- The summation of fractions F2 and F3 for sediment samples analyzed from thirteen of the twenty-one test pits (TP02-04, TP02-08 to TP02-14, TP02-16, TP02-17, TP02-19 to TP02-21) were less than the total concentration of LEPH and HEPH (the TEH) soil quality objective for the decommissioning of the Polaris Mine. Samples from the remaining eight test pits had TEH concentrations in excess of the Polaris Mine remediation objectives for petroleum hydrocarbons. The results are shown on Figure 5.
- Except for analyzed sediment from TP02-04, TP02-09, TP02-10, TP02-12, TP02-14, TP02-19 and TP02-21 (seven of 21 test pits), analyzed samples from the test pits contained concentrations of fractions F2 and F3 greater than the PHC CWS Parkland land use guidelines for soil.
- Of the six samples of sediment that were analyzed for BETX and styrene, only one sample (from TP02-01) contained concentrations of BETX constituents greater than the CEQG Parkland land use soil quality guidelines. Concentrations of BETX in five of the analyzed samples were at or below the analytical detection limits. Sediment guidelines for BETX constituents and styrene have not been established under the CEQG.
- Of the six samples of sediment that were analyzed for fraction F1, one sample (from TP02-01) contained a concentration of fraction F1 constituents that exceeded the PHC CWS Parkland land use guideline for soil less than 10 m from a surface water body. Concentrations of fraction F1 constituents in the other five analyzed samples were not detected.
- Low concentrations of fraction F4 were detected in all analyzed samples of sediment. Concentrations of fraction F4 were less than the PHC CWS Parkland land use guideline.
- Sediment samples from TP02-01, TP02-17, TP02-19 and TP02-20 contained concentrations of some PAH parameters greater than the CEQG marine sediment quality guidelines as shown on Figure 5. Sediment samples from the remaining test pits that were analyzed for PAH parameters did not contain concentrations of PAHs that exceeded the marine sediment quality guidelines. Analyzed samples from TP02-01 and TP02-20 contained fluorene that exceeded the interim sediment quality guideline (ISQG) (0.0212 mg/kg). Samples from TP02-01 and TP02-17 contained concentrations of naphthalene greater than the ISQG (0.0346 mg/kg). Samples from TP02-01 and TP02-20 contained phenanthrene that exceeded the ISQG (0.0867 mg/kg); and samples from TP02-01, TP02-19 and TP02-20 contained 2-methylnaphthalene that exceeded the ISQG (0.0202 mg/kg). The QA/QC results presented in Appendix D indicate that the results of the naphthalene and 2-methylnaphthalene analyses should be interpreted with caution.
- The character of the gas chromatographs that are provided in the hydrocarbon distribution reports for the analyzed sediment samples (appended to the analytical certificates) are similar and suggest that the chromatographic signature of petroleum hydrocarbons in the analyzed samples is, in general, that of diesel.

### 4.3.4 Groundwater Chemistry

The results of the laboratory analyses of groundwater from accessible wells that were installed by GLL are summarized in Tables 7 and 8. Also shown on these tables, for reference, are the CEQG marine water aquatic life guidelines for surface water quality and the British Columbia non-aqueous phase liquid (NAPL) Indicator standard for groundwater. Copies of the analytical certificates appear in Appendix D.

Groundwater from accessible wells was analyzed for EPH and PAHs. The results of these analyses are summarized as follows:

- Analyzed groundwater from WELL02-3, WELL02-5, WELL02-7, WELL02-9 and WELL02-11 contained a concentration of EPHw10-19 that exceeds 5 mg/L. The highest concentration of EPHw10-19 (69.7 mg/L) was measured in groundwater from WELL02-3. The presence of concentrations of EPHw10-19 in groundwater that exceeds 5 mg/L suggests that LPH is likely present in the analyzed water samples from these wells. Therefore a reliable evaluation of the concentrations of dissolved phase hydrocarbons in samples from these wells cannot be made.
- Groundwater results from wells WELL02-2, WELL02-4, and WELL02-6, installed below the low tide markers, contained concentrations of EPHw10-19 less than 5 mg/L and can therefore be used to make a reliable interpretation of the dissolved hydrocarbon concentrations at these locations. Sample results from all of these wells indicate non-detectable concentrations of the hydrocarbon compounds analyzed.
- The character of the hydrocarbon gas chromatographs scans for the analyzed groundwater samples that were provided by ALS (appended to the analytical certificates) are similar and suggest that the chromatographic signature of petroleum hydrocarbons in the analyzed samples is, in general, that of diesel.

# 5. Discussion

## 5.1 Hydrogeology

Based on general hydrogeological principles, local variations in topography, and observations made during remedial excavations, the direction of groundwater flow from the discharge site is interpreted to be westward, towards Crozier Strait. The subsurface hydrocarbon plume expanded to the north when it reached the road ditch and flowed northward to an existing culvert, as illustrated on Figure 3.

Frozen sediments (permafrost conditions) were encountered in test pits between depths of 0.3 m and 0.9 m. Near-surface groundwater flow within and near the investigated area is likely limited to flow in the non-frozen soil and sediment at its contact with the underlying permafrost.

Because a shallow groundwater flow system exists at or near the intertidal zone, a single seepage face appears to have developed in the intertidal zone. Observations made during the mapping of the intertidal smear zone (Figure 2) indicated a 40 m long seepage face impacted by petroleum hydrocarbons downgradient of the discharge point.

## 5.2 Soil Quality

Following the Spill, soil (and subsurface liquid petroleum hydrocarbons) that was located beneath the surface flow path of the diesel/water mixture was excavated and disposed at a permitted location. The results of the laboratory analysis of the soil sampled to confirm the adequacy of remediation of the Spill area are presented in Table 1. An area approximately 4 metres wide by 40 metres long of potentially impacted soil at the permafrost horizon remains between the West Interceptor Ditch and the intertidal zone.

Based on the observations made during the investigations and documented in this report, there is currently a low potential for spilled diesel/water mixture to cause additional impacts in the investigated intertidal zone. The source of contamination has effectively been removed. Accordingly, there is a low potential for soil and groundwater that is located hydraulically up-gradient from the intertidal zone to act as sources of mobile subsurface contaminants that are capable of impacting the intertidal zone.

## 5.3 Sediment Quality

The results of the laboratory analyses of sediment from the intertidal zone indicate the following:

- Based on the results of the laboratory analyses, the chemical compounds of concern for sediment within the investigated area are BETX, PHC CWS fractions F1 through F3 and PAHs.

- Mappable (i.e. with a lateral dimension of greater than approximately 1.0 m) areas of stained sediment are concentrated within a 40 m stretch of the intertidal zone hydraulically down gradient of the discharge point. These areas comprise a small proportion of the area of investigation.
- Sediment impacted by the Spill is bounded by TP02-04 to the south and the Foldaway Buildings at the old dock to the north.
- Analyzed sediment from most non-stained areas sampled (TP02- 04, TP02-09, TP02-10, TP02-12, TP02-14, TP02-19 and TP02-21) was not impacted with petroleum hydrocarbons. This suggests that sediment impact is primarily, confined to areas of visible surface staining.
- The presence of hydrocarbon impacted sediment above a depth of approximately 0.3 m and non-impacted sediment below a depth of approximately 0.3 m at TP02-13 suggests that the origin of petroleum hydrocarbons at this location (near the north boundary of the West Interceptor Ditch) may be limited to petroleum hydrocarbons originating from floating LPH on the ocean surface.
- The elevated hydrocarbon concentrations in soil at TP02-15 appears to be associated with its location at the culvert outflow.
- North of the culvert (TP02-16, TP02-17, TP02-18, and TP02-20) sediment contamination does not appear to be from groundwater seepage impacted by the Spill. It is most likely from floating LPH on the ocean surface, runoff from the parking area or other sources.
- Based on the distribution of soil contamination at TP02-20, it appears that the source of hydrocarbons at this location was floating LPH on the ocean surface.

If the staining in the "40 m Zone" is due to impacted seeps and the source of the seeps has not been excavated, hydrocarbons may continue to accumulate in this area. Additional remedial action, either in the form of monitoring to address the impact of hydrocarbons in this area or excavation of the impacted sediments, may be required to mitigate the impacted of LPH in this area.

## 5.4 Groundwater Quality

The results of the laboratory analysis of groundwater collected from within the sediments at the intertidal zone suggest that:

- The presence of EPHw10-19 concentrations above 5 mg/L in wells established at the midway point between high and low tide and sampled suggests the localized presence of liquid petroleum hydrocarbons (LPH) in areas of stained sediment. A reliable evaluation of the concentrations of dissolved phase hydrocarbon in groundwater samples from these wells cannot be made.
- The wells established below the low tide markers that were sampled had non-detectable concentrations of the hydrocarbon compounds analyzed indicating the sediment below the low tide contour has not been impacted by LPH.

# 6. Conclusions

Based on the results of the field work and the chemical analyses of soil, sediment and groundwater presented in the preceding sections, the following conclusions have been drawn:

- The area down slope of the discharge point where the release originated has been excavated to remove hydrocarbon impacted soils.
- Based on the findings presented in this report a liquid petroleum hydrocarbon(LPH) impacted zone remains between the down slope boundary of the West Interceptor Ditch and the low tide contour over a length of 40 m.
- The stained soils within the "40 m Zone" are interpreted to originate as a result of subsurface transport of LPH in groundwater along the permafrost table and the subsequent discharge as seeps.
- Additional investigation will be required to assess the impact of the hydrocarbon that remains within the "40 m Zone".
- Excavation of impacted sediments within the "40 m Zone" is not recommended, as this may result in further environmental impairment of this sensitive area due to soil erosion and sedimentation within the aquatic environment. Natural attenuation of the LPH (degradation of the LPH in situ by natural processes) may provide a less disruptive remediation option, but will require ongoing monitoring to confirm its effectiveness.
- Isolated pockets of petroleum impacted sediments are also present to the north within the area designated the "175 m Zone". The source of the isolated pockets may have been petroleum hydrocarbons discharged from the culvert to the ocean during the Spill, with subsequent migration due to shoreline drift of the hydrocarbon impacted water. Additional sources of hydrocarbons within the "175 m Zone" may have originated as runoff from existing or historical operation areas (i.e. the Dock area, the Heavy Equipment Parking Area).

GLL considers Teck Cominco's Spill response measures and follow-up remediation action to be appropriate and sufficient to minimize further environmental impairment that occurred as a result of the Spill. Further work within the "40 m Zone" is required to address potential impacts that remain within this area.

# 7. Limitations

This report was prepared for the exclusive use of Teck Cominco. The report is intended to provide the results of environmental monitoring and other activities as documented in the report, at the subject Site on Little Cornwallis Island, Nunavut. The report, which specifically includes all tables and figures, is based on data and information collected during the investigations conducted by GLL, and is based solely on the conditions of the Site at the time of the investigation, supplemented by historical information and data obtained by GLL, as described in this report.

The monitoring and investigation programs as described in this report, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Except where specifically stated to the contrary, the information contained in this report was provided to GLL by others and has not been independently verified or otherwise examined by GLL to determine its accuracy or completeness. GLL has relied in good faith on this information and does not accept responsibility for any deficiency, mis-statements, or inaccuracies contained in the report as a result of omissions, misinterpretation, fraudulent acts of the persons interviewed or contacted or errors or omissions in the reviewed documentation.

The assessment of environmental conditions and possible hazards at this Site have been made using the results of chemical analysis of soil/sediment and pore water from a limited number of locations. The Site conditions between sampling locations have been inferred based on conditions observed at sampling locations. Subsurface conditions may vary from those encountered at the sample locations. Additional study, including further subsurface investigation, can reduce the inherent uncertainties associated with this type of study. However, it is never possible, even with exhaustive sampling and testing, to dismiss the possibility that part of a site may be contaminated and remain undetected.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibility of such third parties. GLL accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on the information contained in this report.

The content of this report is based on information collected during our investigation, our present understanding of the site conditions, and our professional judgment in light of such information at the time of this report. This report provides a professional opinion and therefore no warranty is either expressed, implied, or made as to the conclusions, advice and recommendations offered in this report. This report does not provide a legal opinion regarding compliance with applicable laws. With respect to regulatory compliance issues, it should be noted that regulatory statutes and the interpretation of regulatory statutes are subject to change.

The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, including excavations, borings, or other studies, GLL should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

We trust that the above information is sufficient for your present requirements. Should you have any questions or require further information, please contact the undersigned.

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# Tables

# Table 1 - Initial Excavation Organic Vapour Concentration Results in Soil

Gartner Lee

| Sample ID | Field screen ppm | Sample ID | Field screen ppm | Sample ID | Field screen ppm |
|---|---|---|---|---|---|
| SS02-01 | 2.1 | SS02-02 | 1.3 | SS02-03 | 12.3 |
| SS02-04 | 2.8 | SS02-05 | 1.7 | SS02-06 | 59.2 |
| SS02-07 | 2.8 | SS02-08 | 28 | SS02-09 | 7.8 |
| SS02-10 | 2.2 | SS02-11 | 2.3 | SS02-12 | 2.3 |
| SS02-13 | 2.2 | SS02-14 | 2.4 | SS02-15 | 2.8 |
| SS02-16 | 2.4 | SS02-17 | 2.6 | SS02-18 | 2.6 |
| SS02-19 | 2.2 | SS02-20 | 7.8 | SS02-21 | 2.3 |
| SS02-22 | 2.6 | SS02-23 | 2.6 | SS02-24 | 1.9 |
| SS02-25 | 2.9 | SS02-26 | 1.9 | SS02-27 | 1.5 |
| SS02-28 | 1.7 | SS02-29 | 2.4 | SS02-30 | 1.4 |
| SS02-31 | 1.3 | SS02-32 | 1.5 | SS02-33 | 1.5 |
| SS02-34 | 2.3 | SS02-35 | 1.4 | SS02-36 | 1.8 |
| SS02-37 | 1.6 | SS02-38 | 1.8 | SS02-39 | 1.3 |
| SS02-40 | 0.1 | SS02-41 | 0.7 | SS02-42 | 1.4 |
| SS02-43 | 37.5 | SS02-44 | 2.1 | SS02-45 | 6.9 |
| SS02-46 | 13.9 | SS02-47 | 12.3 | SS02-48 | 1.4 |
| SS02-49 | 6.7 | SS02-50 | 1 | SS02-51 | 6.6 |
| SS02-52 | 2.3 | SS02-53 | 8 | SS02-54 | 5.5 |
| SS02-55 | No sample | SS02-56 | 7.4 | SS02-57 | 0.9 |
| SS02-58 | 1.6 | SS02-59 | 2.2 | SS02-60 | 43.9 |
| SS02-61 | 11.7 | SS02-62 | 1.2 | SS02-63 | 1.3 |
| SS02-64 | 1.1 | SS02-65 | 1.8 | SS02-66 | 2.7 |
| SS02-67 | 1.4 | SS02-68 | 1 | - | - |
| SS02-122 | 6.2 | SS02-124 | 3.4 | SS02-125 | 8 |

Field screening results are measured based on a 'dry headspace' method

# Table 2 - Final Excavation Organic Vapour Concentration Results in Soil

Gartner Lee

| Sample ID | Field screen ppm | Sample ID | Field screen ppm | Sample ID | Field screen ppm |
|---|---|---|---|---|---|
| SS02-69 | 0.9 | SS02-70 | 0.6 | SS02-71 | 1.7 |
| SS02-72 | 1 | SS02-73 | 0.5 | SS02-74 | 0.5 |
| SS02-75 | 0.8 | SS02-76 | 2.3 | SS02-77 | 2 |
| SS02-78 | 6.7 | SS02-79 | 0.9 | SS02-80 | 0.9 |
| SS02-81 | 9.4 | SS02-82 | 5.8 | SS02-83 | 6.9 |
| SS02-84 | 4.1 | SS02-85 | 18 | SS02-86 | 4.3 |
| SS02-87 | 2 | SS02-88 | 2 | SS02-89 | 2.9 |
| SS02-90 | 0.5 | SS02-91 | 0.6 | SS02-92 | 0.9 |
| SS02-93 | 1.1 | SS02-94 | No sample | SS02-95 | 0.4 |
| SS02-96 | 0.6 | SS02-97 | 0.7 | SS02-98 | 0.5 |
| SS02-99 | 0.5 | SS02-100 | 0.5 | SS02-101 | 0.6 |
| SS02-102 | 0.4 | SS02-103 | 0.4 | SS02-104 | 0.3 |
| SS02-105 | 1.8 | SS02-106 | 0.8 | SS02-107 | 1.3 |
| SS02-108 | 0.6 | SS02-109 | 2.5 | SS02-110 | 0.4 |
| SS02-111 | 1 | SS02-112 | 45 | SS02-113 | 1.5 |
| SS02-114 | 1.2 | SS02-115 | 2.4 | SS02-116 | 7.9 |
| SS02-117 | 5.1 | SS02-118 | 3.4 | SS02-119 | 2.7 |
| SS02-120 | 2.6 | SS02-121 | 16.4 | SS02-123 | 4.5 |
| SS02-126 | 5.2 | SS02-127 | 7.5 | SS02-128 | 4.7 |
| SS02-129 | 89.8 | SS02-130 | 4.1 | SS02-131 | 37.4 |
| SS02-132 | 198 | SS02-133 | 8.1 | SS02-134 | 4.2 |
| SS02-135 | 5.4 | SS02-136 | 4.6 | SS02-137 | 3.7 |
| SS02-138 | 5.2 | SS02-139 | 4.8 | SS02-140 | 4.4 |
| SS02-141 | 4.5 | - | - | - | - |

Field screening results are measured based on a 'dry headspace' method

# Table 3 - Summary of Analytical Results for Hydrocarbons in Soil

Gartner Lee

| | FEDERAL CCME GUIDELINES[a] | | | | POLARIS MINE | Sample ID | A1 | A2 | A3 | A4 | B1 | B2 | B3 | B4 | B5 | B6 | B7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parkland Land Use Guideline | | Industrial Land Use Guideline | | | Sample Interval (m) | 0.1 - 0.2 | 0.1 - 0.2 | 0.1 - 0.2 | 0.1 - 0.2 | 0.1 - 0.2 | 0.1 - 0.2 | 0.1 - 0.2 | 0.1 - 0.2 | 0.1 - 0.2 | 0.1 - 0.2 | 0.1 - 0.2 |
| | | | | | | Date Sampled | 9/6/02 | 9/6/02 | 9/6/02 | 9/6/02 | 9/6/02 | 9/6/02 | 9/6/02 | 9/6/02 | 9/6/02 | 9/6/02 | 9/6/02 |
| | CEQG[b] | PHC CWS[c,d,e] | CEQG[b] | PHC CWS[c,d,e] | Remediation Objectives | Units | Analytical Results | | | | | | | | | | |
| Moisture % | | | | | | % | 6.5 | 2.8 | 15.7 | 2.3 | 2.4 | 2.2 | 5.4 | 2.1 | 17.8 | 5.4 | 4.8 |
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | | | | | |
| Benzene (B) | *5* | | *39* | | - | mg/kg | - | - | <0.04 | - | - | <0.04 | - | - | <0.04 | - | - |
| Fraction 1 (C6-10) | - | - | - | - | - | mg/kg | - | - | <30 | - | - | <30 | - | - | <30 | - | - |
| Fraction 1-BTEX | | *130* | | *330* | - | mg/kg | - | - | <30 | - | - | <30 | - | - | <30 | - | - |
| Ethylbenzene (E) | *1.2* | | *20* | | - | mg/kg | - | - | <0.05 | - | - | <0.05 | - | - | <0.05 | - | - |
| Styrene | - | - | - | - | - | mg/kg | - | - | <0.05 | - | - | <0.05 | - | - | <0.05 | - | - |
| Toluene (T) | *1.4* | | *14* | | - | mg/kg | - | - | <0.05 | - | - | <0.05 | - | - | <0.05 | - | - |
| meta- & para-Xylene | | | | | - | mg/kg | - | - | <0.05 | - | - | <0.05 | - | - | <0.05 | - | - |
| ortho-Xylene | | | | | - | mg/kg | - | - | <0.05 | - | - | <0.05 | - | - | <0.05 | - | - |
| Total Xylene[f] (X) | *1.0* | | *21* | | - | mg/kg | - | - | <0.05 | - | - | <0.05 | - | - | <0.05 | - | - |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | | | | | |
| Fraction 2 (C10-16) | | *450* [g] | | *760* [g] | - | mg/kg | 218 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | 112 | 50 |
| Fraction 2-Napthalene | | *450* | | *760* | - | mg/kg | - | - | - | - | - | - | - | - | - | - | - |
| Fraction 3 (C16-34) | | *400* [g] | | *1700* [g] | - | mg/kg | *1240* | 93 | <50 | 161 | <50 | <50 | 115 | 64 | <50 | 235 | 140 |
| Fraction 3-PAH | | *400* | | *1700* | - | mg/kg | - | - | - | - | - | - | - | - | - | - | - |
| TEH (C10-34)[h] | - | - | - | - | **2000** | mg/kg | 1458 | <143 | <100 | <211 | <100 | <100 | <165 | <114 | <100 | 347 | 190 |
| Fraction 4 (C34-50) | | *2800* | | *3300* | - | mg/kg | 98 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 |

*Associated ALS files: P8989*

| | |
|---|---|
| *italics* | Concentration greater than or equal to CCME Parkland land use Guideline for soil |
| *ITALICS* | Concentration greater than or equal to CCME Industrial land use Guideline for soil |
| **BOLD** | Concentration greater than or equal to Polaris Mine Remediation Objective for soil |

Notes:
< = Less than the detection limit indicated.
- = Analysis not conducted or no guideline.

[a] Canadian Environmental Quality Guidelines (CEQG) and Petroleum Hydrocarbon Canada-Wide Standards (PHC CWS) presented apply to soil.
[b] Guideline is based on the limiting exposure pathway of Protection of Environmental Health
[c] Guideline is dependant upon depth of sample (surface, subsoil >1.5 m depth). Surface soil analyzed.
[d] Guideline is dependent on median grain size of soil analyzed (Fine ≤75 µm, Coarse >75 µm). Median grain size of soil analyzed is >75 µm.
[e] Guideline is based on the site-specific exposure pathway of Ecological Soil Contact
[f] Total Xylene calculated as the sum of meta, para and ortho Xylenes
[g] Use of the guideline requires that PAHs be subtracted from the fraction. Based on the results for soil sample A1 it is assumed that PAHs form a small percentage of the fractions F2 and F3 for the samples not analyzed for PAHs.
[h] Total Extractable Hydrocarbons (TEH) calculated as the sum of Fractions F2 and F3.

# Table 4 - Summary of Analytical Results for Polycyclic Aromatic Hydrocarbons in Soil

Gartner Lee

| | FEDERAL CCME GUIDELINES | | Sample Location | A1 | A3 | B2 | B5 |
|---|---|---|---|---|---|---|---|
| | CEQG[a] | | Sample Interval (m) | 0.1-0.2 | 0.1-0.2 | 0.1-0.2 | 0.1-0.2 |
| | Parkland Land Use[b] | Industrial Land Use[b] | Date Sampled | 9/6/02 | 9/6/02 | 9/6/02 | 9/6/02 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | **Units** | **Analytical Results** | | | |
| Acenaphthene | - | - | mg/kg | <0.02 | <0.005 | <0.005 | <0.005 |
| Acenaphthylene | - | - | mg/kg | <0.01 | <0.005 | <0.005 | <0.005 |
| Anthracene | - | - | mg/kg | <0.02 | <0.01 | <0.01 | <0.01 |
| Benz(a)anthracene | - | - | mg/kg | <0.02 | <0.01 | <0.01 | <0.01 |
| Benzo(a)pyrene | *0.7* | 0.7 | mg/kg | <0.02 | <0.01 | <0.01 | <0.01 |
| Benzo(b)fluoranthene | - | - | mg/kg | <0.03 | <0.01 | <0.01 | <0.01 |
| Benzo(g,h,i)perylene | - | - | mg/kg | <0.02 | <0.01 | <0.01 | <0.01 |
| Benzo(k)fluoranthene | - | - | mg/kg | <0.02 | <0.01 | <0.01 | <0.01 |
| Chrysene | - | - | mg/kg | <0.02 | <0.01 | <0.01 | <0.01 |
| Dibenz(a,h)anthracene | | - | mg/kg | <0.01 | <0.005 | <0.005 | <0.005 |
| Fluoranthene | - | - | mg/kg | <0.02 | <0.01 | <0.01 | <0.01 |
| Fluorene | - | - | mg/kg | 0.05 | <0.01 | <0.01 | <0.01 |
| Indeno(1,2,3-c,d)pyrene | - | - | mg/kg | <0.02 | <0.01 | <0.01 | <0.01 |
| Naphthalene | *0.6* | 22 | mg/kg | <0.05 | <0.01 | <0.01 | <0.01 |
| Phenanthrene | - | | mg/kg | 0.09 | <0.01 | <0.01 | <0.01 |
| Pyrene | - | - | mg/kg | <0.02 | <0.01 | <0.01 | <0.01 |
| 2-Methylnaphthalene | - | - | mg/kg | 0.18 | <0.01 | <0.01 | <0.01 |

*Associated ALS files: P8989*

| | |
|---|---|
| *ITALICS* | Concentration greater than or equal to CEQG Guideline for Parkland land use |
| **BOLD** | Concentration greater than or equal to CEQG Guideline for Industrial land Use |

Notes:
< = Less than the detection limit indicated.
- = Analysis not conducted or no guideline.

[a] CEQG - Canadian Environmental Quality Guidelines

[b] Guideline is based on the limiting exposure pathway of Protection of Environmental Health

# Table 5 - Summary of Analytical Results for Hydrocarbons in Sediment

Gartner Lee

| | FEDERAL CCME GUIDELINES[a] | | POLARIS MINE | Sample Location | TP02-01 | | | | | | TP02-02 | | | TP02-03 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | TP02-01-1 | TP01-11-1 | TP02-01-2 | TP01-11-2 | TP01-01-3 | TP01-11-3 | TP01-02-1 | TP01-02-2 | TP01-02-3 | TP01-03-1 | TP01-03-2 |
| | Parkland Land Use Guideline | | | Sample Interval (m) | 0.0-0.15 | 0.0-0.15 | 0.15-0.50 | 0.15-0.50 | 0.50-0.60 | 0.50-0.60 | 0.0-0.20 | 0.20-0.55 | 0.55-0.65 | 0.0-0.15 | 0.15-0.35 |
| | | | | Date Sampled | 7/9/2002 | duplicate sample | 7/9/2002 | duplicate sample | 7/9/2002 | duplicate sample | 7/9/2002 | 7/9/2002 | 7/9/2002 | 7/9/2002 | 7/9/2002 |
| | CEQG[b] | PHC CWS[c,d,e] | Remediation Objectives | Median Grain Size | coarse | of | coarse | of | coarse | of | coarse | coarse | coarse | coarse | coarse |
| | | | | Field Screen (ppm)[f] | 685 | TP02-01-1 | 594 | TP01-01-2 | 535 | TP01-01-3 | 539 | 516 | 360 | 441 | 480 |
| | | | | Units | Analytical Results | | | | | | | | | | |
| Moisture % | | | | % | 5.8 | 5.9 | 4.8 | 5.3 | 11 | 10 | 4.9 | - | 10.8 | 4.1 | 6.1 |
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | | | |
| Benzene (B) | *0.5* | | - | mg/kg | <0.04 | - | - | - | - | - | - | - | - | - | - |
| Fraction 1 (C6-10) | | | | mg/kg | *566* | - | - | - | - | - | - | - | - | - | - |
| Fraction 1-BTEX | | *130* (coarse) | - | mg/kg | *546* | - | - | - | - | - | - | - | - | - | - |
| Ethylbenzene (E) | *1.2* | | - | mg/kg | *2.61* | - | - | - | - | - | - | - | - | - | - |
| Styrene | | | - | mg/kg | <0.05 | - | - | - | - | | - | - | - | - | |
| Toluene (T) | *1.4* | | - | mg/kg | 1.24 | - | - | - | - | - | - | - | - | - | - |
| meta- & para-Xylene | | | - | mg/kg | *9.95* | - | - | - | - | - | - | - | - | - | - |
| ortho-Xylene | | | - | mg/kg | *5.95* | - | - | - | - | - | - | - | - | - | - |
| Total Xylene[g] (X) | *1.0* | | - | mg/kg | *15.9* | | | | | | | | | | |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | | | |
| Fraction 2 (C10-16) | | **150** (coarse)[h] | | mg/kg | *9270* | *8420* | *3710* | *3820* | *3580* | *3460* | *3010* | - | *721* | *1670* | *3040* |
| Fraction 2-Napthalene | | **150** (coarse) | - | mg/kg | *9250* | - | - | - | - | - | - | - | - | - | - |
| Fraction 3 (C16-34) | | **400** (coarse)[h] | | mg/kg | *2950* | *2730* | *1200* | *1280* | *1280* | *1210* | *1570* | - | *834* | *1110* | *1060* |
| Fraction 3-PAH | | **400** (coarse) | - | mg/kg | *2950* | - | - | - | - | - | - | - | - | - | - |
| TEH (C10-34)[i] | - | - | **2000** | mg/kg | **12220** | **11150** | **4910** | **5100** | **4860** | **4670** | **4580** | - | **1555** | **2780** | **4100** |
| Fraction 4 (C34-50) | | **2800** (coarse) | - | mg/kg | 87 | 96 | 98 | 88 | 94 | 79 | 75 | - | 126 | 80 | 61 |

*Associated ALS files: P6911, P7047*

| | |
|---|---|
| *italics* | Concentration in sediment greater than or equal to CCME Parkland land use guideline for soil |
| **BOLD** | Concentration in sediment greater than or equal to Polaris Mine Remediation Objective for soil |

Notes:
< = Less than the detection limit indicated.
- = Analysis not conducted or no guideline.

[a] Canadian Environmental Quality Guidelines (CEQG) and Petroleum Hydrocarbon Canada-Wide Standard (PHC CWS) presented apply to soil. No equivalent sediment quality guidelines have been developed.
[b] Guideline is based on the limiting exposure pathway of Protection of Environmental Health
[c] Guideline is dependant upon depth of sample (surface, subsoil >1.5 m depth). Surface soil analyzed.
[d] Guideline is dependent on median grain size of soil analyzed (Fine ≤75 µm, Coarse >75 µm). Median grain size of soil analyzed is >75 µm.
[e] Guideline is based on the more stringent site-specific exposure pathway of those for the Protection of Groundwater for Aquatic Life and Ecological Soil Contact
[f] Field screening results are measured based on a 'dry headspace' method.
[g] Total Xylene calculated as the sum of meta, para and ortho Xylenes
[h] Use of the guideline requires that PAHs be subtracted from the fraction. Based on the results for soil sample A1 it is assumed that PAHs form a small percentage of the fractions F2 and F3 for the samples not analyzed for PAHs.
[i] Total Extractable Hydrocarbons (TEH) calculated as the sum of Fractions F2 and F3.

## Table 5 - Summary of Analytical Results for Hydrocarbons in Sediment

Gartner Lee

| | FEDERAL CCME GUIDELINES[a] | | POLARIS MINE | Sample Location | TP02-04 | TP02-05 | TP02-06 | | TP02-07 | | TP02-08 | TP02-09 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | TP02-04-1 | TP02-05-1 | TP02-06-1 | TP02-06-2 | TP02-07-1 | TP02-07-2 | TP02-08-1 | TP02-09-1 | TP02-09-2 |
| | Parkland Land Use Guideline | | | Sample Interval (m) | 0.0-0.45 | 0.0-0.35 | 0.0-0.1 | 0.1-0.30 | 0.0-0.15 | 0.15-0.65 | 0.0-0.6 | 0.0-0.15 | 0.15-0.55 |
| | | | | Date Sampled | 7/10/2002 | 7/10/2002 | 7/10/2002 | 7/10/2002 | 7/10/2002 | 7/10/2002 | 7/10/2002 | 7/10/2002 | 7/10/2002 |
| | CEQG[b] | PHC CWS[c,d,e] | Remediation Objectives | Median Grain Size | coarse | coarse | coarse | coarse | coarse | coarse | coarse | coarse | coarse |
| | | | | Field Screen (ppm)[f] | 2.3 | 381 | 539 | 334 | 481 | 362 | 94.2 | 2.5 | 3.5 |
| | | | | Units | Analytical Results | | | | | | | | |
| Moisture % | | | | % | 4.7 | 5.1 | 5 | - | 4.2 | - | 5.2 | - | 6.6 |
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | |
| Benzene (B) | *0.5* | | - | mg/kg | <0.04 | - | - | - | - | - | - | - | <0.04 |
| Fraction 1 (C6-10) | | | | mg/kg | <30 | - | - | - | - | - | - | - | <30 |
| Fraction 1-BTEX | | *130* (coarse) | - | mg/kg | <30 | - | - | - | - | - | - | - | <30 |
| Ethylbenzene (E) | *1.2* | | - | mg/kg | <0.05 | - | - | - | - | - | - | - | <0.05 |
| Styrene | | | - | mg/kg | <0.05 | - | - | - | - | - | - | - | <0.05 |
| Toluene (T) | *1.4* | | - | mg/kg | <0.05 | - | - | - | - | - | - | - | <0.05 |
| meta- & para-Xylene | | | - | mg/kg | <0.05 | - | - | - | - | - | - | - | <0.05 |
| ortho-Xylene | | | - | mg/kg | <0.05 | - | - | - | - | - | - | - | <0.05 |
| Total Xylene[g] (X) | *1.0* | | - | mg/kg | <0.1 | | | | | | | | <0.1 |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | |
| Fraction 2 (C10-16) | | **150** (coarse)[h] | | mg/kg | <50 | *1960* | *4700* | - | *6350* | - | *338* | - | <50 |
| Fraction 2-Napthalene | | **150** (coarse) | - | mg/kg | <50 | - | - | - | - | - | - | - | <50 |
| Fraction 3 (C16-34) | | **400** (coarse)[h] | | mg/kg | 137 | *909* | *1770* | - | *2380* | - | 275 | - | 201 |
| Fraction 3-PAH | | **400** (coarse) | - | mg/kg | 137 | - | - | - | - | - | - | - | 201 |
| TEH (C10-34)[i] | - | - | **2000** | mg/kg | <187 | **2869** | **6470** | - | **8730** | - | 613 | - | <251 |
| Fraction 4 (C34-50) | | **2800** (coarse) | - | mg/kg | 66 | 90 | 75 | - | 72 | - | 72 | - | 93 |

*Associated ALS files: P6911, P7047*

| | |
|---|---|
| *italics* | Concentration in sediment greater than or equal to CCME Parkland land use guideline for soil |
| **BOLD** | Concentration in sediment greater than or equal to Polaris Mine Remediation Objective for soil |

Notes:
< = Less than the detection limit indicated.
- = Analysis not conducted or no guideline.

[a] Canadian Environmental Quality Guidelines (CEQG) and Petroleum Hydrocarbon Canada-Wide Standard (PHC CWS) presented apply to soil. No equivalent sediment quality guidelines have been developed.
[b] Guideline is based on the limiting exposure pathway of Protection of Environmental Health
[c] Guideline is dependant upon depth of sample (surface, subsoil >1.5 m depth). Surface soil analyzed.
[d] Guideline is dependent on median grain size of soil analyzed (Fine ≤75 µm, Coarse >75 µm). Median grain size of soil analyzed is >75 µm.
[e] Guideline is based on the more stringent site-specific exposure pathway of those for the Protection of Groundwater for Aquatic Life and Ecological Soil Contact
[f] Field screening results are measured based on a 'dry headspace' method.
[g] Total Xylene calculated as the sum of meta, para and ortho Xylenes
[h] Use of the guideline requires that PAHs be subtracted from the fraction. Based on the results for soil sample A1 it is assumed that PAHs form a small percentage of the fractions F2 and F3 for the samples not analyzed for PAHs.
[i] Total Extractable Hydrocarbons (TEH) calculated as the sum of Fractions F2 and F3.

# Table 5 - Summary of Analytical Results for Hydrocarbons in Sediment

Gartner Lee

| | FEDERAL CCME GUIDELINES[a] | | POLARIS MINE | Sample Location | TP02-10 | TP02-11 | | TP02-12 | TP02-13 | | TP02-14 | TP02-15 | TP02-16 | TP02-17 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | TP02-10-1 | TP02-11-1R | TP02-11-2R | TP02-12-1 | TP02-13-1 | TP02-13-2 | TP02-14-1 | TP02-15-1 | TP02-16-1 | TP02-17-1 | TP02-17-2 |
| | Parkland Land Use Guideline | | | Sample Interval (m) | 0.0-0.55 | 0.0-0.20 | 0.20-0.55 | 0.0-0.5 | 0.0-0.3 | 0.3-0.45 | 0.0-0.3 | 0.0-0.4 | 0.0-0.3 | 0.0-0.4 | 0.4-0.9 |
| | | | | Date Sampled | 7/10/2002 | 7/10/2002 | 7/10/2002 | 7/11/2002 | 7/11/2002 | 7/11/2002 | 7/11/2002 | 7/11/2002 | 7/11/2002 | 7/11/2002 | 7/11/2002 |
| | CEQG[b] | PHC CWS[c,d,e] | Remediation Objectives | Median Grain Size | coarse | coarse | coarse | coarse | coarse | coarse | coarse | coarse | coarse | coarse | coarse |
| | | | | Field Screen (ppm)[f] | 21 | 38.8 | 174 | 4.9 | 63.9 | 9.3 | 7.9 | 163 | 8.7 | 68.2 | 9.2 |
| | | | | Units | Analytical Results | | | | | | | | | | |
| Moisture % | | | | % | 18.2 | 17.1 | 8.5 | 5.1 | 4 | 6.5 | 7.8 | 14.3 | 7 | 5.9 | 16.2 |
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | | | |
| Benzene (B) | *0.5* | | - | mg/kg | - | - | - | - | - | - | - | - | - | - | <0.04 |
| Fraction 1 (C6-10) | | | | mg/kg | - | - | - | - | - | - | - | - | - | - | <30 |
| Fraction 1-BTEX | | *130* (coarse) | - | mg/kg | - | - | - | - | - | - | - | - | - | - | <30 |
| Ethylbenzene (E) | *1.2* | | - | mg/kg | - | - | - | - | - | - | - | - | - | - | <0.05 |
| Styrene | | | - | mg/kg | - | - | - | - | - | - | - | - | - | - | <0.05 |
| Toluene (T) | *1.4* | | - | mg/kg | - | - | - | - | - | - | - | - | - | - | <0.05 |
| meta- & para-Xylene | | | - | mg/kg | - | - | - | - | - | - | - | - | - | - | <0.05 |
| ortho-Xylene | | | - | mg/kg | - | - | - | - | - | - | - | - | - | - | <0.05 |
| Total Xylene[g] (X) | *1.0* | | - | mg/kg | | | | | | | | | | | <0.1 |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | | | |
| Fraction 2 (C10-16) | | **150** (coarse)[h] | | mg/kg | 53 | *877* | *723* | <50 | *410* | <50 | 65 | *3890* | *312* | *966* | 78 |
| Fraction 2-Napthalene | | **150** (coarse) | - | mg/kg | - | - | - | - | - | - | - | - | - | - | 78 |
| Fraction 3 (C16-34) | | **400** (coarse)[h] | | mg/kg | 223 | *423* | *434* | 136 | 371 | 136 | 138 | *1530* | 242 | *642* | 98 |
| Fraction 3-PAH | | **400** (coarse) | - | mg/kg | - | - | - | - | - | - | - | - | - | - | 98 |
| TEH (C10-34)[i] | - | - | **2000** | mg/kg | 276 | 1300 | 1157 | <186 | 781 | <186 | 203 | **5420** | 554 | 1608 | 176 |
| Fraction 4 (C34-50) | | **2800** (coarse) | - | mg/kg | 84 | <50 | 84 | 50 | 60 | 54 | <50 | 78 | <50 | 80 | <50 |

*Associated ALS files: P6911, P7047*

| | |
|---|---|
| *italics* | Concentration in sediment greater than or equal to CCME Parkland land use guideline for soil |
| **BOLD** | Concentration in sediment greater than or equal to Polaris Mine Remediation Objective for soil |

Notes:
< = Less than the detection limit indicated.
- = Analysis not conducted or no guideline.

[a] Canadian Environmental Quality Guidelines (CEQG) and Petroleum Hydrocarbon Canada-Wide Standard (PHC CWS) presented apply to soil. No equivalent sediment quality guidelines have been developed.
[b] Guideline is based on the limiting exposure pathway of Protection of Environmental Health
[c] Guideline is dependant upon depth of sample (surface, subsoil >1.5 m depth). Surface soil analyzed.
[d] Guideline is dependent on median grain size of soil analyzed (Fine ≤75 µm, Coarse >75 µm). Median grain size of soil analyzed is >75 µm.
[e] Guideline is based on the more stringent site-specific exposure pathway of those for the Protection of Groundwater for Aquatic Life and Ecological Soil Contact
[f] Field screening results are measured based on a 'dry headspace' method.
[g] Total Xylene calculated as the sum of meta, para and ortho Xylenes
[h] Use of the guideline requires that PAHs be subtracted from the fraction. Based on the results for soil sample A1 it is assumed that PAHs form a small percentage of the fractions F2 and F3 for the samples not analyzed for PAHs.
[i] Total Extractable Hydrocarbons (TEH) calculated as the sum of Fractions F2 and F3.

## Table 5 - Summary of Analytical Results for Hydrocarbons in Sediment

Gartner Lee

| | FEDERAL CCME GUIDELINES[a] | | POLARIS MINE | Sample Location | TP02-18 | | TP02-19 | TP02-20 | | TP02-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sample ID | TP02-18-1 | TP02-18-2 | TP02-19-1 | TP02-20-1 | TP02-20-2 | TP02-21-1 | TP02-22-1 |
| | Parkland Land Use Guideline | | | Sample Interval (m) | 0.4-0.4 | 0.4-0.8 | 0.0-0.5 | 0.0-0.4 | 0.4-0.6 | 0.0-0.4 | 0.0-0.4 |
| | | | | Date Sampled | 7/11/2002 | 7/11/2002 | 7/12/2002 | 7/12/2002 | 7/12/2002 | 7/12/2002 | duplicate sample |
| | CEQG[b] | PHC CWS[c,d,e] | Remediation Objectives | Median Grain Size | coarse | coarse | coarse | coarse | coarse | coarse | of |
| | | | | Field Screen (ppm)[f] | 42.3 | 17.4 | 2.5 | 16.2 | 2.3 | 0.9 | TP02-21-1 |
| | | | | Units | Analytical Results | | | | | | |
| Moisture % | | | | % | 4.3 | 5.5 | 6.4 | 7.9 | 19 | 5.4 | 5.2 |
| **Non-Halogenated Volatiles** | | | | | | | | | | | |
| Benzene (B) | *0.5* | | - | mg/kg | - | - | - | - | <0.04 | <0.04 | - |
| Fraction 1 (C6-10) | | | | mg/kg | - | - | - | - | <30 | <30 | - |
| Fraction 1-BTEX | | *130* (coarse) | - | mg/kg | - | - | - | - | <30 | <30 | - |
| Ethylbenzene (E) | *1.2* | | - | mg/kg | - | - | - | - | 0.05 | <0.05 | - |
| Styrene | | | - | mg/kg | - | - | - | - | <0.05 | <0.05 | - |
| Toluene (T) | *1.4* | | - | mg/kg | - | - | - | - | <0.05 | <0.05 | - |
| meta- & para-Xylene | | | - | mg/kg | - | - | - | - | <0.05 | <0.05 | - |
| ortho-Xylene | | | - | mg/kg | - | - | - | - | <0.05 | <0.05 | - |
| Total Xylene[g] (X) | *1.0* | | - | mg/kg | | | | | <0.1 | <0.1 | |
| **Extractable Hydrocarbons** | | | | | | | | | | | |
| Fraction 2 (C10-16) | | **150** (coarse)[h] | | mg/kg | *2180* | *826* | 51 | *499* | 61 | <50 | <50 |
| Fraction 2-Napthalene | | **150** (coarse) | - | mg/kg | - | - | 51 | *499* | 61 | <50 | - |
| Fraction 3 (C16-34) | | **400** (coarse)[h] | | mg/kg | *1040* | *534* | 227 | *769* | 255 | 86 | 109 |
| Fraction 3-PAH | | **400** (coarse) | - | mg/kg | - | - | 227 | *769* | 255 | 86 | - |
| TEH (C10-34)[i] | - | - | **2000** | mg/kg | **3220** | 1360 | 278 | 1268 | 316 | <136 | <159 |
| Fraction 4 (C34-50) | | **2800** (coarse) | - | mg/kg | 69 | 81 | 99 | 115 | 73 | <50 | <50 |

*Associated ALS files: P6911, P7047*

| | |
|---|---|
| *italics* | Concentration in sediment greater than or equal to CCME Parkland land use guideline for soil |
| **BOLD** | Concentration in sediment greater than or equal to Polaris Mine Remediation Objective for soil |

Notes:
< = Less than the detection limit indicated.
- = Analysis not conducted or no guideline.

[a] Canadian Environmental Quality Guidelines (CEQG) and Petroleum Hydrocarbon Canada-Wide Standard (PHC CWS) presented apply to soil. No equivalent sediment quality guidelines have been developed.
[b] Guideline is based on the limiting exposure pathway of Protection of Environmental Health
[c] Guideline is dependant upon depth of sample (surface, subsoil >1.5 m depth). Surface soil analyzed.
[d] Guideline is dependent on median grain size of soil analyzed (Fine ≤75 µm, Coarse >75 µm). Median grain size of soil analyzed is >75 µm.
[e] Guideline is based on the more stringent site-specific exposure pathway of those for the Protection of Groundwater for Aquatic Life and Ecological Soil Contact
[f] Field screening results are measured based on a 'dry headspace' method.
[g] Total Xylene calculated as the sum of meta, para and ortho Xylenes
[h] Use of the guideline requires that PAHs be subtracted from the fraction. Based on the results for soil sample A1 it is assumed that PAHs form a small percentage of the fractions F2 and F3 for the samples not analyzed for PAHs.
[i] Total Extractable Hydrocarbons (TEH) calculated as the sum of Fractions F2 and F3.

# Table 6 - Summary of Analytical Results for Polycyclic Aromatic Hydrocarbons in Sediment

Gartner Lee

| | FEDERAL CCME GUIDELINES | | Sample Location | TP02-01 | TP02-04 | TP02-09 | TP02-17 | TP02-19 | TP02-20 | | TP02-21 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sample ID | TP02-01-1 | TP02-04-1 | TP02-09-2 | TP02-17-2 | TP02-19-1 | TP02-20-1 | TP02-20-2 | TP02-21-1 |
| | CEQG[a] | | Sample Interval (m) | 0.0-0.15 | 0.0-0.45 | 0.15-0.55 | 0.4-0.9 | 0.0-0.5 | 0.0-0.4 | 0.4-0.6 | 0.0-0.4 |
| | Marine Sediment | | Date Sampled | 7/9/02 | 7/10/02 | 7/10/02 | 7/11/02 | 7/12/02 | 7/12/02 | 7/12/02 | 7/12/02 |
| | *ISQG*[b] | PEL[c] | Field Screen (ppm)[d] | 685 | 2.3 | 3.5 | 9.2 | 2.5 | 16.2 | 2.3 | 0.9 |
| **Parameter** | | | **Units** | **Analytical Results** | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | | | | | | |
| Acenaphthene | *0.00671* | 0.0889 | mg/kg | <2 | <0.005 | <0.005 | <0.007 | <0.005 | <0.2 | <0.007 | <0.005 |
| Acenaphthylene | *0.00587* | 0.128 | mg/kg | <0.5 | <0.005 | <0.005 | <0.005 | <0.005 | <0.03 | <0.005 | <0.005 |
| Anthracene | *0.0469* | 0.245 | mg/kg | <0.2 | <0.01 | <0.01 | <0.01 | <0.01 | <0.03 | <0.01 | <0.01 |
| Benz(a)anthracene | *0.0748* | 0.693 | mg/kg | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Benzo(a)pyrene | *0.0888* | 0.763 | mg/kg | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Benzo(b)fluoranthene | - | - | mg/kg | <0.01 | <0.01 | <0.01 | <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 | 0.01 | 0.01 | <0.01 |
| Benzo(k)fluoranthene | - | - | mg/kg | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Chrysene | *0.108* | 0.846 | mg/kg | <0.02 | <0.01 | <0.01 | <0.01 | <0.02 | <0.01 | <0.01 | <0.01 |
| Dibenz(a,h)anthracene | *0.00622* | 0.135 | mg/kg | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Fluoranthene | *0.113* | 11.494 | mg/kg | <0.04 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Fluorene | *0.0212* | 0.144 | mg/kg | **1.9** | <0.01 | <0.01 | 0.01 | <0.01 | **0.25** | <0.01 | <0.01 |
| Indeno(1,2,3-c,d)pyrene | - | - | mg/kg | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Naphthalene | *0.0346* | 0.391 | mg/kg | **18.7** | <0.01 | 0.01 | ***0.04*** | 0.02 | ***<0.2*** | 0.03 | <0.01 |
| Phenanthrene | *0.0867* | 0.544 | mg/kg | **2.4** | <0.01 | <0.01 | 0.01 | 0.01 | ***0.37*** | 0.01 | <0.01 |
| Pyrene | *0.153* | 1.398 | mg/kg | 0.1 | <0.01 | <0.01 | <0.01 | <0.01 | 0.02 | <0.01 | <0.01 |
| 2-Methylnaphthalene | *0.0202* | 0.201 | mg/kg | **39.1** | 0.02 | 0.02 | ***0.1*** | ***0.06*** | **<0.3** | ***0.08*** | 0.01 |

*Associated ALS files: P6911, P7047*

| | |
|---|---|
| *ITALICS* | Concentration greater than or equal to CEQG ISQG Guideline |
| **BOLD** | Concentration greater than or equal to CEQG PEL Guideline |

Notes:
< = Less than the detection limit indicated.
- = Analysis not conducted or no guideline

[a] CEQG - Canadian Environmental Quality Guidelines
[b] *ISQG* - Interim Sediment Quality Guidelines (dry weight)
[c] PEL - Probable Effect Levels (dry weight)
[d] Field screening results are measured based on a 'dry headspace' method.

# Table 7 - Summary of Analytical Results for Hydrocarbons in Groundwater

Gartner Lee

| | | | Extractable Petroleum Hydrocarbons (EPH) | | | |
|---|---|---|---|---|---|---|
| | | | EPH10-19[d] | EPH19-32 | LEPH[e] | HEPH[f] |
| | | Units | mg/L | mg/L | mg/L | mg/L |
| Location | Sample ID | Date Sampled | Analytical Results | | | |
| WELL02-2 | MW02-003 | 7/16/02 | <0.3 | <1 | - | - |
| | MW02-004 | 7/16/02 | <0.3 | <1 | - | - |
| WELL02-3 | MW02-005 | 7/16/02 | **69.7** | 7 | **69.6** | 7 |
| | MW02-006 | 7/16/02 | **39.5** | 4 | - | - |
| WELL02-4 | MW02-007 | 7/16/02 | <0.3 | <1 | <0.3 | <1 |
| WELL02-5 | MW02-009 | 7/16/02 | **5.5** | 1 | - | - |
| | MW02-010 | 7/16/02 | **7.7** | 2 | **7.7** | 2 |
| WELL02-6 | MW02-011 | 7/16/02 | <0.3 | <1 | - | - |
| | MW02-012 | 7/16/02 | <0.3 | <1 | - | - |
| WELL02-7 | MW02-013 | 7/16/02 | **12.4** | 2 | - | - |
| | MW02-014 | 7/16/02 | **5.2** | <1 | - | - |
| WELL02-9 | MW02-017 | 7/16/02 | **19.5** | 2 | - | - |
| | MW02-018 | 7/16/02 | **9.8** | 1 | - | - |
| WELL02-11 | MW02-021 | 7/16/02 | **7.5** | 1 | - | - |
| | MW02-022 | 7/16/02 | **7** | 1 | - | - |
| | | | | | | |
| BC Standard[a] | NAPL Indicator[b,c] | | 5 | - | - | - |

*Associated ALS files: P7199r*

**BOLD** Concentration greater than or equal to BC NAPL Indicator Standard

Notes:
< = Less than the detection limit indicated.
- = Analysis not conducted or no guideline.

[a] Used strickly for comparative purposes to assess water quality with respect to its content of petroleum hydrocarbons, as no federal guidelines have been established.

[b] BC Contaminated Site Regulation (CSR) defines proof of presence of petroleum hydrocabons non-aqueous phase liquid (NAPL) in water.

[c] Applicable at all BC sites irrespective of water use.

[d] EPH10-19 is equivalent to EHw10-19.

[e] LEPH - Light Extractable Petroleum Hydrocarbons.

[f] HEPH - Heavy Extractable Petroleum Hydrocarbons.

# Table 8 - Summary of Analytical Results for Polycyclic Aromatic Hydrocarbons in Groundwater

Gartner Lee

| | FEDERAL CCME GUIDELINES | Sample Location | WELL02-03[b] | WELL02-04 | WELL02-05[b] |
|---|---|---|---|---|---|
| | CEQG MWAL[a] | Sample ID | MW02-005 | MW02-007 | MW02-010 |
| | | Date Sampled | 7/16/02 | 7/16/02 | 7/16/02 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | **Units** | **Analytical Results** | | |
| Acenaphthene | - | mg/L | <0.008 | <0.00005 | <0.0009 |
| Acenaphthylene | - | mg/L | <0.003 | <0.00005 | <0.0004 |
| Acridine | - | mg/L | <0.002 | <0.00005 | <0.0002 |
| Anthracene | - | mg/L | <0.001 | <0.00005 | <0.0002 |
| Benz(a)anthracene | - | mg/L | <0.0005 | <0.00005 | <0.00005 |
| Benzo(a)pyrene | - | mg/L | <0.00001 | <0.00001 | 0.00001 |
| Benzo(b)fluoranthene | - | mg/L | <0.00005 | <0.00005 | <0.00005 |
| Benzo(g,h,i)perylene | - | mg/L | <0.00005 | <0.00005 | 0.00005 |
| Benzo(k)fluoranthene | - | mg/L | <0.00005 | <0.00005 | <0.00005 |
| Chrysene | - | mg/L | <0.0005 | <0.00005 | <0.00005 |
| Dibenz(a,h)anthracene | - | mg/L | <0.00005 | <0.00005 | <0.00005 |
| Fluoranthene | - | mg/L | <0.0005 | <0.00005 | 0.00023 |
| Fluorene | - | mg/L | 0.0125 | <0.00005 | 0.00206 |
| Indeno(1,2,3-c,d)pyrene | - | mg/L | <0.00005 | <0.00005 | <0.00005 |
| Naphthalene | **0.0014** | mg/L | **0.0611** | <0.00005 | **<0.002** |
| Phenanthrene | - | mg/L | 0.0167 | <0.00005 | 0.00236 |
| Pyrene | - | mg/L | 0.001 | <0.00005 | 0.00114 |
| Quinoline | - | mg/L | <0.01 | <0.00005 | <0.002 |

*Associated ALS files: P7199r*

**BOLD** Concentration greater than or equal to CEQG Guideline

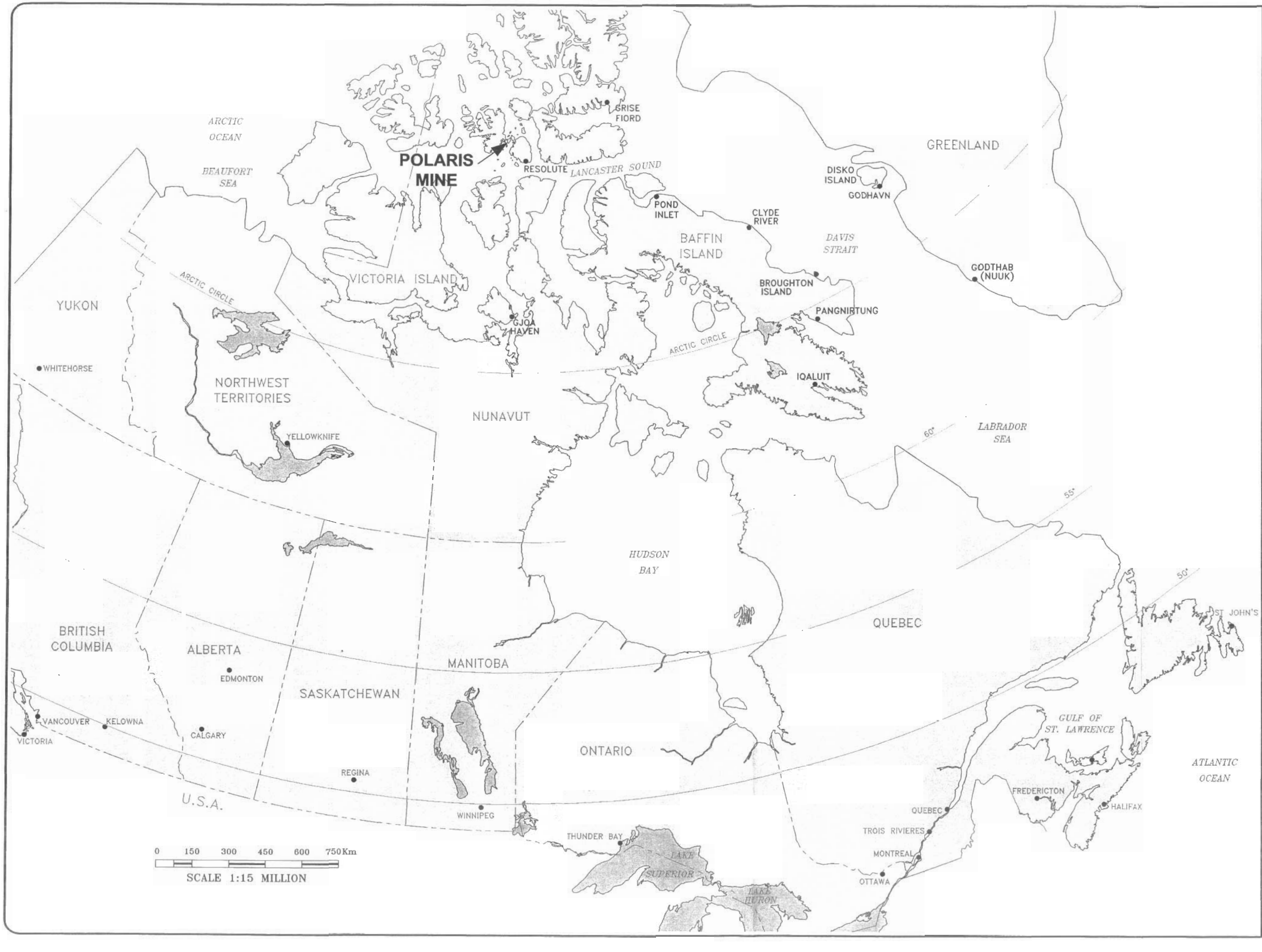
Notes:

< = Less than the detection limit indicated.
- = No guideline.

[a] Canadian Environmental Quality Guidelines (CEQG) for the Protection of Marine Water Aquatic Life (MWAL)

[b] Well interpreted to be in contact with liquid petroleum hydrocarbons and therefore reliable intrepretation of dissolved hydrocarbon concentrations in groundwater is not possible.

# Figures




LEGEND

NUNAVUT TERRITORY

SOURCE OF DRAWING:
GSC MAP D1880A (1996) CD DIGITAL MAP
PROJECTION:
LAMBERT CONIC CONFORMAL
NAD 27
UNITS METRES

| | |
|---|---|
| REVIEWED BY: | AL |
| DRAWN BY: | CPW |
| DATE ISSUED: | NOVEMBER, 2002 |
| PROJECT NUMBER: | 22-303 |
| FILE NAME: | 22303-D2-02.DWG |
| REVISION: | 0 |

Gartner Lee Limited

# LOCATION PLAN

2002 FUEL SPILL ASSESSMENT
POLARIS MINE
LITTLE CORNWALLIS ISLAND, NUNAVUT

teckcominco

Figure No. 1

Gartner Lee Limited

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August 26, 2002

Project 22-303

Teck Cominco Limited.
Little Cornwallis Island,
Polaris, Nunavut
X0A 0Y0

**Attention: Mr. John Knapp, Manager, Polaris Operation**

Dear Mr. Knapp

**Re: Independent Inspection of June 2002 Hydrocarbon Spill, Polaris Mine Site, Nunavut**

As requested by Teck Cominco Ltd. ("Teck Cominco"), between July 6, 2002 and July 13, 2002, Gartner Lee Limited (GLL) inspected environmental conditions at the Polaris Mine site on Little Cornwallis Island, Nunavut (the "Site") to document the effectiveness of Teck Cominco's response to a petroleum hydrocarbons release that occurred at the Site on June 25, 2002 (the "Spill").

This letter describes GLL's proposed work plan for the investigation and how it was developed. Included as an attachment is a field report describing work that was undertaken by GLL during the inspection along with GLL's observations that were made during the investigation. The results of laboratory analyses that are referenced in this letter, our interpretation of the analytical results and recommendations for additional activities, if any, will be documented in a report that is scheduled to be issued under separate cover.

**Objective of the Inspection**

The objectives of GLL's investigation were to:

1. Document environmental conditions within the source area of the release and within areas hydraulically down-gradient of the spill; and,
2. Recommend additional mitigation measures, as appropriate, to supplement response measures that were undertaken by Teck Cominco prior to and/or during the GLL investigation.

**Scope of Work**

The scope of work was developed in consultation with the Polaris Mine Manager; the Polaris Operations Manager and senior GLL environmental professionals experienced in the assessment and remediation of hydrocarbon impacted soil and water. Dr. Jon Lindstrom, Senior Chemist, Shannon & Wilson, Inc., provided input to GLL with regard to environmental consequences of marine oil spills. Dr. Lindstrom assisted with evaluating the environmental effects of the 1989 *Exxon Valdez* oil spill in Prince William Sound, Alaska.

**Background**

On July 2, 2002, Teck Cominco contacted GLL and requested that GLL provide immediate assistance in assessing and remediating the effects of a release of diesel at the site's tank-farm containment berm. The release was described to have flowed to and into the Arctic Ocean.

According to information provided by Teck Cominco:

- On June 25, 2002, upon observing water in the containment berm, Teck Cominco activated the containment system's sump pump.
- Water within the berm immediately prior to the release was present due to the accumulation of spring melt water and rainfall.
- On June 26, 2002, approximately 20 hours following the onset of pumping, Teck Cominco personnel observed what appeared to be petroleum hydrocarbons on the road and hillside down gradient from the tank farm.
- Following an investigation, Teck Cominco concluded that water retained by the tank farm containment berm became contaminated with petroleum hydrocarbons (mainly diesel) leaking from a pipe. The pipe was used to transfer fuel between two diesel storage tanks within the containment area.
- Volume measurements in the two diesel storage tanks involved in the fuel transfer were taken by Teck Cominco after the release. They show that between approximately 1,500 L and 4,500 L of petroleum hydrocarbons may have leaked from the pipe into the containment area prior to and / or during the release.
- Following the release, approximately 3,000 L to 3,500 L of liquid petroleum hydrocarbons was removed from behind the containment berm.
- Teck Cominco estimates that between approximately 1,200 L and 1,500 L of petroleum hydrocarbons was released to the environment via the sump pump.

According to Teck Cominco, Site conditions at the time of the release included a predominately northerly wind direction and the presence of sea ice frozen to the ocean bed within approximately 1 m from the shore. Such conditions contained the release, assisted in Teck Cominco's efforts to recover floating petroleum hydrocarbons on the ocean surface and limited the size of the petroleum hydrocarbons "smear zone" (discussed below) that developed along the ocean shore.

Between June 26th and July 6th, after Teck Cominco became aware of the presence of the petroleum hydrocarbons release, Teck Cominco responded to the release by:

- Reporting of the spill to the NWT Spill Hotline on June 26th, 2002;
- Contacting the Department of Fisheries and Oceans (DFO) on June 27th, 2002;
- Identifying the source of the release and ensuring that there was no danger of a further release to the environment;
- Installing absorbent booms in a drainage culvert which passed beneath a road between the discharge site and the shoreline to contain floating petroleum hydrocarbons on the surface of water flowing to the ocean;