<10	<10	<10	<10
Titanium (Ti)	mg/kg	-	79	5	88	27	80	73	39	65
Uranium (U)	mg/kg	**300**	<1	<1	<1	2	<1	<1	<1	<1
Vanadium (V)	mg/kg	**130**	22	9	20	44	17	20	18	24
Zinc (Zn)	mg/kg	**360**	54	<50	<50	80	<50	130	50	68

Notes:

***** CCME Canadian Environmental Quality Guidelines for **Industrial** site land use (September 2007 update)

RDL = Reportable Detection Limit

Exceeds Industrial

Table D3: PAHs IN SOIL RESULTS
Sand Point Kurdistan Oily Waste Disposal Site

Maxxam ID	Units	CCME CEQG Industrial Guideline*	IA9915	IA9918	IA9921	IA9922	IA9923	IA9924	IA9925	IA9929
Sampling Date			1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10	1-Dec-10
COC Number			B124762	B124762	B124762	B124762	B124762	B124762	B124762	B124762
Sample ID			SPA10-TP02	SPA10-TP05	SPA10-TP06	SPA10-TP09	SPA10-TP12	SPA10-TP15	SPA10-TP18	SPA10-TP19
PAHs										
1-Methylnaphthalene	mg/kg	-	<0.1	0.6	<0.1	<0.01	<0.1	<0.1	<0.1	0.02
2-Methylnaphthalene	mg/kg	-	<0.1	0.5	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Acenaphthene	mg/kg	-	<0.1	0.3	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Acenaphthylene	mg/kg	-	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Anthracene	mg/kg	-	<0.1	0.1	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Benzo(a)anthracene	mg/kg	**10**	<0.1	0.3	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Benzo(a)pyrene	mg/kg	**0.7**	<0.1	0.1	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Benzo(b)fluoranthene	mg/kg	**10**	<0.1	0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Benzo(g,h,i)perylene	mg/kg	-	<0.1	0.1	<0.1	<0.01	<0.1	0.1	<0.1	<0.01
Benzo(k)fluoranthene	mg/kg	**10**	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Chrysene	mg/kg	-	<0.1	1.3	<0.1	<0.01	<0.1	<0.1	<0.1	0.01
Dibenzo(a,h)anthracene	mg/kg	**10**	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Fluoranthene	mg/kg	-	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Fluorene	mg/kg	-	<0.1	0.5	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	**10**	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Naphthalene	mg/kg	**22**	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01
Perylene	mg/kg	-	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	<0.1	0.15
Phenanthrene	mg/kg	**50**	<0.1	1.5	<0.1	<0.01	<0.1	<0.1	<0.1	0.01
Pyrene	mg/kg	**100**	<0.1	0.7	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01

Notes:

* CCME Canadian Environmental Quality Guidelines for **Industrial** site land use (September 2006 update)

RDL = Reportable Detection Limit

Exceeds Industrial

Table D4: PAHs in Soil
Sand Point Kurdistan Oily Waste Disposal Site

Maxxam ID	Units	CCME Direct Contact	CCME PEFs	IA9915	Sample TPE	IA9918	Sample TPE	IA9921	Sample TPE	IA9922	Sample TPE	IA9923	Sample TPE	IA9924	Sample TPE	IA9925	Sample TPE	IA9929	Sample TPE
Sampling Date				1-Dec-10		1-Dec-10		1-Dec-10		1-Dec-10		1-Dec-10		1-Dec-10		1-Dec-10		1-Dec-10	
COC Number				B124762		B124762		B124762		B124762		B124762		B124762		B124762		B124762	
				SPA10-TP02		SPA10-TP05		SPA10-TP06		SPA10-TP09		SPA10-TP12		SPA10-TP15		SPA10-TP18		SPA10-TP19	
PAHs																			
1-Methylnaphthalene	mg/kg	NV	-	0.05	-	0.6	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.02	-
2-Methylnaphthalene	mg/kg	NV	-	0.05	-	0.5	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Acenaphthene	mg/kg	NV	-	0.05	-	0.3	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Acenaphthylene	mg/kg	NV	-	0.05	-	0.05	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Anthracene	mg/kg	NV	-	0.05	-	0.1	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Benzo(a)anthracene	mg/kg	NV	0.1	0.05	0.005	0.3	0.03	0.05	0.005	0.005	0.0005	0.05	0.005	0.05	0.005	0.05	0.005	0.005	0.0005
Benzo(a)pyrene	mg/kg	NV	1	0.05	0.05	0.1	0.1	0.05	0.05	0.005	0.005	0.05	0.05	0.05	0.05	0.05	0.05	0.005	0.005
Benzo(b)fluoranthene	mg/kg	NV	0.1	0.05	0.005	0.2	0.02	0.05	0.005	0.005	0.0005	0.05	0.005	0.05	0.005	0.05	0.005	0.005	0.0005
Benzo(g,h,i)perylene	mg/kg	NV	0.01	0.05	0.0005	0.1	0.001	0.05	0.0005	0.005	0.00005	0.05	0.0005	0.05	0.0005	0.05	0.0005	0.005	0.00005
Benzo(k)fluoranthene	mg/kg	NV	0.1	0.05	0.005	0.05	0.005	0.05	0.005	0.005	0.0005	0.05	0.005	0.05	0.005	0.05	0.005	0.005	0.0005
Chrysene	mg/kg	NV	0.01	0.05	0.0005	1.3	0.013	0.05	0.0005	0.005	0.00005	0.05	0.0005	0.05	0.0005	0.05	0.0005	0.005	0.00005
Dibenzo(a,h)anthracene	mg/kg	NV	1	0.05	0.05	0.05	0.05	0.05	0.05	0.005	0.005	0.05	0.05	0.05	0.05	0.05	0.05	0.005	0.005
Fluoranthene	mg/kg	NV	-	0.05	-	0.05	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Fluorene	mg/kg	NV	-	0.05	-	0.5	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Indeno(1,2,3-cd)pyrene	mg/kg	NV	0.1	0.05	0.005	0.05	0.005	0.05	0.005	0.005	0.0005	0.05	0.005	0.05	0.005	0.05	0.005	0.005	0.0005
Naphthalene	mg/kg	NV	-	0.05	-	0.05	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Perylene	mg/kg	NV	-	0.05	-	0.05	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.15	-
Phenanthrene	mg/kg	NV	-	0.05	-	1.5	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.01	-
Pyrene	mg/kg	NV	-	0.05	-	0.7	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
B (a) P TPE	mg/Kg	5.3	-	-	0.121	-	0.224	-	0.121	-	0.0121	-	0.121	-	0.121	-	0.121	-	0.0121
Uncertainty Factor	mg/Kg	3	-	-	0.363	-	0.672	-	0.363	-	0.0363	-	0.363	-	0.363	-	0.363	-	0.0363

Notes:
* CCME Canadian Environmental Quality Guidelines for the Protection of Envrionmental and Human Health (2010)

NV - No Value

PEF - Potency Equivalence Factor
Potency Equivalent - Calculated by

Screening:
Bold - Indicates an exceedance of CCME guidelines
Red indicates value was below the reportable detection limit and half the RDL was used for the calculation.

References:

Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Soil Quality Guidelines (CEQG), Last Accessed October 2008 - Commercial land use, coarse textured soil

Table D5: PAHs in Soil
Sand Point Kurdistan Oily Waste Disposal Site

Maxxam ID	Units	CCME Direct Contact	CCME PEFs	IA9915	Sample TPE	IA9918	Sample TPE	IA9921	Sample TPE	IA9922	Sample TPE	IA9923	Sample TPE	IA9924	Sample TPE	IA9925	Sample TPE	IA9929	Sample TPE
Sampling Date				1-Dec-10		1-Dec-10		1-Dec-10		1-Dec-10		1-Dec-10		1-Dec-10		1-Dec-10		1-Dec-10	
COC Number				B124762		B124762		B124762		B124762		B124762		B124762		B124762		B124762	
				SPA10-TP02		SPA10-TP05		SPA10-TP06		SPA10-TP09		SPA10-TP12		SPA10-TP15		SPA10-TP18		SPA10-TP19	
PAHs																			
1-Methylnaphthalene	mg/kg	NV	-	0.05	-	0.6	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.02	-
2-Methylnaphthalene	mg/kg	NV	-	0.05	-	0.5	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Acenaphthene	mg/kg	NV	-	0.05	-	0.3	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Acenaphthylene	mg/kg	NV	-	0.05	-	0.05	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Anthracene	mg/kg	NV	-	0.05	-	0.1	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Benzo(a)anthracene	mg/kg	NV	0.33	0.05	0.0165	0.3	0.099	0.05	0.0165	0.005	0.00165	0.05	0.0165	0.05	0.0165	0.05	0.0165	0.005	0.00165
Benzo(a)pyrene	mg/kg	NV	0.37	0.05	0.0185	0.1	0.037	0.05	0.0185	0.005	0.00185	0.05	0.0185	0.05	0.0185	0.05	0.0185	0.005	0.00185
Benzo(b)fluoranthene	mg/kg	NV	0.16	0.05	0.008	0.2	0.032	0.05	0.008	0.005	0.0008	0.05	0.008	0.05	0.008	0.05	0.008	0.005	0.0008
Benzo(g,h,i)perylene	mg/kg	NV	6.8	0.05	0.34	0.1	0.68	0.05	0.34	0.005	0.034	0.05	0.34	0.05	0.34	0.05	0.34	0.005	0.034
Benzo(k)fluoranthene	mg/kg	NV	0.16	0.05	0.008	0.05	0.008	0.05	0.008	0.005	0.0008	0.05	0.008	0.05	0.008	0.05	0.008	0.005	0.0008
Chrysene	mg/kg	NV	2.1	0.05	0.105	1.3	2.73	0.05	0.105	0.005	0.0105	0.05	0.105	0.05	0.105	0.05	0.105	0.005	0.0105
Dibenzo(a,h)anthracene	mg/kg	NV	0.23	0.05	0.0115	0.05	0.0115	0.05	0.0115	0.005	0.00115	0.05	0.0115	0.05	0.0115	0.05	0.0115	0.005	0.00115
Fluoranthene	mg/kg	NV	-	0.05	-	0.05	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Fluorene	mg/kg	NV	-	0.05	-	0.5	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Indeno(1,2,3-cd)pyrene	mg/kg	NV	2.7	0.05	0.135	0.05	0.135	0.05	0.135	0.005	0.0135	0.05	0.135	0.05	0.135	0.05	0.135	0.005	0.0135
Naphthalene	mg/kg	NV	-	0.05	-	0.05	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
Perylene	mg/kg	NV	-	0.05	-	0.05	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.15	-
Phenanthrene	mg/kg	NV	-	0.05	-	1.5	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.01	-
Pyrene	mg/kg	NV	-	0.05	-	0.7	-	0.05	-	0.005	-	0.05	-	0.05	-	0.05	-	0.005	-
SQG PW IACR	mg/Kg	1	-	-	0.6425	-	**3.7325**	-	0.6425	-	0.06425	-	0.6425	-	0.6425	-	0.6425	-	0.06425

Notes:

Notes:

All values expressed in µg/g unless otherwise indicated

NV - No Value

SQG_{PW} - Soil Quality Guideline for Protection of Potable Water

IACR - Index of Additive Cancer Risk

SQG_{PW} IACR - Index of Additive Cancer Risk for Protection of Potable Water - Calculated by dividing the concentration of each PAH in the sample by its SQG_{PW} and summing the results

Screening:

Bold - Indicates an exceedance of CCME guidelines

Red indicates value was below the reportable detection limit and half the RDL was used for the calculation.

References:

Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Soil Quality Guidelines (CEQG), Last Accessed October 2008 - Commercial land use, coarse textured soil

TABLE D6: Volatile Organics in Soil Results
Sand Point Kurdistan Oily Waste Disposal Site

	Maxxam ID		Guideline[1]	IA9918	IA9925
	Sample ID			SPA10-TP05	SPA10-TP18
	Date Sampled			1-Dec-10	1-Dec-10
PARAMETER	***UNITS***	***EQL*** [2]			
VOC's					
CHLOROBENZENES					
1,2-Dichlorobenzene	ug/kg	30	10000*	<30	<30
1,3-Dichlorobenzene	ug/kg	30	10000*	<30	<30
1,4-Dichlorobenzene	ug/kg	30	10000*	<30	<30
Chlorobenzene	ug/kg	30	10000*	<30	<30
VOLATILES					
1,1,1-Trichloroethane	ug/kg	30	50000*	<30	<30
1,1,2,2-Tetrachloroethane	ug/kg	30	50000*	<30	<30
1,1,2-Trichloroethane	ug/kg	30	50000*	<30	<30
1,1-Dichloroethane	ug/kg	30	50000*	<30	<30
1,1-Dichloroethylene	ug/kg	30	50000*	<30	<30
1,2-Dichloroethane	ug/kg	30	50000*	<30	<30
1,2-Dichloropropane	ug/kg	30	50000*	<30	<30
Benzene	ug/kg	0.003	5000	<30	<30
Bromodichloromethane	ug/kg	30	NG	<30	<30
Bromoform	ug/kg	30	NG	<30	<30
Bromomethane	ug/kg	200	NG		
Carbon Tetrachloride	ug/kg	30	50000*	<30	<30
Chloroethane	ug/kg	200	NG		
Chloroform	ug/kg	30	50000*	<30	<30
Chloromethane	ug/kg	30	NG	<30	<30
cis-1,2-Dichloroethylene	ug/kg	30		<30	<30
cis-1,3-Dichloropropene	ug/kg	30	50000*	<30	<30
Dibromochloromethane	ug/kg	30	NG	<30	<30
Ethylbenzene	ug/kg	0.01	20000	<30	<30
Ethylene Dibromide	ug/kg	30		<30	<30
Methylene Chloride(Dichloromethane)	ug/kg	30	50000*	<30	<30
o-Xylene	ug/kg	30	20000	40	<30
p+m-Xylene	ug/kg	30	20000	<30	<30
Styrene	ug/kg	30	50000*	<30	<30
Tetrachloroethylene	ug/kg	30	600	<30	<30
Toluene	ug/kg	0.03	800	<30	<30
trans-1,2-Dichloroethylene	ug/kg	30	50000*	<30	<30
trans-1,3-Dichloropropene	ug/kg	30	50000*	<30	<30
Trichloroethylene	ug/kg	30	31000	<30	<30
Trichlorofluoromethane (FREON 11)	ug/kg	30	NG	<30	<30
Vinyl Chloride	ug/kg	30	NG	<30	<30

NOTES:

Samples analyzed at Maxxam Analytics Inc. - CAEAL accredited
EPA 8260 Analytical Methodology followed

[1] - CCME Canadian Environmental Quality Guidelines for Soils on Industrial Properties (2006 Update).
[2] - Estimated Quantitation Limit
*** - see narrative with guideline regarding use and origin of guideline**
Equals or Exceeds Guidelines

exp Services Inc.
301 Alexandra Street
Sydney, Nova Scotia, B1S 2E8
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Fax: 902-564-5660

BORING NUMBER SP10-TP01

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Located just off the road to the south, ground surface was flat, test pit oriented north to south.		ORGANICS: Rootmat, trace sand, loose, moist, brown 0.15
				FILL: Sand and Gravel (rounded beach stone), loose, moist, moderate brown 0.36
0.5		No oily waste was encountered.		FILL: Sand and Gravel (angular), loose, moist to wet, grey
1.0		Water inflow at the base of the pit.		
				1.19

Test pit terminated at 1.19 metres depth on Bedrock or Boulder refusal. Test pit was backfilled.
Bottom of borehole at 1.19 meters.

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BORING NUMBER SP10-TP02

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Ground surface was flat, test pit oriented north to south, moss cover.		0.10 ORGANICS: Rootmat, trace sand, loose, moist, brown
				FILL: Sand and Gravel (rounded), trace boulders (rounded), loose, moist, moderate brown
0.5		SA#1 Collected, trace "oil" but no odour.		
				0.61 FILL: Sand and Gravel (angular and flat), loose, moist, grey, no odour
1.0				1.07
		Water inflow at 1.17 metres depth. Water inflow at 1.52 metres depth with LNAPL sheen.		TILL: Silty Sand, trace gravel, compact, moist, moderate brown
1.5				1.52
				Test pit terminated at 1.52 metres depth on Bedrock refusal. Test pit was backfilled. Bottom of borehole at 1.52 meters.

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BORING NUMBER SP10-TP03

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Three trees were moved, ground surface was moss covered, ground surface was flat, test pit oriented north to south. No oily waste was encountered.		ORGANICS: Top soil, rootlets, loose, moist, black
				0.20
0.5		Water inflow from east at 0.81 metres depth.		TILL: Silty Sand, some gravel, trace cobble, compact, moist, moderate brown
				0.81

Test pit was terminated at 0.81 metres depth in Till. Test pit was backfilled.
Bottom of borehole at 0.81 meters.

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BORING NUMBER SP10-TP04

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Located 6 to 9 metres south of road near existing cut line, ground surface was flat, test pit oriented north to south. Some beach gravels in test pit along north face from 0 to 0.25 metres. No water was encountered. No oily waste was encountered.		ORGANICS: Topsoil, rootlets, loose, moist, black
				0.20
				TILL: Silty Sand, trace cobble and gravel, compact, moist, reddish brown
0.5				
				0.71
				Test pit terminated at 0.71 metres depth in Till. Test pit was backfilled Bottom of borehole at 0.71 meters.

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BORING NUMBER SP10-TP05

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Small clearing north of road, grass and tree cover. Ground surface was flat. Test pit oriented north to south.		0.08 ORGANICS: Rootmat, moss
				FILL: Reworked till, silty Sand, trace gravel, loose, moist, moderate brown
				0.41
0.5				FILL: Sand and Gravel, loose, moist, moderate brown
		Strong hydrocarbon odour coming from pit during excavation. Oily waste, Hydrocarbon odour, tar like, not asphalt like, encountered at 0.41 to 1.98 metres depth.		
1.0				
1.5		Sample was taken for VOC testing.		
				1.98
2.0		Water encountered at 1.98 metres depth, LNAPL sheen on the water.		TILL: Silty Sand, trace gravel and cobble, loose to compact, moderate brown
2.5				2.54
				Test pit terminated at 2.54 metres depth in Till. Test pit was backfilled. Bottom of borehole at 2.54 meters.

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BORING NUMBER SP10-TP06

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Located just north of roadway. Ground surface was flat, test pit oriented north to south.		FILL: Silty Sand, trace rootlets and gravels, loose to compact, moist moderate brown
				0.20
				FILL: Sand and Gravel, some cobble, from 1.40 to 1.55 metres mostly gravels and cobble, loose, moist, brown and black
0.5		Oily waste encountered between 0.20 and 1.55 meters depth. Tar like.		
1.0		Sample was taken at 1.02 metres depth.		
1.5				1.55
		Water encountered at 1.55 metres depth, LNAPL sheen.		TILL: Silty Sand, trace gravel, compact, moist, moderate brown
				1.91
				Test pit terminated at 1.91 metres depth in Till. Test pit was backfilled. Bottom of borehole at 1.91 meters.

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BORING NUMBER SP10-TP07

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Ground surface was flat, moss and grass cover, test pit oriented north to south.		FILL: Silty Sand and Gravel, compact, moist, moderate brown
				0.28
				FILL: Sand and Gravel (rounded beach stone), loose, moist, dusky brown
0.5		No oily waste was encountered.		
		No water was encountered.		
				0.97
1.0				TILL: Silty Sand, some gravel, compact, moist, reddish brown.
				1.14
				Test pit terminated at 1.14 metres depth in Till. Test pit was backfilled. Bottom of borehole at 1.14 meters.

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BORING NUMBER SP10-TP08

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Ground surface was flat, moss and grass cover, test pit oriented north to south.		ORGANICS: Rootmat, trace sand, loose, moist, brown
				0.15 FILL: Sand, some silt and gravel, yellowish brown, loose to compact, moist
0.5				
				0.66 TILL: Silty Sand, trace gravel and cobble, compact to dense, moist, moderate to reddish brown
1.0		No oily waste was encountered.		
1.5				
		No water was encountered.		1.70 Test pit terminated at 1.70 metres depth in Till. Test pit was backfilled. Bottom of borehole at 1.71 meters.

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BORING NUMBER SP10-TP09

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Located north of the slope, ground surface was flat, test pit oriented north to south.		ORGANICS: Topsoil, rootmat, loose, moist, brown
			0.15	FILL: Sandy Silt, some debris (glass, garbage bags), loose, mosit, moderate brown, some grey mottling
		No oily waste was encountered.		
0.5				
		No hydrocarbon odour. Sample was collected at 0.76 metres depth.		
		No water was encountered.	0.91	Test pit terminated at 0.91 metres depth on Bedrock refusal. Test pit was backfilled. Bottom of borehole at 0.91 meters.

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BORING NUMBER SP10-TP10

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Ground surface was flat, test pit oriented north to south. No oily waste was encountered.		ORGANICS: Rootmat, topsoil, loose, moist, moderate brown
			0.15	TILL: Silty Sand, trace gravel, compact, moist, yellowish brown
0.5		No water was encountered.		
			0.71	Test pit terminated at 0.71 metres depth on Bedrock refusal. Test pit was backfilled. Bottom of borehole at 0.71 meters.

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BORING NUMBER SP10-TP11

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Ground surface was flat, located west of slope, test pit oriented north to south.		ORGANICS: Topsoil, rootmat, loose, moist, brown 0.15
				FILL: Silty Sand, some as cover, compact, moist, moderate brown
0.5		No oily waste was encountered.		
				0.97
1.0				TILL: Silty, Sand, some gravel, yellowish brown, compact, moist
		No water was encountered.		
				1.37
				Test pit terminated at 1.37 metres depth on fractured sandstone Bedrock. Test pit was backfilled. Bottom of borehole at 1.37 meters.

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BORING NUMBER SP10-TP12

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Ground surface was flat, located south of road, test pit oriented north to south.		FILL: Reworked till, silty Sand, some gravel, loose, moist, moderate brown
			0.20	
		Oily waste was encountered, pockets of tar gravel to north and west.	0.30	FILL: Sand and Gravel (rounded), trace tar, loose, moist, dusky brown, grey
0.5		Sample collected at 0.69 metres depth.		TILL: Silty Sand, some gravel, loose, moist, moderate brown
1.0		No water was encountered.		
			1.17	

Test pit terminated at 1.17 metres depth on Bedrock refusal. Test pit was backfilled.
Bottom of borehole at 1.17 meters.

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BORING NUMBER SP10-TP13

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Ground surface was flat, test pit oriented north to south, moss cover.		0.10 ORGANICS: Rootmat, sand and gravel, loose, moist, black
				FILL: Sand and Gravel, thinning out towards south, trace oily waste rock, loose, moist, dusky brown
				0.30 TILL: Silty Sand, some gravel, loose, moist, moderate brown
0.5		Trace pocket of waste oil on Northeast corner.		
1.0		No water was encountered.		
				1.32 Test pit terminated at 1.32 metres depth in Till. Test pit was backfilled. Bottom of borehole at 1.32 meters.

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BORING NUMBER SP10-TP14

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Ground surface was uneven, test pit oriented north to south.		FILL: Silty Sand, trace rootlets, loose, moist, brown
			0.15	FILL: Sand and Gravel, loose, moist, dusky brown
			0.30	FILL: Reworked till, silty Sand, trace gravel and cobble, some roots, loose, wet moderate brown
0.5				
1.0				
1.5		Water inflow at 1.52 metres depth.	1.52	TILL: Silty Sand, some gravel, loose to compact, moist, reddish brown
			1.63	Test pit terminated at 1.63 metres depth in Till. Test pit was backfilled. Bottom of borehole at 1.63 meters.

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BORING NUMBER SP10-TP15

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Moved east of clearing as wasterock was at surface, dense spruce tree cover. Knocked down several trees to get across.Ground surface was flat, test pit oriented north to south. Sample was collected between 0.41 and 0.91 metres depth. No water was encountered.		0.08 ORGANICS: Spruce needles, loose, moist, red
				TILL: Reworked till, silty Sand, some debris (car parts, bottles, steel), loose, moist, yellowish brown
				0.41
0.5				FILL: Sand and Gravel, loose, moist, dusky brown
				0.91
1.0				TILL: Reworked till, silty sand, trace debris, compact, moist, yellowish brown, iron stains throughout.
				1.17
				Test pit terminated at 1.17 metres depth on Bedrock refusal. Test pit was backfilled. Bottom of borehole at 1.17 meters.

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BORING NUMBER SP10-TP16

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Ground surface sloping north, area overgrown by spruce, knocked down several trees to gain access. Test pit oriented east to west. No till was encountered.		ORGANICS: Rootmat, topsoil, loose, moist, brown
0.18				FILL: Sand and Gravel (rounded), loose, moist, dusky brown
0.5				
1.0		No water was encountered.		
1.5				
1.73				Test pit terminated at 1.73 metres depth on Bedrock refusal. Test pit was backfilled. Bottom of borehole at 1.73 meters.

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BORING NUMBER SP10-TP17

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG		MATERIAL DESCRIPTION
		Ground surface was uneven and sloping north, test pit located 6 metres north of TP16. Test pit oriented east to west.		0.08	ORGANICS: Spruce needles, rootlets, loose, moist, red
					FILL: Reworked till, silty Sand, trace gravel, loose, moist, moderate brown
0.5		No oily waste was encountered.		0.51	
		No water was encountered.			TILL: Silty Sand, some gravel and cobbles, compact, moist, moderate brown
				0.81	
					Test pit terminated at 0.81 metres depth on Bedrock (sandstone) refusal. Test pit was backfilled. Bottom of borehole at 0.81 meters.

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BORING NUMBER SP10-TP18

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Middle of disposal site, ground surface sloped northeast to southwest, test pit oriented east to west, moss cover.		FILL: Reworked till, rootlets, loose, moist, brown
0.15				GRAVEL: Gravel (rounded), trace sand, loose, moist, grey
0.5		Water level was at 1.22 metres depth 2 full bags (clear plastic) found at about 1.22 metres depth, hole was caving fast due to water and gravels, depth measured using excavator arm. Hydrocarbon odor throughout, sheen and scum on water, LNAPL, rocks stained.		
1.0				
1.5		Sample was collected for VOC testing.		
2.0				
2.29				Test pit was terminated at 2.29 metres depth due to caving. Test pit was backfilled. Bottom of borehole at 2.29 meters.

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BORING NUMBER SP10-TP19

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Middle of disposal site, test pit oriented east to west, ground surface was flat, spruce tree cover.		ORGANICS: Root mat, Sand and Gravel, loose, moist, brown
				0.25
				FILL: Gravel, some sand (rounded), loose, moist becoming wet, black, trace cobble and boulder
0.5		Hydrocarbon odour, trace debris (big fragments) from 0.25 to 2.18 metres depth.		
1.0				
1.5				
2.0				2.03
				TILL: Silty Sand, trace gravel, loose, wet, moderate brown
		Sample collected from till under waste rock.		2.29
				Test pit was terminated at 2.29 metres depth on Bedrock. Test pit was backfilled.
2.5				
				Bottom of borehole at 2.54 meters.

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BORING NUMBER SP10-TP20

CLIENT Nova Scotia Transportation and Infrastructure Renewal
PROJECT NAME Hydrogeological Investigations
PROJECT NUMBER SYD-00020401-A0
PROJECT LOCATION Sand Point Kurdistan Oily Waste Disposal Site
DATE STARTED 1/12/10 **COMPLETED** 1/12/10
GROUND ELEVATION
DRILLING CONTRACTOR Norvon Construction
GROUND WATER LEVELS:
DRILLING METHOD CAT 311C
AT TIME OF DRILLING ---
LOGGED BY SRS **CHECKED BY** FEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
		Test pit oriented north to south. Ground surface was flat. Test pit located at toe of slope. Oily waste exposed at top of slope. No water was encountered.		ORGANICS: Topsoil, debris, loose, moist, brown
				0.30 FILL: Silt, loose, moist, yellowish brown
				0.46 Test pit was terminated at 0.46 metres depth on Bedrock refusal. Test pit was backfilled. Bottom of borehole at 0.46 meters.