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PHASE II ENVIRONMENTAL ASSESSMENT
RED RIVER ESSO SERVICE STATION
SITE #860265
287 MAIN STREET
SELKIRK, MANITOBA

Prepared for:

Imperial Oil Limited
Calgary, Alberta

Prepared by:

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Confidential

THIS REPORT CONTAINS PROVISIONS LIMITING LIABILITY, THE SCOPE OF THE REPORT, AND THIRD PARTY RELIANCE.

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1 INTRODUCTION

Aqua Terre Solutions Inc. (Aqua Terre) was retained by Imperial Oil Limited (IOL) to conduct a Phase II environmental site assessment at the Red River Esso service station located at 287 Main Street in Selkirk, Manitoba (Figure 1).

Field investigations were conducted on August 15, 2003 and September 11, 2003. Paddock Drilling Ltd. (Paddock) of Brandon, Manitoba provided borehole drilling and monitoring well installation services for this work program under contract with Aqua Terre. The IOL project manager is Ms. Emma Kirsh. A site plan illustrating major site features and monitoring well locations is shown on Figure 2.

1.1 Scope of Work

The scope of the work program was to:

- Assess local site conditions (soils and groundwater) by supervising the drilling and installation of seven (MW-32 to MW-38) groundwater monitoring wells;
- Submit up to three (minimum of two) soil samples from each of MW-32 to MW-38 for laboratory analysis of benzene, toluene, ethylbenzene, xylenes, (BTEX), petroleum hydrocarbon fractions (F1 to F4), lead, and grain size;
- Conduct groundwater monitoring at all accessible wells to measure concentrations of organic hydrocarbon vapours within the wells, depth to groundwater, hydraulic conductivity, and the thickness of phase-separated hydrocarbons (if present);
- Submit groundwater samples from all newly drilled monitoring wells for laboratory analyses of BTEX, and petroleum hydrocarbon fractions (F1 and F2);
- Complete a site sensitivity assessment and determine the appropriate risk management criteria for the site; and,
- Compare laboratory results with the appropriate risk management criteria and identify areas where soil and/or groundwater results were determined to exceed their respective criteria.

All field work was conducted in accordance with standard field procedures as outlined in Appendix A. This report documents procedures and results of the work program.

1.2 Site Conditions

Site facilities include four underground petroleum storage tanks, two pump islands, a kiosk and a car wash (Figure 2).

Surrounding land use comprises residential and commercial properties (Figure 3). Residential properties are located north, southeast, south, and northwest of the site. A service station is

located to the southwest while other commercial properties are situated northeast, east and southeast of the site. The site is zoned as Strip Commercial (C-3) by the City of Selkirk.

Water and sewer services to the site and surrounding properties are provided by the City of Selkirk. The nearest surface water feature is the Red River, located approximately 500 m east of the site.

1.3 Previous Work

In late 1988, O'Connor Associates Environmental Inc. (OAEI) supervised the drilling and installation of 11 monitoring wells. Liquid petroleum product was detected in E2, E4, BH1 and BH10. Vapour extraction systems (VES) were connected to the tanknest monitoring wells and to the catch basin onsite. In early 1989, OAEI installed an interception trench on the southern portion of the site to recover organic vapour, liquid product, and impacted groundwater. Phase-separated product was detected at BH4 for the first time in 1989. In February 1989, a second trench was installed along the west boundary of the site. Phase-separated product was measured in RW1 and BH1 for the first time in February 1989.

In May 1989, the underground storage tanks were replaced under the supervision of OAEI. A portion of the impacted soil was removed from the site and vapour extraction systems were installed in both the old and new tank nest areas.

OAEI continued to monitor the site between 1989 and 1998. According to OAEI monitoring reports in 1998, the total amount of liquid product recovered from the site was estimated to be 243 L. The vapour extraction units had removed an estimated 3573 L, resulting in a combined total of 3816 L of product estimated to have been removed from the site.

2 FIELD INVESTIGATION

2.1 Borehole Drilling And Monitoring Well Installation

Borehole drilling was completed on August 15, 2003 by Paddock, using a truck-mounted, hollow-stem auger rig equipped with split spoon sampling equipment. Drilling was supervised by Aqua Terre personnel following standard methods (Appendix A). Split spoon sampling was carried out where possible. All identifiable public and private utilities were located and cleared prior to proceeding with drilling activities. A site plan illustrating site features and monitoring well locations is shown on Figure 2.

Seven boreholes (MW-32, MW-33, MW-34, MW-35, MW-36, MW-37 and MW-38) were drilled to a maximum depth of 6.1 m below ground surface (b.g.s.) (Table 1). All boreholes were completed as monitoring wells. Borehole locations were chosen to identify any onsite soil and groundwater quality issues (Figure 2). Borehole logs are provided in Appendix B. Photographs of monitoring well locations are presented in Appendix C.

Up to three soil samples from each borehole were submitted for chemical analysis of BTEX, F1 to F4, and lead. Additionally, three samples were submitted for grain size determination and a composite for flashpoint analysis. Soil samples were packed with ice into a cooler and shipped to PSC Analytical Services Corporation (PSC) in Edmonton, Alberta via Federal Express courier services (FedEx) on August 18, 2003. Laboratory certificates of analyses are provided in Appendix D.

2.2 Groundwater Monitoring and Sampling

On September 11, 2003 all accessible monitoring wells were measured for the concentration of organic hydrocarbon vapours within the well, depth to groundwater, and thickness of phase-separated hydrocarbons (Table 1 and Table 2). A groundwater sample was collected from all newly drilled monitoring wells and submitted to PSC for analyses of BTEX and F1 and F2. Prior to sampling, field sensitive parameters (pH, EC, temperature) were measured (Table 2). Groundwater samples were packed in an ice-filled cooler and delivered to the PSC laboratory in Edmonton, Alberta, on September 11, 2003.

Single well response tests were performed at MW-32, MW-33, MW-34, MW-35, MW-36, MW-37 and MW-38 to determine hydraulic conductivity. Test results are provided in Appendix B.

3 RESULTS

3.1 Risk Management Guidelines Selection

Due to the lack of a specific guideline(s) for petroleum storage tank sites in Manitoba, Alberta Environment "Risk Management Guidelines for Petroleum Storage Tank Site" document (Alberta Environment, 2001) were used as a basis for comparison. The risk-based guidelines are selected based on soil grain size, potential for groundwater use, distance to the nearest surface water feature, and surrounding land use.

3.1.1 Grain Size

Field observations during drilling (Appendix B) and grain-size analyses (Table 3) indicate that the dominant soil type is fine-grained. Hydraulic conductivity values also provide a qualitative indication of dominant grain-size. The bulk hydraulic conductivity at the wells tested was determined to be in the range of 10^{-8} m/s, which is representative of fine-grained material. Therefore, based on field observations, grain size analyses, and hydraulic conductivity results (discussed further in Section 3.3.1), the fine-grained guidelines are considered appropriate for comparison of analytical data.

3.1.2 Nearest Surface Water Body

As noted, the nearest surface water feature is the Red River, located approximately 500 m east of the site. Consequently, fresh water aquatic guidelines are not considered the most appropriate for comparison.

3.1.3 Groundwater Consumption

The Town of Selkirk water supply system consists of four municipal wells as shown on the location figure in Appendix E. Well #1 (Tower), located approximately 440 m from the site, is screened at a depth of 27 m. Well #2 (Christie), located approximately 440 m from the site, and Well #3 (Rosser), located approximately 460 m from the site, are both screened at a depth of 64 m. Well #4 (McLean), located approximately 380 m from the site, is screened at a depth of 54 m. All municipal wells are completed in Bedrock. Seven additional private wells were identified within the Town of Selkirk. Drilling records for these wells are provided in Appendix E. Town bylaw prevents private owners from utilizing private wells, however enforcement is not in place and it was beyond the scope of this work program to verify the status of the private (domestic) wells.

Drilling records suggest that bedrock is overlain by more than 13 m of fine grained surficial deposits. The maximum observed depth of hydrocarbon impacts is approximately 4.5 m b.g.s., therefore approximately 8 m or more of non-impacted fine grained material overlies bedrock. As noted in Section 3.3.1, hydraulic conductivity values were measured to be on the order of 10^{-8} to 10^{-7} m/s at the new monitoring wells, completed in surficial deposits. Considering the thickness and hydraulic conductivity of the confining layer overlying the bedrock aquifer, the protection of drinking water guidelines have been disregarded at this time.

3.1.4 Surrounding Land Use

The site and surrounding properties (Figure 3) to the south and west are zoned as Strip Commercial (C-3). Properties to the east and southeast are zoned as Central Commercial (C-2) and the properties to the north of the site are zoned as Residential. According to Land Use By-Law 4968, one of the discretionary uses of both Strip commercial and Central commercial zoned property is multi-family dwellings (Selkirk and District Planning Area). Therefore, due to the residential properties to the north and the discretionary uses mentioned above, the site will be considered residential as this is the most stringent land use allowed.

3.1.5 Exposure Pathways

Since the site and surrounding area is nearly entirely covered with asphalt and the impacts encountered were greater than 0.3 m below grade, the soil dermal contact and soil ingestion (livestock, wildlife, and human) pathways have been disregarded at this time. Also, as stated in Sections 3.1.2 and 3.1.3, the freshwater aquatic life and consumption pathways can be excluded due to the distance from the site to the nearest surface water feature and the interpreted local hydrogeology. The primary exposure pathway is considered to be indoor vapour inhalation. Vapour migration through the foundation walls of onsite buildings may be increased by the presence of utility corridors leading to the buildings.

Based on the above information, the 2001 Alberta Environment fine-grained guidelines for residential land use are considered appropriate as a basis for comparison at the site.

3.2 Soil

Details of local soil conditions and soil headspace vapour concentrations are given on the borehole logs in Appendix B. Laboratory certificates of analyses are presented in Appendix D.

3.2.1 Stratigraphy

The majority of the site is covered by asphalt. Sand fill was encountered beneath the asphalt to a depth of approximately 0.6 – 1.2 m b.g.s. at all borehole locations. The fill was, in turn, underlain by silt to approximately 1.5 m b.g.s., except at MW-36 where fine-grained sand was encountered to 1.5 m b.g.s. The silt was underlain by stiff clay to the maximum depth of drilling (4.6 – 5.3 m b.g.s). At MW-34, MW-35, and MW-37 silt was encountered below the clay at 4.6 – 4.9 m b.g.s. Fine-grained sand lenses (less than or equal to 10 cm) were encountered at depths of approximately 5.0 m to 6.0 m.b.g.s. These sand lenses are not considered laterally continuous. Grain-size analyses performed on selected samples collected beneath the fill, including the zone where the sand lenses were encountered, were verified to be predominantly fine-grained.

3.2.2 Soil Headspace Vapour Concentrations

Maximum headspace vapour concentrations in soil samples ranged from 25 ppmv at MW-33 to 45% LEL at MW-34 (2.3 m to 3.1 m). Soil headspace vapour concentrations in all boreholes are provided on the borehole logs in Appendix B.

3.2.3 *Soil Analytical Results*

Analytical results for soil samples collected from the borehole drilling are summarized in Table 3 and are presented on Figure 3.

A summary of the exceedances are as follows:

Sample ID	Average Sample Depth	Parameters Exceeded
MW34-4*	2.6 m	Benzene (7.4 mg/kg), F1 (420 mg/kg)
MW34-6	4.3 m	Benzene (2.3 mg/kg)
MW36-5*	3.4 m	Benzene (2.6 mg/kg), F1 (320 mg/kg)
MW37-6	4.2 m	F1 (370 mg/kg)

* Note: If a field duplicate was collected, the higher concentration is summarized here.

3.3 Groundwater

3.3.1 *Groundwater Flow*

Using the bail and recovery method, hydraulic conductivity tests were conducted at MW-32, MW-33, MW-34, MW-35, MW-36, MW-37 and MW-38 on September 11, 2003. Hydraulic conductivity values were measured to be on the order of 10^{-8} m/s. These results are comparable with literature values for clay (Freeze and Cherry, 1979). Appendix B presents the hydraulic conductivity test results.

As shown on Table 1, the depth to groundwater on September 11, 2003, ranged from 1.82 m b.g.s. (BH10) to 3.64 m b.g.s. (MW-36). Figure 5 illustrates the groundwater surface elevations on September 11, 2003. The lateral groundwater flow direction was indeterminate on September 11, 2003, due to the fact that water levels in the wells had not yet stabilized. This is attributed to the low hydraulic conductivity of the surficial deposits at the site. Historically, the lateral groundwater flow direction has been interpreted to be in a southeasterly direction (OAEI, 1991). Given a calculated lateral hydraulic gradient of 0.023 (between PZ29 and BH10), and assuming an effective porosity of 0.15, and a hydraulic conductivity value of 10^{-8} m/s, the lateral groundwater flow velocity is estimated to be on the order of 0.05 m/year.

3.3.2 *Field Parameters*

Field measured parameters are summarized in Table 2. On September 11, 2003 monitoring well headspace vapour concentrations ranged from 5 ppmv (PZ-29) to 94% LEL (MW-34). Temperature of the groundwater ranged from 11.8 °C (MW-34) to 13.4 °C (MW-33), the pH ranged from 6.86 (MW-34) to 7.29 (MW-33) and the electrical conductivity ranged from 1.17 mS/cm (MW-33) to 1.73 mS/cm (MW-36).

3.3.3 *Groundwater Quality*

Analytical results for water samples collected from all newly drilled monitoring wells are summarized in Table 5 and presented on Figure 6.

A summary of the exceedances are as follows:

Sample ID	Parameters Exceeded
MW-34*	Benzene (8.94 mg/L)

* Note: If a field duplicate was collected, the higher concentration is summarized here.

3.4 Quality Assurance / Quality Control

Duplicate soil samples of MW34-4, and MW36-5 were prepared in the field and submitted for analyses. Based on the calculated RPDs between the analysed parameters, there was no significant discrepancy in the results of the duplicate samples analyses. This suggests that the analytical results are reproducible.

One duplicate groundwater sample was collected for MW-34 and submitted for laboratory analyses. Based on the calculated RPDs between the analysed parameters (all less than 25%), there was no significant discrepancy in the results of the duplicate samples analyses. This suggests that the analytical results are reproducible.

A trip blank was prepared and accompanied the groundwater sampling bottles during the sample collection process. The blank did not contain detectable levels of BTEX or F1 and all method blanks were less than the respective method detection limit (MDL).

4 REFERENCES

Alberta Environment, 2001. *"Risk Management Guidelines for Petroleum Storage Tank Sites"*.

City of Selkirk, "*City of Selkirk Zoning By-Law 4968*".

Freeze, R.L. and Cherry, J.A., 1979. *"Groundwater"*. Prentice Hall, New York.

O'Connor Associates Inc., 1991. "*Site Monitoring Report – 91/05/29*".

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Rand McNally. "Manitoba Provincial Map".

5 LIMITATION OF LIABILITY, SCOPE OF REPORT AND THIRD PARTY RELIANCE

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The investigation undertaken by Aqua Terre with respect to this report and any conclusions or recommendations made in this report reflect Aqua Terre's judgement based on the site conditions observed at the time of the site inspection on the date(s) set out in this report and on information available at the time of preparation of this report. This report has been prepared for specific application to the site and it is based, in part, upon visual observation of the site, subsurface investigation at discrete locations and depths, and specific analysis of specific chemical parameters and materials during a specific time interval, all as described in this report. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, portions of the site which were unavailable for direct investigation, subsurface locations which were not investigated directly, or chemical parameters, materials or analysis which were not addressed. Substances other than those addressed by the investigation described in this report may exist within the site, substances addressed by the investigation may exist in areas of the site not investigated and concentrations of substances addressed which are different than those reported may exist in areas other than the locations from which samples were taken.

If site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings, conclusions and recommendations in this report may be necessary.

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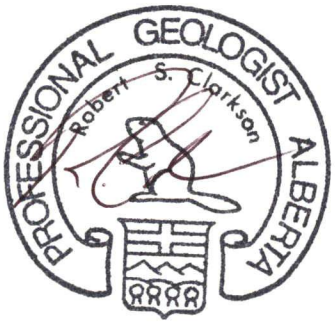
Respectfully submitted,
Aqua Terre Solutions Inc.



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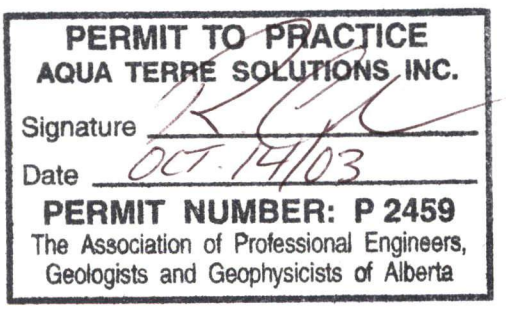


TABLES

Table 1. Summary of Monitoring Well Construction Details, Groundwater Surface Elevations and Hydraulic Conductivities

Monitoring Well	Ground Elevation (m)	Stick-Up PVC pipe (m)	Top of PVC Casing (m)	Total Depth of Borehole (m b.g.s.)	Screened Interval (m b.g.s.)	Date (dd-mm-yr)	Depth to Water (m.b.t.c)	Groundwater Surface Elevation (m) [1]	Hydraulic Conductivity[2] (m/s)	Lithology
BH1	99.73	0.13	99.86	2.3	-	11-Sep-03	2.23	97.63	-	Clay
BH9	99.44	-0.06	99.38	6.2	-	11-Sep-03	2.16	97.22	-	Clay
BH10	99.47	-0.11	99.36	6.1	-	11-Sep-03	1.82	97.54	-	Clay
BH11	99.48	-0.07	99.41	6.1	-	11-Sep-03	2.00	97.42	-	Clay
PZ28	99.90	-0.13	99.77	-	-	11-Sep-03	1.75	98.02	-	-
PZ29	99.98	-0.14	99.85	-	-	11-Sep-03	1.88	97.97	-	-
PZ30	-	-	-	-	-	11-Sep-03	NA	-	-	-
PZ31	100.12	-0.16	99.97	-	-	11-Sep-03	2.00	97.97	-	-
MW-32	100.12	-0.08	100.04	4.6	1.6 - 4.6	11-Sep-03	2.40	97.64	3.0×10^{-8}	Clay
MW-33	100.07	-0.07	100.00	4.6	1.6 - 4.6	11-Sep-03	2.78	97.22	3.7×10^{-8}	Clay
MW-34	99.80	-0.11	99.69	5.3	1.6 - 4.6	11-Sep-03	3.10	96.59	2.1×10^{-8}	Clay
MW-35	100.01	-0.09	99.92	5.3	1.6 - 4.6	11-Sep-03	3.57	96.35	1.5×10^{-8}	Clay
MW-36	99.89	-0.08	99.81	5.3	1.6 - 4.6	11-Sep-03	3.64	96.17	2.4×10^{-8}	Clay
MW-37	100.17	-0.08	100.09	6.1	1.6 - 4.6	11-Sep-03	2.62	97.48	2.3×10^{-8}	Clay
MW-38	99.87	-0.08	99.79	4.6	1.6 - 4.6	11-Sep-03	3.01	96.78	5.1×10^{-8}	Clay

Notes:

1. Groundwater surface elevations are relative to an arbitrary local datum of 100.00 m.

– information not available

NA Not Accessible

Table 2. Field Measured Parameters

Monitoring Well	Monitoring Date (dd-mm-yy)	Apparent Product Thickness (mm)	Field Measured Parameters			
			OVM	Temperature (°C)	pH	EC (mS/cm)
BH1	11-Sep-03	0	20 ppmv	nm	nm	nm
BH9	11-Sep-03	0	50 ppmv	nm	nm	nm
BH10	11-Sep-03	0	60 ppmv	nm	nm	nm
BH11	11-Sep-03	0	80 ppmv	nm	nm	nm
PZ28	11-Sep-03	0	10 ppmv	nm	nm	nm
PZ29	11-Sep-03	0	5 ppmv	nm	nm	nm
PZ31	11-Sep-03	0	25 ppmv	nm	nm	nm
MW-32	11-Sep-03	0	80 ppmv	12.9	7.11	1.22
MW-33	11-Sep-03	0	70 ppmv	13.4	7.29	1.17
MW-34	11-Sep-03	0	94% LEL	11.8	6.86	1.39
MW-35	11-Sep-03	0	11% LEL	12.5	7.01	1.51
MW-36	11-Sep-03	0	6% LEL	12.9	6.97	1.73
MW-37	11-Sep-03	0	5% LEL	12.7	6.90	1.41
MW-38	11-Sep-03	0	75 ppmv	12.0	7.21	1.22

Notes:

OVM	total non methane hydrocarbon concentration within the well as recorded with an organic vapour meter
ppmv	parts per million by volume
% LEL	percentage of the lower explosion limit
EC	electric conductivity
nm	not measured

Table 3. Soil Analytical Results

Parameter	MDL[1]	AENV[2] Fine-Grained Residential	Soil Sample ID										
			MW32-4	MW32-6	MW33-4	MW33-5	MW34-4	Dup. of MW34-4 [3]	MW34-6	MW34-7	MW35-3	MW35-5	MW35-6
PSC Laboratory Sample ID	na	na	33028854	33028855	33028856	33028857	33028858	33028859	33028860	33028861	33028862	33028863	33028864
Average Sample Depth (m b.g.s.)	na	na	2.6	4.3	2.6	3.4	2.6	2.6	4.3	4.9	1.8	3.4	4.3
OVM Concentration	5 ppmv	na	50 ppmv	<5 ppmv	25 ppmv	25 ppmv	45% LEL	45% LEL	400 ppmv	50 ppmv	125 ppmv	6% LEL	125 ppmv
Date Sampled (dd-mm-yr)	na	na	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03
Benzene	0.02	1.9	<0.04	<0.04	<0.04	<0.04	**7.4**	**2.8**	**2.3**	-	-	1.1	0.13
Toluene	0.10	300	<0.10	<0.10	<0.10	<0.10	16	11	2.2	-	-	<0.10	<0.10
Ethylbenzene	0.10	450	<0.10	<0.10	<0.10	<0.10	5.0	6.5	1.1	-	-	2.4	<0.10
m+p-Xylenes	0.10	nr	<0.10	<0.10	<0.10	<0.10	19	19	4.1	-	-	3.7	<0.10
o-Xylenes	0.10	nr	<0.10	<0.10	<0.10	<0.10	7.5	7.6	1.0	-	-	<0.10	<0.10
Total Xylenes	0.1	500	<0.1	<0.1	<0.1	<0.1	27	27	5.1	-	-	3.7	<0.1
F1 (C_6-C_{10} Hydrocarbons)	10	260	<10	<10	<10	<10	**310**	**420**	58	-	-	220	<10
F2 (C_{10}-C_{16} Hydrocarbons)	10	900	<10	<10	<10	<10	52	63	<10	-	-	26	<10
F3 (C_{16}-C_{34} Hydrocarbons)	10	800	<10	<10	47	<10	<10	<10	<10	-	-	29	20
F4 (C_{34}-C_{50} Hydrocarbons)	10	5600	<10	<10	40	<10	<10	<10	<10	-	-	<10	<10
Grain size < 0.075 mm - fine grain (wt%)	0.01	nr	-	-	-	-	-	-	-	86.6	99.8	-	-
Grain size > 0.075 mm - coarse grain (wt%)	0.01	nr	-	-	-	-	-	-	-	13.4	0.2	-	-
Lead	2.0	140	13.7	10.8	11.3	15.3	15.2	14.6	8.8	-	-	14.4	10.0

Notes:
1. Method Detection Limit - lowest level of the parameter that can be quantified with confidence.
2. Alberta Environment, 2001. "Risk Management Guidelines for Petroleum Storage Tank Sites," Generic Hydrocarbon Criteria for Fine-Grained Soil, Residential Land Use.
3. Duplicate sample of MW34-4 is labelled MW34-14 in laboratory Certificate of Analysis.
4. Duplicate sample of MW36-5 is labelled MW36-15 in laboratory Certificate of Analysis.
5. Concentration Units are mg/kg (parts per million) unless otherwise noted.
6. Laboratory Certificate of Analysis provided in Appendix D.
7. Laboratory services were provided by Philip Analytical Services of Edmonton, Alberta.

m b.g.s.	meters below ground surface	–	no laboratory analyses available
OVM	total non methane hydrocarbon concentration as recorded with an organic vapour meter	na	not applicable
ppmv	parts per million by volume	nd	concentration less than the method detection limit
%LEL	percent of the lower explosive limit	nr	parameter not directly regulated
Bold	exceeds AENV Fine-Grained Residential Guidelines		

Table 3. Soil Analytical Results (Continued)

Parameter	MDL[1]	AENV[2] Fine-Grained Residential	Soil Sample ID									
			MW36-5	Dup. of MW36-5 [4]	MW36-6	MW37-6	MW37-7	MW37-8	MW38-2	MW38-3	MW38-4	MW38-5
PSC Laboratory Sample ID	na	na	33028865	33028866	33028867	33028868	33028869	33028870	33028871	33028872	33028873	33028874
Average Sample Depth (m b.g.s.)	na	na	3.4	3.4	4.3	4.2	4.9	5.6	1.3	1.8	2.6	3.4
OVM Concentration	5 ppmv	na	20% LEL	20% LEL	150 ppmv	9% LEL	6% LEL	75 ppmv	130 ppmv	75 ppmv	25 ppmv	30 ppmv
Date Sampled (dd-mm-yr)	na	na	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03	15-Aug-03
Benzene	0.02	1.9	**2.6**	**2.6**	0.89	1.7	1.5	0.16	<0.04	<0.04	-	<0.04
Toluene	0.04	300	0.48	1.0	<0.10	0.19	<0.10	<0.10	<0.10	<0.10	-	<0.10
Ethylbenzene	0.04	450	2.5	6.4	<0.10	3.9	0.73	<0.10	<0.10	<0.10	-	<0.10
m+p-Xylenes	nr	nr	5.6	16	0.15	7.9	4.9	3.9	<0.10	<0.10	-	<0.10
o-Xylenes	nr	nr	0.90	2.9	<0.10	1.6	1.4	<0.10	<0.10	<0.10	-	<0.10
Total Xylenes	0.09	500	6.5	19	0.2	9.5	6.3	3.9	<0.1	<0.1	-	<0.1
F1 (C_6-C_{10} Hydrocarbons)	10	260	150	**320**	<10	**370**	59	<10	<10	<10	-	<10
F2 (C_{10}-C_{16} Hydrocarbons)	10	900	60	64	<10	55	<10	<10	<10	<10	-	<10
F3 (C_{16}-C_{34} Hydrocarbons)	10	800	45	22	28	18	<10	18	20	42	-	25
F4 (C_{34}-C_{50} Hydrocarbons)	10	5600	<10	<10	13	<10	<10	<10	<10	16	-	<10
Grain size < 0.075 mm - fine grain (wt%)	0.01	nr	-	-	-	-	-	-	-	-	99.9	-
Grain size > 0.075 mm - coarse grain (wt%)	0.01	nr	-	-	-	-	-	-	-	-	0.1	-
Lead	2.0	140	14.5	13.4	9.8	13.7	7.6	9.6	9.7	14.0	-	13.9

Notes:
1. Method Detection Limit - lowest level of the parameter that can be quantified with confidence.
2. Alberta Environment, 2001. "Risk Management Guidelines for Petroleum Storage Tank Sites," Generic Hydrocarbon Criteria for Fine-Grained Soil, Residential Land Use.
3. Duplicate sample of MW34-4 is labelled MW34-14 in laboratory Certificate of Analysis.
4. Duplicate sample of MW36-5 is labelled MW36-15 in laboratory Certificate of Analysis.
5. Concentration Units are mg/kg (parts per million) unless otherwise noted.
6. Laboratory Certificate of Analysis provided in Appendix D.
7. Laboratory services were provided by Philip Analytical Services of Edmonton, Alberta.

m b.g.s.	meters below ground surface	–	no laboratory analyses available
OVM	total non methane hydrocarbon concentration as recorded with an organic vapour meter	na	not applicable
ppmv	parts per million by volume	nd	concentration less than the method detection limit
%LEL	percent of the lower explosive limit	nr	parameter not directly regulated

Bold exceeds AENV Fine-Grained Residential Guidelines

Table 4. Groundwater Analytical Results

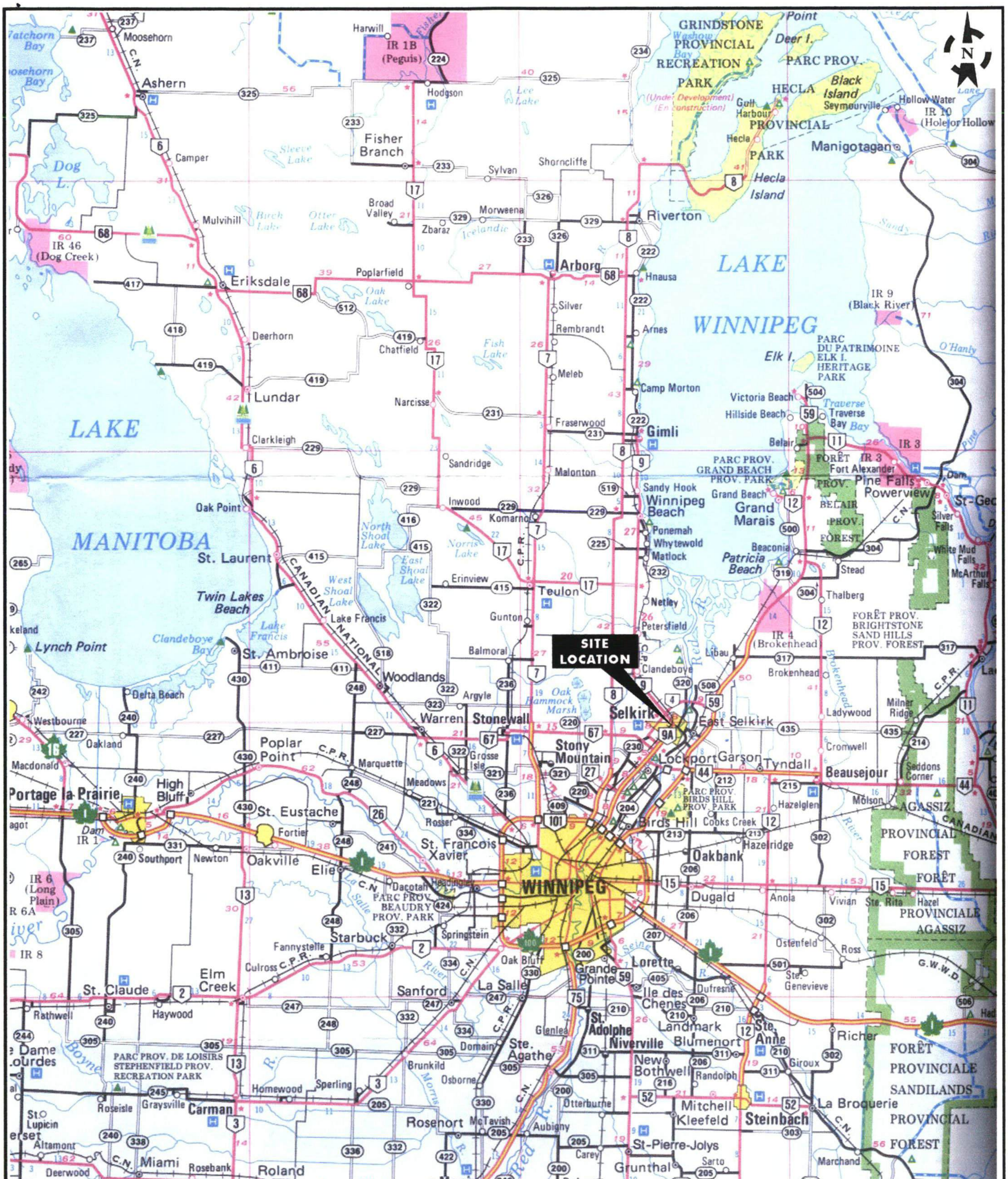
Parameter	MDL[1]	AENV[2] Fine-Grained Residential	Sample ID							
			MW-32	MW-33	MW-34	Duplicate of MW-34[3]	MW-35	MW-36	MW-37	MW-38
PSC Laboratory Sample ID	na	na	33032278	33032279	33032280	33032281	33032282	33032283	33032284	33032285
Date Sampled (dd-mm-yr)	na	na	11-Sep-03	11-Sep-03	11-Sep-03	11-Sep-03	11-Sep-03	11-Sep-03	11-Sep-03	11-Sep-03
Benzene	0.0005	3.5	<0.0005	<0.0005	**8.94**	**8.84**	2.68	0.0535	1.22	<0.0005
Toluene	0.0005	228	<0.0005	<0.0005	6.52	6.61	0.178	0.0005	0.165	<0.0005
Ethylbenzene	0.0005	ng	<0.0005	<0.0005	0.413	0.33	0.131	0.0049	0.299	<0.0005
m+p-Xylenes	0.0005	ng	<0.0005	<0.0005	3.80	3.55	0.179	0.0048	1.57	<0.0005
o-Xylenes	0.0005	ng	<0.0005	<0.0005	1.59	1.50	0.0881	<0.0005	0.490	<0.0005
Total Xylenes	0.0005	163	<0.0005	<0.0005	5.40	5.10	0.270	0.0048	2.10	<0.0005
F1 (C_6-C_{10} Hydrocarbons)	0.1	9	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	1.2	<0.1
F2 (C_{10}-C_{16} Hydrocarbons)	0.1	11	<0.1	<0.1	1.9	1.8	0.4	<0.1	1.4	<0.1

NOTES:

1. Method Detection Limit - lowest level of the parameter that can be quantified with confidence.
2. Alberta Environment, 2001. "Risk Management Guidelines for Petroleum Storage Tank Sites," Generic Hydrocarbon Groundwater Criteria for Fine-Grained Soil, Residential Land Use.
3. Duplicate sample of MW-34 is labelled MW-134 in laboratory Certificate of Analysis.
4. Concentration Units are mg/kg (parts per million) unless otherwise noted.
5. Laboratory Certificate of Analysis provided in Appendix D.
6. All laboratory analyses completed by PSC Analytical Services in Edmonton, Alberta.

m b.g.s.	meters below ground surface
OVM	total non-methane hydrocarbon concentration as recorded with an organic vapour meter
ppmv	parts per million by volume
%LEL	percent of the lower explosive limit
–	no laboratory analysis available
na	not applicable
ng	no guideline
Bold	Exceeds AENV Fine-Grained Residential Guidelines

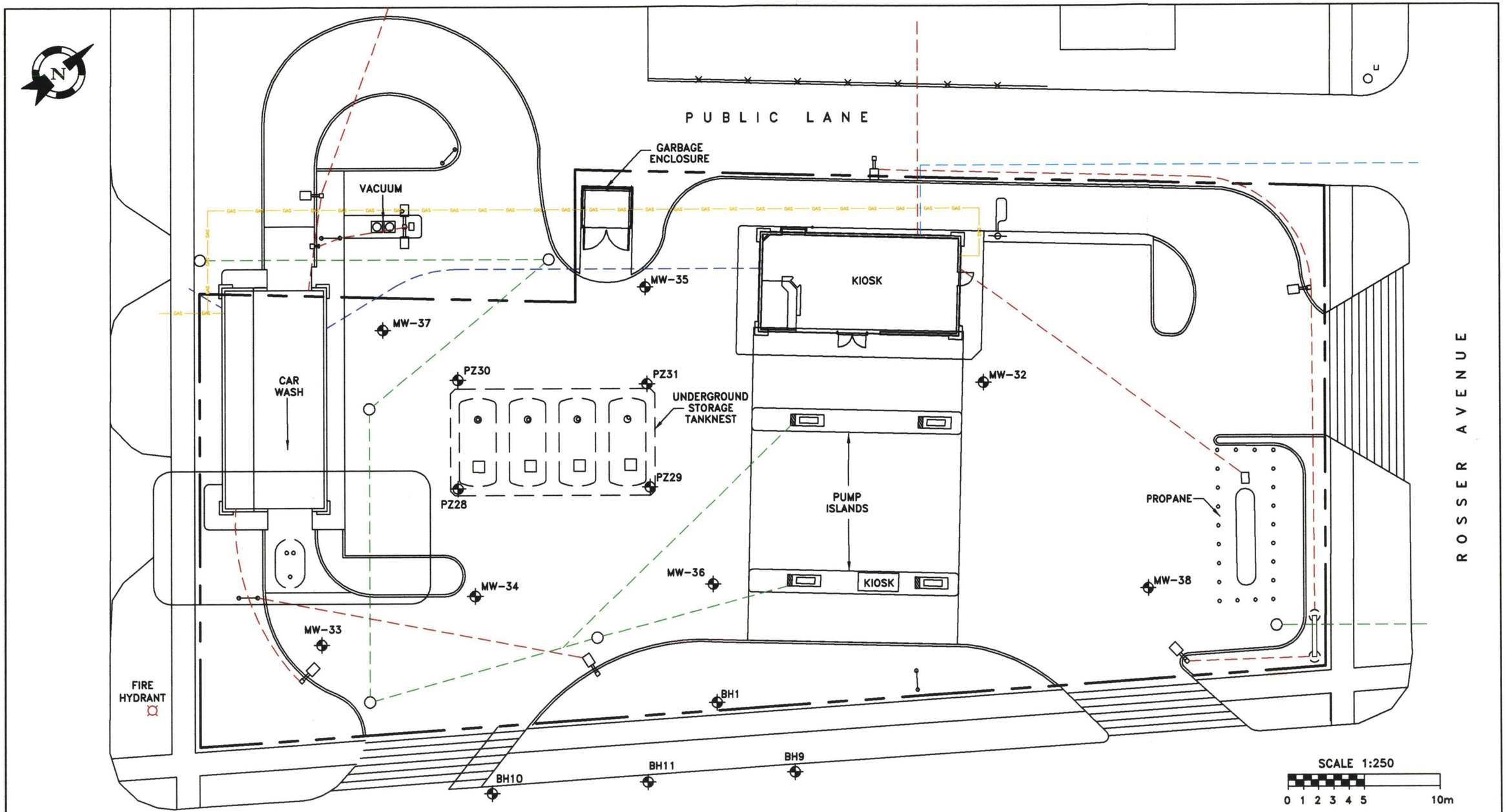
FIGURES



BASE MAP PROVIDED BY RAND MCNALLY, "MANITOBA, PROVINCIAL MAP".

AQUA TERRE	IMPERIAL OIL LIMITED RED RIVER ESSO (860265) SELKIRK, MANITOBA		Title: SITE LOCATION MAP	
	Project: 03937	Scale: ~1:100,000	Date: OCTOBER 2003	FIGURE 1
	Drawn by: BB	Approved: BK	Filename: FIG1	

F:\...\PROJ2003\03937\FIGURES\FIG1.CDR



LEGEND

⌖	MONITORING WELL LOCATION	GAS	GAS LINE
			TELEPHONE LINE
	WATER LINE		ELECTRIC LINE
	SEWER LINE		PROPERTY LINE

NOTES:
1. BASE PLAN FROM IMPERIAL OIL LIMITED, "SITE PLAN, 287 MAIN ST. & ROSSER AVE.", DWG. #86-0265-13."
2. SITE FEATURE LOCATIONS ARE APPROXIMATE.

AQUA TERRE

IMPERIAL OIL LIMITED RED RIVER ESSO (860265) SELKIRK, MANITOBA		Title: SITE PLAN	
Project: 03937	Scale: 1:250	Date: OCTOBER 2003	FIGURE 2
Drawn: BB	Approved: BK	Filename: FIG2	

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LEGEND	
C-3	ZONING DESIGNATION (Strip Commercial)
C-2	ZONING DESIGNATION (Central Commercial)
R	ZONING DESIGNATION (Residential)
(Residential)	CURRENT LAND USE

SCALE 1:1000

0 10 20 40(m)

NOTES:

1. BASE PLAN FROM IMPERIAL OIL LIMITED, "SITE PLAN, 287 MAIN ST. & ROSSER AVE.", DWG. #86-0265-13."
2. SITE FEATURE LOCATIONS ARE APPROXIMATE.

AQUA TERRE

IMPERIAL OIL LIMITED RED RIVER ESSO (860265) SELKIRK, MANITOBA		Title: SURROUNDING LAND USE	
Project: 03937	Scale: 1:1000	Date: OCTOBER 2003	FIGURE 3
Drawn: BB	Approved: BK	Filename: FIG3	

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PUBLIC LANE

ROSSER AVENUE

MAIN STREET

GARBAGE ENCLOSURE

VACUUM

CAR WASH

KIOSK

PUMP ISLANDS

KIOSK

PROPANE

FIRE HYDRANT

UNDERGROUND STORAGE TANKNEST

PZ30

PZ31

PZ28

PZ29

BH1

BH9

BH10

BH11

MW35-5	MW35-6
B=1.1	B=0.13
T=<0.10	T=<0.10
E=2.4	E=<0.10
X=3.7	X=<0.1
F1=220	F1=<10
F2=26	F2=<10
F3=29	F3=20
F4=<10	F4=<10
Pb=14.4	Pb=10.0

MW37-6	MW37-7	MW37-8
B=1.7	B=1.5	B=0.16
T=0.19	T=<0.10	T=<0.10
E=3.9	E=0.73	E=<0.10
X=9.5	X=6.3	X=3.9
F1=370	F1=59	F1=<10
F2=55	F2=<10	F2=<10
F3=18	F3=<10	F3=18
F4=<10	F4=<10	F4=<10
Pb=13.7	Pb=7.6	Pb=9.6

MW32-4	MW32-6
B=<0.04	B=<0.04
T=<0.10	T=<0.10
E=<0.10	E=<0.10
X=<0.1	X=<0.1
F1=<10	F1=<10
F2=<10	F2=<10
F3=<10	F3=<10
F4=<10	F4=<10
Pb=13.7	Pb=13.7

MW36-5	MW36-5*	MW36-6
B=2.6	***B=2.6***	B=0.89
T=0.48	T=1.0	T=<0.10
E=2.5	E=6.4	E=<0.10
X=6.5	X=19	X=0.2
F1=150	***F1=320***	F1=<10
F2=60	F2=64	F2=<10
F3=45	F3=22	F3=28
F4=<10	F4=<10	F4=13
Pb=14.5	Pb=13.4	Pb=9.8

MW34-4	MW34-4*	MW34-6
B=7.4	***B=2.8***	***B=2.3***
T=16	T=11	T=2.2
E=5.0	E=6.5	E=1.1
X=27	X=27	X=5.1
F1=310	***F1=420***	F1=58
F2=52	F2=63	F2=<10
F3=<10	F3=<10	F3=<10
F4=<10	F4=<10	F4=<10
Pb=15.2	Pb=14.6	Pb=8.8

MW33-4	MW33-5
B=<0.04	B=<0.04
T=<0.10	T=<0.10
E=<0.10	E=<0.10
X=<0.1	X=<0.1
F1=<10	F1=<10
F2=<10	F2=<10
F3=47	F3=<10
F4=40	F4=<10
Pb=11.3	Pb=15.3

MW38-2	MW38-3	MW38-5
B=<0.04	B=<0.04	B=<0.04
T=<0.10	T=<0.10	T=<0.10
E=<0.10	E=<0.10	E=<0.10
X=<0.1	X=<0.1	X=<0.1
F1=<10	F1=<10	F1=<10
F2=<10	F2=<10	F2=<10
F3=20	F3=42	F3=25
F4=<10	F4=<10	F4=<10
Pb=9.7	Pb=14.0	Pb=13.9

NOTES:

1. BASE PLAN FROM IMPERIAL OIL LIMITED, "SITE PLAN, 287 MAIN ST. & ROSSER AVE.", DWG. #86-0265-13."
2. SITE FEATURE LOCATIONS ARE APPROXIMATE.
3. B=BENZENE, T=TOLUENE, E=ETHYLBENZENE, X=XYLENES, F1=HYDROCARBON FRACTION C6-C10, F2=HYDROCARBON FRACTION C10-C16, F3=HYDROCARBON FRACTION C16-C34, F4=HYDROCARBON FRACTION C34-C50, Pb=LEAD.
4. CONCENTRATION UNITS=mg/kg (parts per million).
5. SOIL SAMPLES COLLECTED ON AUGUST 15, 2003.
6. ***BOLD***-LABORATORY ANALYSES EXCEEDS SELECTED AENV GUIDELINES (FINE GRAINED RESIDENTIAL CRITERIA).

LEGEND

- MONITORING WELL LOCATION
- * DUPLICATE LAB SAMPLE
- TELEPHONE LINE
- GAS GAS LINE
- WATER LINE
- ELECTRIC LINE
- SEWER LINE
- PROPERTY LINE

SCALE 1:250

0 1 2 3 4 5 10m

AQUA TERRE

IMPERIAL OIL LIMITED
RED RIVER ESSO (860265)
SELKIRK, MANITOBA

Title: SOIL ANALYTICAL RESULTS (BTEX, F1-F4 HYDROCARBONS & LEAD)

Project:	Scale:	Date:	
03937	1:250	OCTOBER 2003	FIGURE 4
Drawn: BB	Approved: BK	Filename: FIG4	

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N

PUBLIC LANE

GARBAGE ENCLOSURE

VACUUM

MW-35
96.35

KIOSK

MW-37
97.48

CAR WASH

PZ30

PZ31
97.97

UNDERGROUND STORAGE TANKNEST

MW-32
97.64

PZ28
98.02

PZ29
97.97

PUMP ISLANDS

PROPANE

MW-36
96.17

KIOSK

MW-34
96.59

MW-38
96.78

MW-33
97.22

FIRE HYDRANT

BH1
97.63

BH11
97.42

BH10
97.54

BH9
97.22

MAIN STREET

ROSSER AVENUE

SCALE 1:250

0 1 2 3 4 5 10m

NOTES:
1. BASE PLAN FROM IMPERIAL OIL LIMITED, "SITE PLAN, 287 MAIN ST. & ROSSER AVE.", DWG. #86-0265-13."
2. SITE FEATURE LOCATIONS ARE APPROXIMATE.
3. GROUNDWATER SURFACE ELEVATIONS MEASURED ON SEPTEMBER 11, 2003.

LEGEND

MONITORING WELL LOCATION	97.65	GROUNDWATER SURFACE ELEVATION AT MONITORING WELL (Relative to Local Datum)
TELEPHONE LINE	GAS	GAS LINE
WATER LINE		PROPERTY LINE
SEWER LINE		
ELECTRIC LINE		

AQUA TERRE

IMPERIAL OIL LIMITED
RED RIVER ESSO (860265)
SELKIRK, MANITOBA

Title: GROUNDWATER SURFACE ELEVATION IN MONITORING WELLS (SEPT. 11, 2003)

Project:	Scale:	Date:	
03937	1:250	OCTOBER 2003	FIGURE 5
Drawn: BB	Approved: BK	Filename: FIG5	

F:\NEW FILE SYSTEM\PROJECT FILES\PROJ2003\03937\FIGURES\FIG5.DWG

PUBLIC LANE

GARBAGE ENCLOSURE

VACUUM

MW-37
B=1.22
T=0.165
E=0.299
X=2.10
F1=1.2
F2=1.4

MW-35
B=2.68
T=0.178
E=0.131
X=0.270
F1=<0.1
F2=0.4

KIOSK

CAR WASH

PZ30

PZ31

UNDERGROUND STORAGE TANKNEST

PZ29

PZ28

MW-34
B=8.94
T=6.52
E=0.413
X=5.40
F1=<0.1
F2=1.9

MW-34*
B=8.84
T=6.61
E=0.33
X=5.10
F1=<0.1
F2=1.8

MW-36
B=0.0535
T=0.0005
E=0.0049
X=0.0048
F1=0.2
F2=<0.1

PUMP ISLANDS

MW-32
B=<0.0005
T=<0.0005
E=<0.0005
X=<0.0005
F1=<0.1
F2=<0.1

KIOSK

PROPANE

MW-38
B=<0.0005
T=<0.0005
E=<0.0005
X=<0.0005
F1=<0.1
F2=<0.1

MW-33
B=<0.0005
T=<0.0005
E=<0.0005
X=<0.0005
F1=<0.1
F2=<0.1

FIRE HYDRANT

BH1

BH9

BH11

BH10

MAIN STREET

ROSSER AVENUE

LEGEND

⊕	MONITORING WELL LOCATION	*	DUPLICATE LAB SAMPLE
TELEPHONE LINE		GAS	GAS LINE
WATER LINE		ELECTRIC LINE	
SEWER LINE		PROPERTY LINE	

SCALE 1:250

0 1 2 3 4 5 10m

NOTES:

1. BASE PLAN FROM IMPERIAL OIL LIMITED, "SITE PLAN, 287 MAIN ST. & ROSSER AVE.", DWG. #86-0265-13."
2. SITE FEATURE LOCATIONS ARE APPROXIMATE.
3. B=BENZENE, T=TOLUENE, E=ETHYLBENZENE, X=XYLENES, F1=HYDROCARBON FRACTION C6-C10, F2=HYDROCARBON FRACTION C10-C16.
4. CONCENTRATION UNITS=mg/L (parts per million).
5. GROUNDWATER SAMPLES COLLECTED ON SEPTEMBER 9, 2003.
6. ***BOLD***-LABORATORY ANALYSES EXCEEDS SELECTED AENV GUIDELINES (FINE GRAINED RESIDENTIAL CRITERIA).

AQUA TERRE

IMPERIAL OIL LIMITED
RED RIVER ESSO (860265)
SELKIRK, MANITOBA

Title: GROUNDWATER ANALYTICAL RESULTS (BTEX AND F1-F2 HYDROCARBONS)

Project:	Scale:	Date:	
03937	1:250	OCTOBER 2003	FIGURE 6
Drawn: BB	Approved: BK	Filename: FIG6	

F:\NEW FILE SYSTEM\PROJECT FILES\PROJ2003\03937\FIGURES\FIG6.DWG

APPENDIX A
FIELD METHODOLOGIES

AQUA TERRE SOLUTIONS: STANDARD PRACTICES AT IOL SITES

Aqua Terre Solutions Inc. (Aqua Terre) uses the following preferred operating practices for all work carried out on behalf of Imperial Oil Limited (IOL). Note that not all tasks detailed below have necessarily been conducted for the work program documented in this document.

Review of Historical Information

Aqua Terre will conduct and review historical information for the Site and adjacent properties to identify activities that could have impacted soil and groundwater. The information will include air photos, site plans, topographic and geologic maps, land titles, fire insurance plans, environmental investigations, city directories, Alberta Environment spill records, EUB spill records, and Environment Canada information on spills and environmental issues. The review will be used to finalize the intrusive investigations. As part of this task, Aqua Terre will obtain legal plans and have legal boundaries of the site verified and local benchmarks established by a land surveyor.

Monitoring and Sampling of Demolition Excavations

Aqua Terre will co-ordinate this task with the IOL contractor retained for the demolition. Prior to any field work commencing, Aqua Terre will attend the contractor Health and Safety "kick-off" meeting. Under this task, Aqua Terre personnel will monitor the removal of all underground structures (*i.e.*, building foundations and footings, piping, underground storage tanks, and other infrastructure) at the site.

Soil samples will be collected from the floors and walls of the building and underground storage tank excavations and areas visibly impacted. For these excavations, soil samples will be collected at a frequency of one sample per 5 m^2 of wall and one sample per 10 m^2 of floor. Samples will be split, and a portion monitored for hydrocarbon vapours using a GasTech® (model 1238) organic vapour meter (OVM) and a portion placed immediately in laboratory jars and immediately stored in coolers with ice. The OVM will be calibrated in the field in non-methane response mode to two hexane gas standards. Soil samples will be logged for lithology and evidence of impact.

Based on the highest OVM readings, soil samples will be submitted to IOL's contract laboratory for selected analytical parameters in accordance with Alberta Environment's submission requirements. Blind duplicate soil samples (approximately 1 for every 10 samples collected) will be submitted for Quality Assurance/Quality Control (QA/QC) purposes. A complete chain of custody form will accompany all submitted samples.

Test Pit Excavations

Test pits will be excavated by IOL's contractor to 1 m below impact or to the maximum reach of the excavator. Test pits will be logged for lithology and inspected for evidence of impact. Soil samples will be collected from test pits every 0.6 m depth and will be split, screened, logged, and handled in the same manner as the excavation samples. At a

minimum, the sample with the highest OVM reading from each test pit will be submitted for laboratory analyses. Additional samples may be submitted to delineate the vertical extent of impacted soil. Blind duplicate soil samples (approximately 1 for every 10 samples collected) will be submitted for QA/QC purposes. A complete chain of custody form will accompany all submitted samples.

Borehole Drilling

Aqua Terre will implement its Health and Safety Program as per IOL's standards and conduct a "kick-off" meeting prior to commencing this task. Boreholes will be drilled with hollow stem augers (approximately 7 5/8" O.D., 4 ¼" I.D.) to a maximum depth below visual/OVM evidence of hydrocarbon contamination or to auger refusal (whichever is greatest).

Soil samples will be collected with a split spoon sampling device every 0.75 m except where frozen soil or surficial fill will be encountered. In this case, the borehole will be advanced with a solid stem auger and samples will be taken at 0.6 m intervals directly from the auger. The outer 0.5 cm of the samples will trimmed to avoid cross contamination from the auger and from the inner surface of the borehole. All soil samples will be logged for lithology and evidence of hydrocarbon impacts. Soil samples will be split, screened, inspected, logged, and handled in the same manner as the excavation samples. At a minimum, the sample with the highest OVM reading from each borehole will be submitted to IOL's contract laboratory for selected analytical parameters in accordance with Alberta Environment submission requirements. Blind duplicate soil samples (approximately 1 for every 10 samples collected) will be submitted for QA/QC purposes. A complete chain of custody form will accompany all submitted samples.

Monitoring Well Installation

Monitoring wells will be located based on findings from the historical review, field measurements and evidence of impacts. In addition, wells may be located to provide spatial coverage and to determine background (*i.e,.* upgradient) water quality.

Monitoring wells will be constructed using flush threaded (F480) 50 mm diameter schedule 40 PVC coupled to a 3.0 m length (No. 10 Slot) PVC well screen. Clean 10/20 grade silica sand is installed from the base of the monitoring well to approximately 0.3 m above the well screen. In general, monitoring wells will be placed so that well screen intersects the water table in order to detect the presence of phase separated hydrocarbons. A bentonite seal (consisting of granular or pellet bentonite clay) will be placed above the sandpack to ground surface. A protective steel casing with locking cap will be placed around each monitoring well at surface. Alternatively, flush mount surface casing (typically set in concrete) will be used in high traffic areas.

In some locations, information pertinent to the vertical hydraulic gradient is required. In these locations, monitoring well nests (completed in separate boreholes) are preferred over multi-level (bundle) monitoring wells, since there is a lower probability of the

monitoring well "leaking" and compromising the water level and water quality results. If multi-level monitoring wells are required, a minimum 1.0 m bentonite seal must separate each monitoring interval. Monitoring wells should be surveyed after installation. Top of casing, top of riser pipe, and ground surface elevations will be surveyed at each well, and the reference datum will be indicated on the borehole log. A monitoring well log detailing well installations and observations made during drilling will be prepared for each monitoring well.

Site Monitoring and Groundwater Sampling

Monitoring well sampling involves the collection of representative groundwater samples for laboratory analyses. The primary purpose of groundwater sampling is to assess background water quality and to establish the nature (*i.e.,* type and concentration) of parameters of concern.

Recommended Procedure:

- Measure OVM readings at all monitoring well locations;
- Measure static water levels and compare with historical values (if available);
- Purge the monitoring well of at least 3 well volumes, or purge dry 3 times. (A well volume is defined as the standpipe volume plus the sandpack pore volume);
- Sample using dedicated bailers or PVC tubing;
- Determine field measured parameters (e.g. temperature, pH, and electrical conductivity) and compare with historical values (if available);
- Ensure each sample is properly labelled with the monitoring well number; and
- All samples will be stored in coolers at 4°C and will be immediately shipped to the laboratory after sampling. A chain of custody form MUST accompany all samples. A copy of this form is to remain with the Aqua Terre representative.

It should be noted the technician will collect samples using clean, disposable latex gloves and will field filter and acidify samples (as necessary).

Water Level Monitoring

Water level monitoring involves determination of the equilibrated or static water level in the monitoring well. This information can then be used to calculate vertical and lateral hydraulic gradients, and to determine the direction of lateral groundwater flow.

Recommended Procedure:

- Water level monitoring should be done in all accessible monitoring wells whether or not samples are to be collected for laboratory analysis;
- Water levels will be measured using an electronic water level tape and be recorded to the nearest 0.5 cm relative to the top of the PVC pipe;
- Successive measurements (a minimum of 10 minutes apart) should be made to ensure equilibrium conditions exist;
- Fluid levels will be expressed relative to a local site or geodetic datum; and,
- The electronic water tape should be thoroughly cleansed before it is used in other monitoring wells.

Hydraulic Testing

Single well hydraulic testing involves removal of water in the well and measuring the subsequent recovery of the groundwater level in the monitoring well. This type of test is used to estimate the hydraulic conductivity of the geologic material in the immediate vicinity of the well. Hydraulic conductivity results are used to estimate lateral groundwater flow velocity and, in turn, the potential for offsite impacts to occur.

Recommended Procedure:

Hydraulic testing can be carried out using one of the following techniques:

- "Slug" tests involve instantaneously increasing or decreasing the water level in the monitoring well, and measuring the response in water levels. Care should be taken to ensure that the slug of water is added/removed instantaneously. If a solid object is to be added to the monitoring well, it should remain fully submersed at the end of the test. Slug tests are typically analysed using either the Hvorslev (1951) or Bouwer and Rice (1976) methods for an unconfined aquifer or the Bouwer and Rice (1976) method for a confined aquifer.
    - Pumping tests involve pumping a well at a constant rate and measuring the water level response in the pumping well and observation wells (if available). Regulatory approvals (e.g. license to divert groundwater) may be required if the volume of water to be pumped exceeds a prescribed limit. Both groundwater level drawdown and recovery should be measured in the pumping well and all observation wells. While conducting the test it is important to ensure that the flow rate does not vary by more than 5%. Pumping or aquifer tests will be analysed using an appropriate analytical solution for an unconfined or confined aquifer.

Non-Aqueous Phase Monitoring

Non-aqueous phase monitoring involves the measurement of product thickness in monitoring wells. Light non-aqueous phase liquid (LNAPL), typically most petroleum products, have a specific gravity less than 1.0 and therefore will float on the water table. In contrast, dense non-aqueous phase liquid (DNAPL) (*e.g.,* chlorinated solvents and coal tar) have a specific gravity greater than 1.0 and will tend to migrate and accumulate at the base of the water bearing unit.

The intent of non-aqueous phase monitoring is to provide a quantitative measure of the apparent thickness of free product in the subsurface.

Recommended Procedure:

- An electronic hydrocarbon-water interface probe will be used to determine the presence and apparent thickness of NAPL in each monitoring well. Product interface measurements should be measured relative to the top of the PVC riser pipe;
- The existence of product will be confirmed using clear bottom filling bailers; and,
- The probe must be cleansed and decontaminated before use in another monitoring well.

Soil Vapour Well Installation

Soil vapour wells are installed using a direct push geoprobe technique. The geoprobe is advanced into the subsurface with a hand-held, direct push drill. Once the geoprobe is at the desired depth, the drilling apparatus is removed and the vapour well is installed through the centre of the probe.

The screen is a 15 cm length by 1 cm width stainless steel fitting with a threaded bottom. A 3 mm diameter Teflon tubing is attached to the top of the screen and the well is inserted into the geoprobe. The threaded end of the screen is secured to the sacrificial endpoint of the geoprobe to keep the well anchored into the subsurface.

As the geoprobe is removed, glass beads are used to backfill around the screen and a powdered bentonite / glass bead mixture is used to backfill the hole to grade. The bentonite mixture is hydrated, a protective cap is placed over the clamped well head, and the area is restored to its original condition.

Soil Vapour Sampling

A 1.7 L, vacated stainless steel canister(s) is obtained from the laboratory and brought to site. Approximately, three casing volumes are purged from the well using an air pump. The canisters are checked with a pressure gauge to ensure there are no leaks. An air flow control devise is attached to the canister and both are subsequently connected to the well. The flow control devise is calibrated by the laboratory to collect the sample over a desired length of time. The time period for the sample collection is dependant on the type of material and moisture content of the soil. Once the sample is collected, the canisters are removed from the well, sealed, and sent to the laboratory for analyses. The wells are immediately clamped and the protective casing is restored.

REFERENCES

Bouwer, H. and R.C. Rice, 1976. "*A Slug Test Method for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partial Penetrating Wells*". Water Resources Research, vol. 12, no. 3, pp. 423-428.

Hvorslev, M.J., 1951. "*Time Lag and Soil Permeability in Ground-Water Observations*". Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp.1-50.

APPENDIX B
BOREHOLE LOGS AND HYDRAULIC CONDUCTIVITY TEST RESULTS

BOREHOLE LOGS

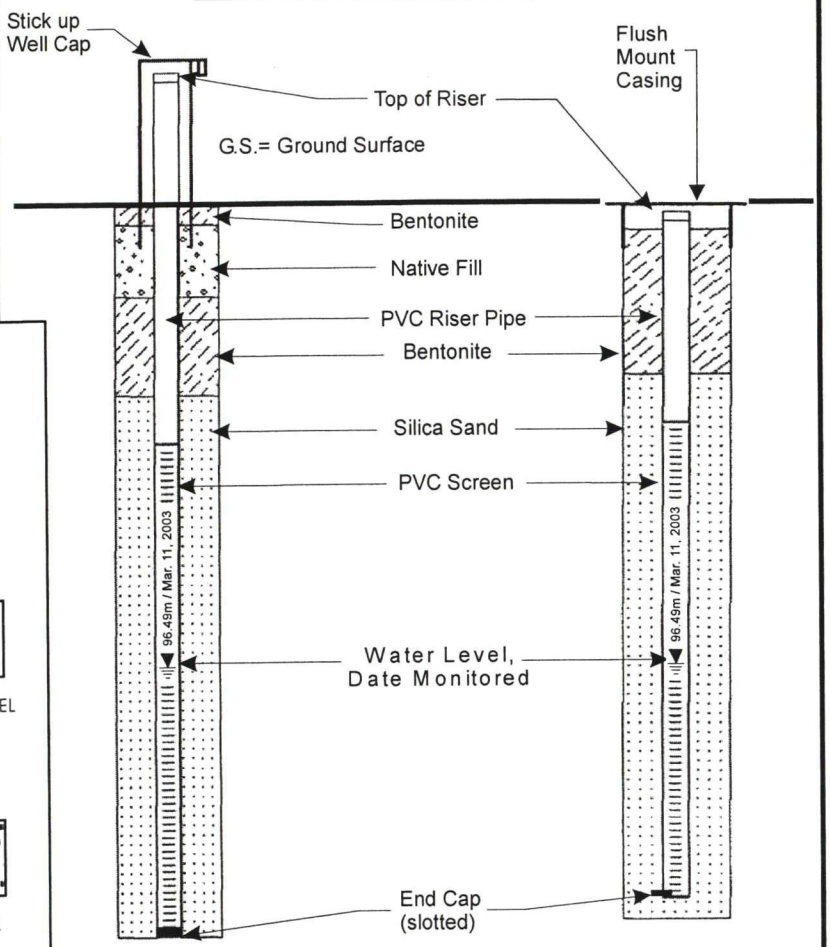
BOREHOLE LOG LEGEND

AQUA TERRE

SAMPLING

- SPLIT SPOON SAMPLED INTERVAL
- BEDROCK CORED SECTION
- GRAB SAMPLE (AUGER/EXCAVATOR)
- NO SAMPLE RECOVERY
- SAMPLE SUBMITTED FOR LABORATORY ANALYSIS
- SHELBY TUBE SAMPLE

WELL INSTALLATION



GRAPHIC LOG

WELL MATERIALS

SILICA SAND, NATIVE FILL, GRAVEL, SAND AND GRAVEL FILL, BENTONITE, CONCRETE, PEA GRAVEL

NATIVE SOILS

SANDY CLAY, SANDY SILT, CLAYEY SAND, TOPSOIL, CLAY, SILT, SAND, GRAVEL, PEAT, TILL, SILTY CLAY, CLAYEY SILT, SILTY SAND, SANDY GRAVEL

BEDROCK

UNDIFFER-ENTIATED ROCK, LIMESTONE, SANDSTONE, GRANITE, SHALE, WEATHERED SHALE, MUDSTONE, META-MORPHIC, SEDIMENTARY, VOLCANIC

FILL

ASPHALT, CONCRETE, GRAVEL, SAND, SILT, CLAY, PAVEMENT, MIXED DEBRIS, SOD, SANDY TOPSOIL AND GRAVEL, PAVEMENT PIECES

Soil Description Chart

DESCRIPTION	(>50%)	AND (>35%–50%)	(21–35%)	SOME (11–20%)	TRACE (1–10%)
FINE	GRAVEL	GRAVEL	GRAVELLY	GRAVEL	GRAVEL
MEDIUM	SAND	SAND	SANDY	SAND	SAND
COARSE	SILT	SILT	SILTY	SILT	SILT
	CLAY	CLAY	CLAYEY	CLAY	CLAY

Borehole/Monitoring Well ID: MW-32

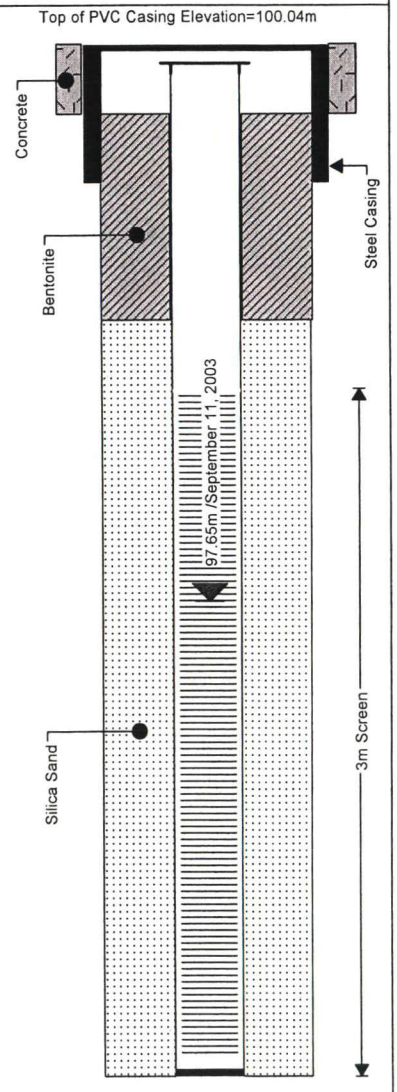
Project No.: 03937
Client: Imperial Oil Limited
Location: Red River Esso (860265)
Date Completed: August 15, 2003
Site Datum: West Bolt on Lightpost

ATSI Supervisor: B. Kohlsmith
Drilling Method: Auger (Split Spoon)
Borehole Diameter: 15cm
Monitoring Well Diameter: 5cm

Drilling Company: Paddock Drilling
Drilling Equipment: Hollow Stem Auger
Well Casing: 5cm PVC Solid Pipe
Well Screen: 5cm PVC Slotted Pipe
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							GROUND SURFACE	100.12
0							ASPHALT	
1		MW32-1		25 ppmv			dry, yellow, loose SAND FILL; gravelly	100.00
2							damp, grey, very stiff CLAY FILL; gravelly, some silt	
3	1	6-5-7	MW32-2	25 ppmv	50		grey SILT; clayey, some sand, trace gravel	
4							sand seam (2cm thickness)	99.00
5		3-5-6	MW32-3	10 ppmv	50		moist, greyish-brown, stiff CLAY; silty, trace gravel	
6	2							
7								98.00
8		3-6-6	MW32-4	50 ppmv	75		light brown	
9								
10	3	3-3-5	MW32-5	20 ppmv	100			97.00
11								
12								
13	4	5-5-5	MW32-6	<5 ppmv	100			96.00
14								
15							End of Hole at 4.6m	

MONITORING WELL CONSTRUCTION / BOREHOLE BACKFILL DETAILS



(1) Blow count per 0.15 m
(2) Organic Vapour Meter (OVM) reading

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

♦ = Sample submitted for laboratory analysis

Soil samples MW32-4 and MW32-6 were submitted for laboratory analyses of CCME -PHC (Fractions 1-4 plus BTEX) and lead.

Borehole/Monitoring Well ID: MW-33

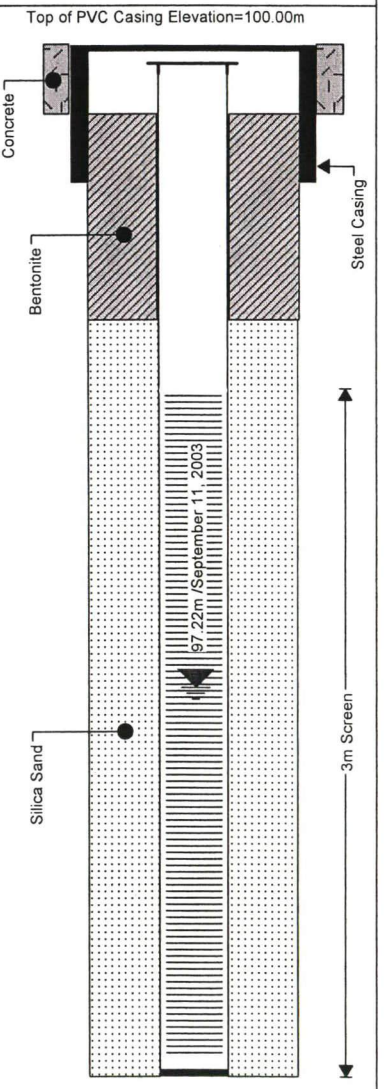
Project No.: 03937
Client: Imperial Oil Limited
Location: Red River Esso (860265)
Date Completed: August 15, 2003
Site Datum: West Bolt on Lightpost

ATSI Supervisor: B. Kohlsmith
Drilling Method: Auger (Split Spoon)
Borehole Diameter: 15cm
Monitoring Well Diameter: 5cm

Drilling Company: Paddock Drilling
Drilling Equipment: Hollow Stem Auger
Well Casing: 5cm PVC Solid Pipe
Well Screen: 5cm PVC Slotted Pipe
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							GROUND SURFACE	100.07
0							ASPHALT	
1		MW33-1		25 ppmv			yellow, coarse grained SAND; gravelly	
2								
3 / 1		MW33-2		5 ppmv				99.00
4							damp, black, firm SILT; sandy, trace gravel	
5								
6	3-4-4	MW33-3		20 ppmv	75		damp, grey, stiff CLAY; silty, trace sand some discontinuous black staining	
7 / 2								98.00
8								
9	2-2-5	MW33-4		25 ppmv	30		moist, brown, stiff SILT; sandy, trace clay some black staining	
10 / 3							moist, brown, stiff CLAY; silty	97.00
11	1-2-3	MW33-5		25 ppmv	100			
12								
13 / 4								96.00
14	1-2-4	MW33-6		25 ppmv	100			
15							End of Hole at 4.6m	

MONITORING WELL CONSTRUCTION / BOREHOLE BACKFILL DETAILS



(1) Blow count per 0.15 m
(2) Organic Vapour Meter (OVM) reading

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

♦ = Sample submitted for laboratory analysis

Soil samples MW33-4 and MW33-5 were submitted for laboratory analyses of CCME -PHC (Fractions 1-4 plus BTEX) and lead.

Borehole/Monitoring Well ID: MW-34

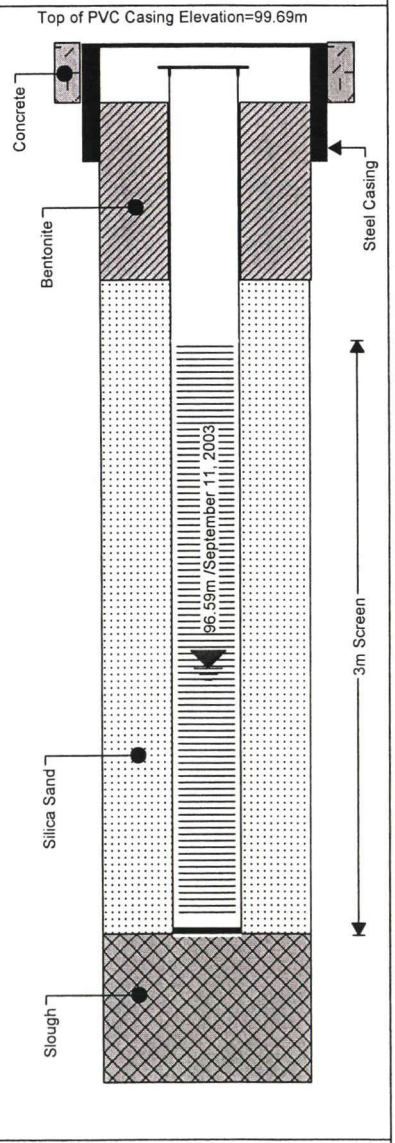
Project No.: 03937
Client: Imperial Oil Limited
Location: Red River Esso (860265)
Date Completed: August 15, 2003
Site Datum: West Bolt on Lightpost

ATSI Supervisor: B. Kohlsmith
Drilling Method: Auger (Split Spoon)
Borehole Diameter: 15cm
Monitoring Well Diameter: 5cm

Drilling Company: Paddock Drilling
Drilling Equipment: Hollow Stem Auger
Well Casing: 5cm PVC Solid Pipe
Well Screen: 5cm PVC Slotted Pipe
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							GROUND SURFACE	99.80
0							ASPHALT	
1		MW34-1		60 ppmv			yellow SAND; gravelly	
2								
3 / 1		MW34-2		60 ppmv				99.00
4							greyish-black, firm SILT; clayey, some sand, trace gravel	
5							damp, grey, very stiff CLAY; silty	
6 / 2	4-5-8	MW34-3		125 ppmv	75			98.00
7								
8	2-3-4	MW34-4		45% LEL	100			
9								97.00
10 / 3								
11	2-2-3	MW34-5		16% LEL	100			
12								
13 / 4	4-5-8	MW34-6		400 ppmv	100		some sand	96.00
14								
15								
16 / 5	3-4-5	MW34-7		50 ppmv	100		brown SILT; clayey, some sand	95.00
17								
18							End of Hole at 5.3m	

MONITORING WELL CONSTRUCTION / BOREHOLE BACKFILL DETAILS



(1) Blow count per 0.15 m
(2) Organic Vapour Meter (OVM) reading

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

♦ = Sample submitted for laboratory analysis

Soil samples MW34-4, MW34-6 and MW34-7 were submitted for laboratory analyses of CCME -PHC (Fractions 1-4 plus BTEX) and lead.

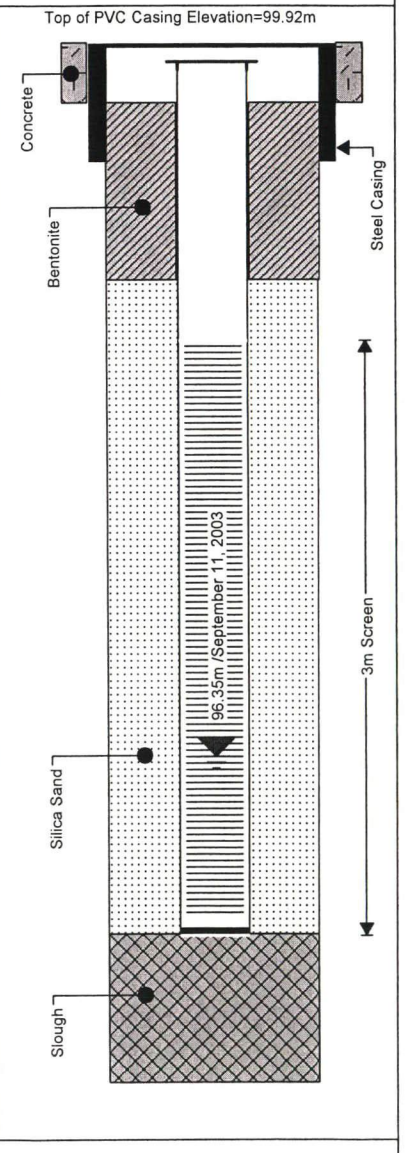
Borehole/Monitoring Well ID: MW-35

Project No.: 03937
Client: Imperial Oil Limited
Location: Red River Esso (860265)
Date Completed: August 15, 2003
Site Datum: West Bolt on Lightpost

ATSI Supervisor: B. Kohlsmith
Drilling Method: Auger (Split Spoon)
Borehole Diameter: 15cm
Monitoring Well Diameter: 5cm

Drilling Company: Paddock Drilling
Drilling Equipment: Hollow Stem Auger
Well Casing: 5cm PVC Solid Pipe
Well Screen: 5cm PVC Slotted Pipe
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0 / 0							GROUND SURFACE	100.01
0 / 0							ASPHALT	
0 / 0							yellow SAND FILL; gravelly	
1 / 0		MW35-1		100 ppmv			damp, greyish-black, very stiff SILT; clayey, some sand, trace gravel	
2 / 1	6-6-7	MW35-2		75 ppmv	10			99.00
5 / 2	4-5-6	MW35-3		125 ppmv	75		damp, brownish-grey, very stiff CLAY; silty, some sand reddish	98.00
8 / 3	3-4-5	MW35-4		200 ppmv	100			
10 / 3	3-3-4	MW35-5		6% LEL	100			97.00
13 / 4	3-3-3	MW35-6		125 ppmv	100		some sand	96.00
15 / 5	3-4-6	MW35-7		100 ppmv	100		moist, brown, stiff SILT; sandy, some coal and clay, trace gravel	
16 / 5							medium grained sand seam (7.5cm thickness)	95.00
18							End of Hole at 5.3m	



MONITORING WELL CONSTRUCTION / BOREHOLE BACKFILL DETAILS

(1) Blow count per 0.15 m
(2) Organic Vapour Meter (OVM) reading

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

♦ = Sample submitted for laboratory analysis

Soil samples MW35-5 and MW35-6 were submitted for laboratory analyses of CCME -PHC (Fractions 1-4 plus BTEX) and lead. Soil sample MW35-3 was submitted for grain size analysis.

Borehole/Monitoring Well ID: MW-36

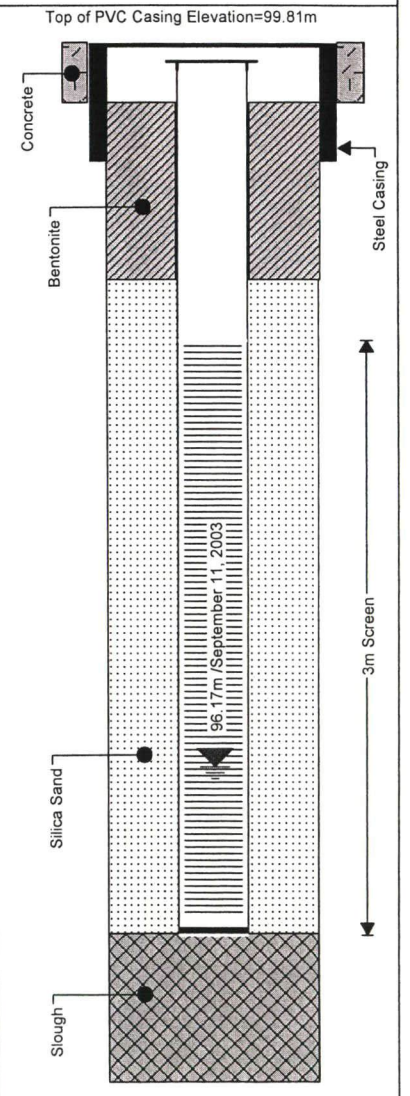
Project No.: 03937
Client: Imperial Oil Limited
Location: Red River Esso (860265)
Date Completed: August 15, 2003
Site Datum: West Bolt on Lightpost

ATSI Supervisor: B. Kohlsmith
Drilling Method: Auger (Split Spoon)
Borehole Diameter: 15cm
Monitoring Well Diameter: 5cm

Drilling Company: Paddock Drilling
Drilling Equipment: Hollow Stem Auger
Well Casing: 5cm PVC Solid Pipe
Well Screen: 5cm PVC Slotted Pipe
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0 / 0							GROUND SURFACE	99.89
							ASPHALT	
1 /		MW36-1		70 ppmv			yellow SAND FILL; gravelly	
2 /								
3 / 1		MW36-2		225 ppmv				99.00
4 /							green SAND; silty, some clay, trace gravel	
5 /							damp, greyish-black, very stiff CLAY; silty, trace sand	
6 / 2	4-5-7	MW36-3		100 ppmv	45			98.00
7 /								
8 /	3-4-4	MW36-4		6% LEL	100			
9 /								
10 / 3	3-3-4	MW36-5		20% LEL	100			97.00
11 /								
12 /								
13 / 4	2-3-4	MW36-6		150 ppmv	100		sand interbeds (<1cm thickness)	96.00
14 /								
15 /								
16 / 5	3-4-6	MW36-7		60 ppmv	100			95.00
17 /								
18 /							End of Hole at 5.3m	

MONITORING WELL CONSTRUCTION / BOREHOLE BACKFILL DETAILS



(1) Blow count per 0.15 m
(2) Organic Vapour Meter (OVM) reading

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

♦ = Sample submitted for laboratory analysis

Soil samples MW36-5 and MW36-6 were submitted for laboratory analyses of CCME -PHC (Fractions 1-4 plus BTEX) and lead.

Borehole/Monitoring Well ID: MW-37

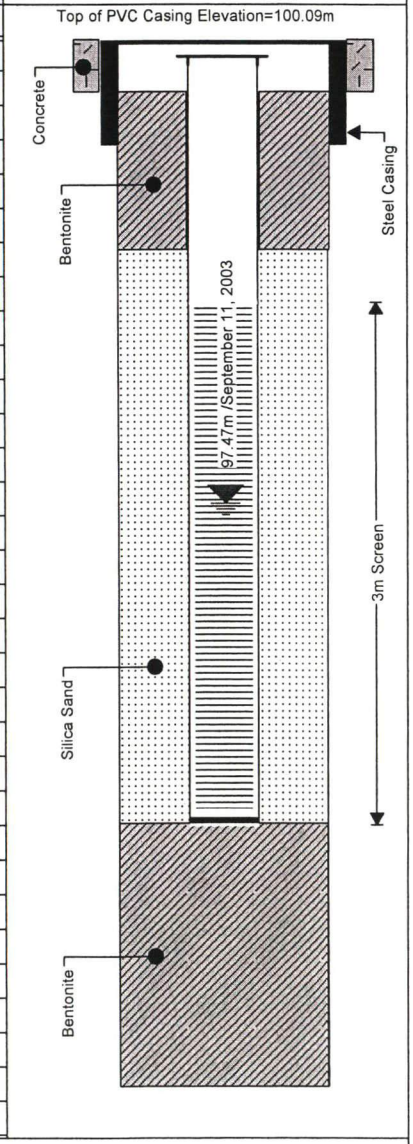
Project No.: 03937
Client: Imperial Oil Limited
Location: Red River Esso (860265)
Date Completed: August 15, 2003
Site Datum: West Bolt on Lightpost

ATSI Supervisor: B. Kohlsmith
Drilling Method: Auger (Split Spoon)
Borehole Diameter: 15cm
Monitoring Well Diameter: 5cm

Drilling Company: Paddock Drilling
Drilling Equipment: Hollow Stem Auger
Well Casing: 5cm PVC Solid Pipe
Well Screen: 5cm PVC Slotted Pipe
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							GROUND SURFACE	100.17
0							ASPHALT	
1		MW37-1		70 ppmv			dry to damp, greyish-black, firm SAND; silty, some gravel some black staining	100.00
2								
3		MW37-2		60 ppmv				
4	1							99.00
5							dry to damp, grey, very stiff SILT; clayey, trace gravel	
6		3-6-7	MW37-3	70 ppmv	50		dry to damp, greyish-brown, very stiff CLAY; silty, trace gravel	
7	2							98.00
8		4-5-5	MW37-4	150 ppmv	75			
9								
10	3							
11		2-3-5	MW37-5	300 ppmv	100			97.00
12								
13	4	2-3-4	MW37-6	9% LEL	100			
14								96.00
15							moist, light brown, firm SILT TILL; clayey, some sand, trace gravel and coal fragments	
16		4-5-5	MW37-7	6% LEL	100			
17	5							95.00
18								
19		2-3-3	MW37-8	75 ppmv	100		medium grained sand interbed (10cm thickness)	
20	6							
							End of Hole at 6.1m	94.00

MONITORING WELL CONSTRUCTION / BOREHOLE BACKFILL DETAILS



(1) Blow count per 0.15 m
(2) Organic Vapour Meter (OVM) reading

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

♦ = Sample submitted for laboratory analysis

Soil samples MW37-6, MW37-7 and MW37-8 were submitted for laboratory analyses of CCME -PHC (Fractions 1-4 plus BTEX) and lead.

Borehole/Monitoring Well ID: MW-38

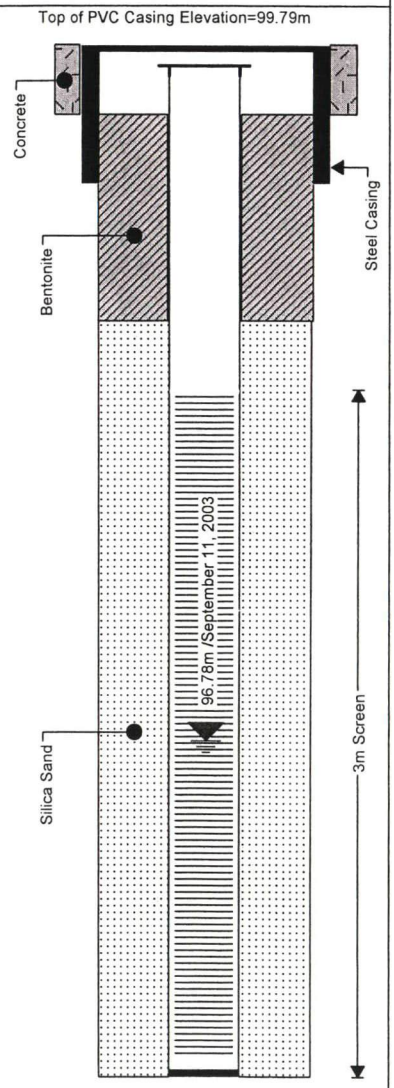
Project No.: 03937
Client: Imperial Oil Limited
Location: Red River Esso (860265)
Date Completed: August 15, 2003
Site Datum: West Bolt on Lightpost

ATSI Supervisor: B. Kohlsmith
Drilling Method: Auger (Split Spoon)
Borehole Diameter: 15cm
Monitoring Well Diameter: 5cm

Drilling Company: Paddock Drilling
Drilling Equipment: Hollow Stem Auger
Well Casing: 5cm PVC Solid Pipe
Well Screen: 5cm PVC Slotted Pipe
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0 / 0							GROUND SURFACE	99.87
							ASPHALT	
							yellow, loose SAND FILL; gravelly	
1 / 2		MW38-1		75 ppmv			damp, black, stiff SILT; sandy, some clay, trace gravel	
3 / 4	1	MW38-2		130 ppmv				99.00
5 / 6							damp, grey, very stiff CLAY; silty, some sand	
	4-6-7	MW38-3		75 ppmv	50			98.00
7 / 8	2							
	3-4-4	MW38-4		25 ppmv	100			
9 / 10	3							97.00
	3-4-4	MW38-5		30 ppmv	100			
11 / 12								
	3-4-6	MW38-6		<5 ppmv	100			96.00
13 / 14	4							
15							End of Hole at 4.6m	

MONITORING WELL CONSTRUCTION / BOREHOLE BACKFILL DETAILS



(1) Blow count per 0.15 m
(2) Organic Vapour Meter (OVM) reading

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

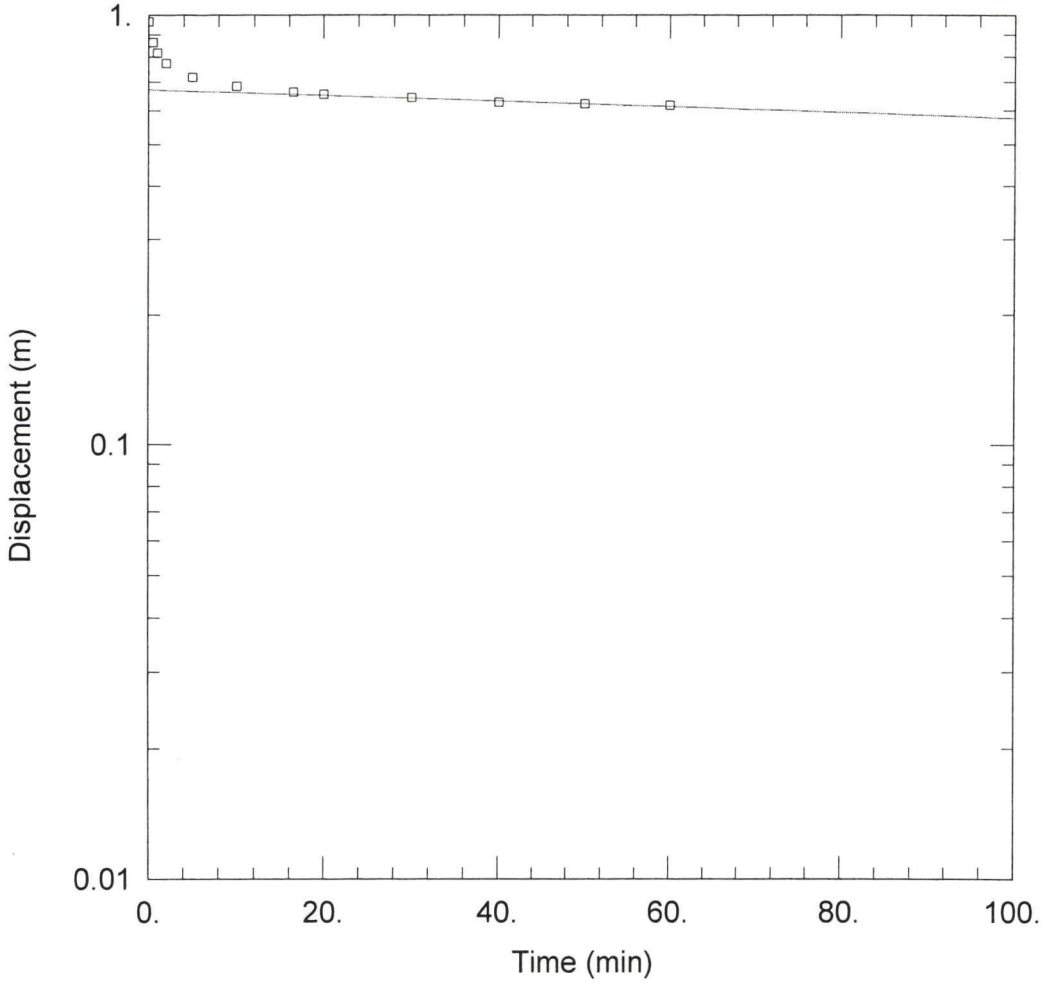
Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

♦ = Sample submitted for laboratory analysis

Soil samples MW38-2, MW38-3 and MW38-5 were submitted for laboratory analyses of CCME -PHC (Fractions 1-4 plus BTEX) and lead. Soil sample MW38-4 was submitted for grain size analysis.

HYDRAULIC CONDUCTIVITY TEST RESULTS

AQUA TERRE



HYDRAULIC CONDUCTIVITY AT MW-32

Data Set: Q:\PROJECTS\PROJ_2~1\03937\K-TESTS\MW-32.AQT
Date: 10/20/03 Time: 10:13:26

PROJECT INFORMATION

Company: Aqua Terre Solutions
Client: Imperial Oil Limited
Project: 03937
Test Location: Red River Esso
Test Well: MW-32
Test Date: 11-Sep-03

AQUIFER DATA

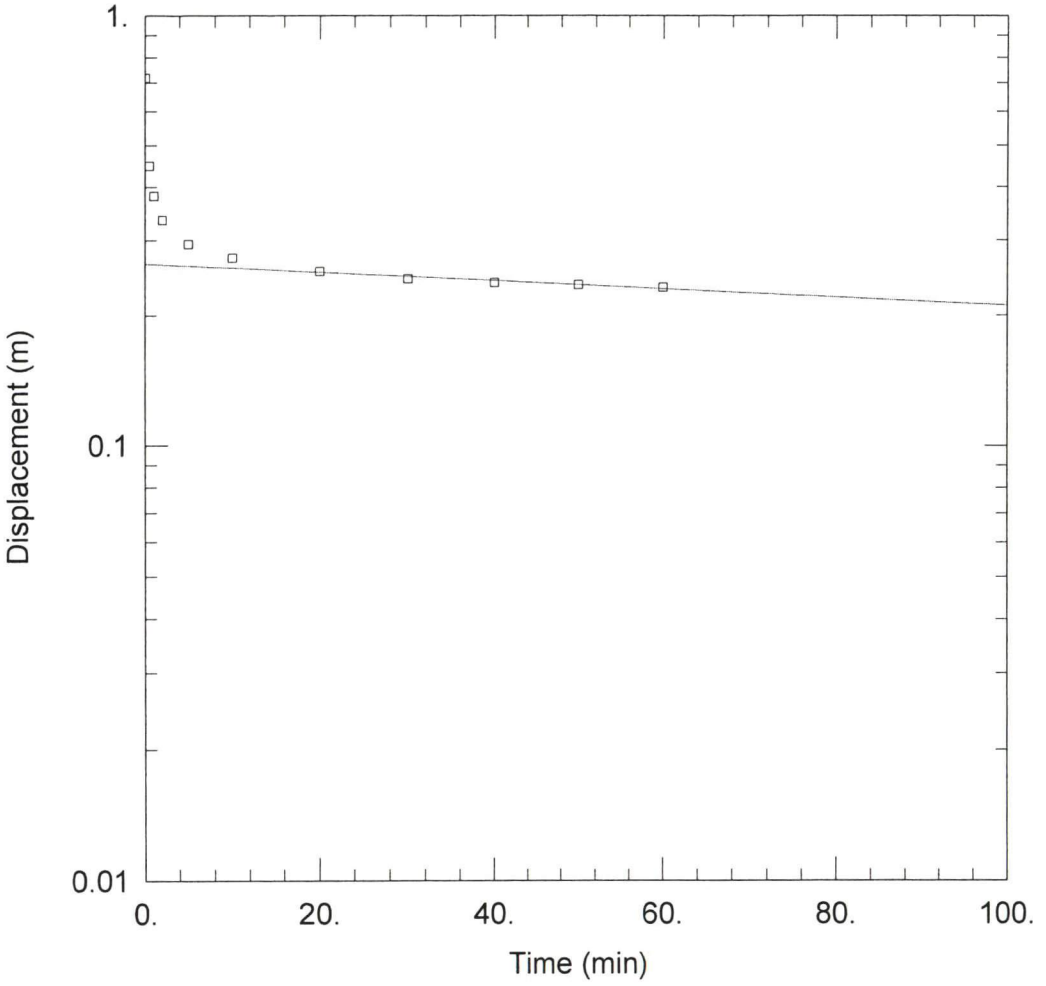
Saturated Thickness: 2.141 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 0.966 m
Casing Radius: 0.025 m
Screen Length: 3. m
Water Column Height: 2.141 m
Wellbore Radius: 0.1 m
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.96E-08 m/sec
y0 = 0.671 m



HYDRAULIC CONDUCTIVITY AT MW-33

Data Set: Q:\PROJECTS\PROJ_2~1\03937\K-TESTS\MW-33.AQT
Date: 10/20/03 Time: 10:13:23

PROJECT INFORMATION

Company: Aqua Terre Solutions
Client: Imperial Oil Limited
Project: 03937
Test Location: Red River Esso
Test Well: MW-33
Test Date: 11-Sep-03

AQUIFER DATA

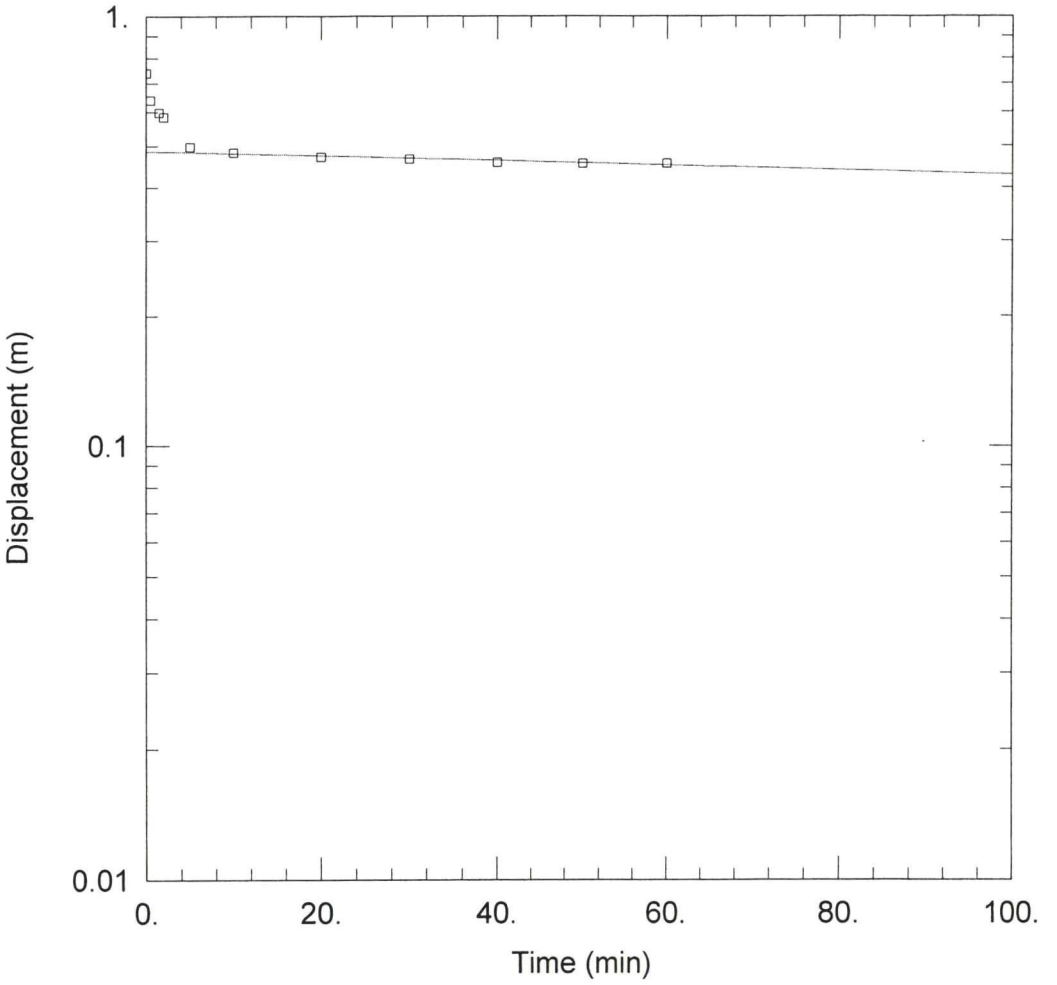
Saturated Thickness: 1.228 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 0.718 m
Casing Radius: 0.025 m
Screen Length: 3. m
Water Column Height: 1.228 m
Wellbore Radius: 0.1 m
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.675E-08 m/sec
y0 = 0.2643 m



HYDRAULIC CONDUCTIVITY AT MW-34

Data Set: Q:\PROJECTS\PROJ_2~1\03937\K-TESTS\MW-34.AQT
Date: 10/20/03 Time: 10:13:19

PROJECT INFORMATION

Company: Aqua Terre Solutions
Client: Imperial Oil Limited
Project: 03937
Test Location: Red River Esso
Test Well: MW-34
Test Date: 11-Sep-03

AQUIFER DATA

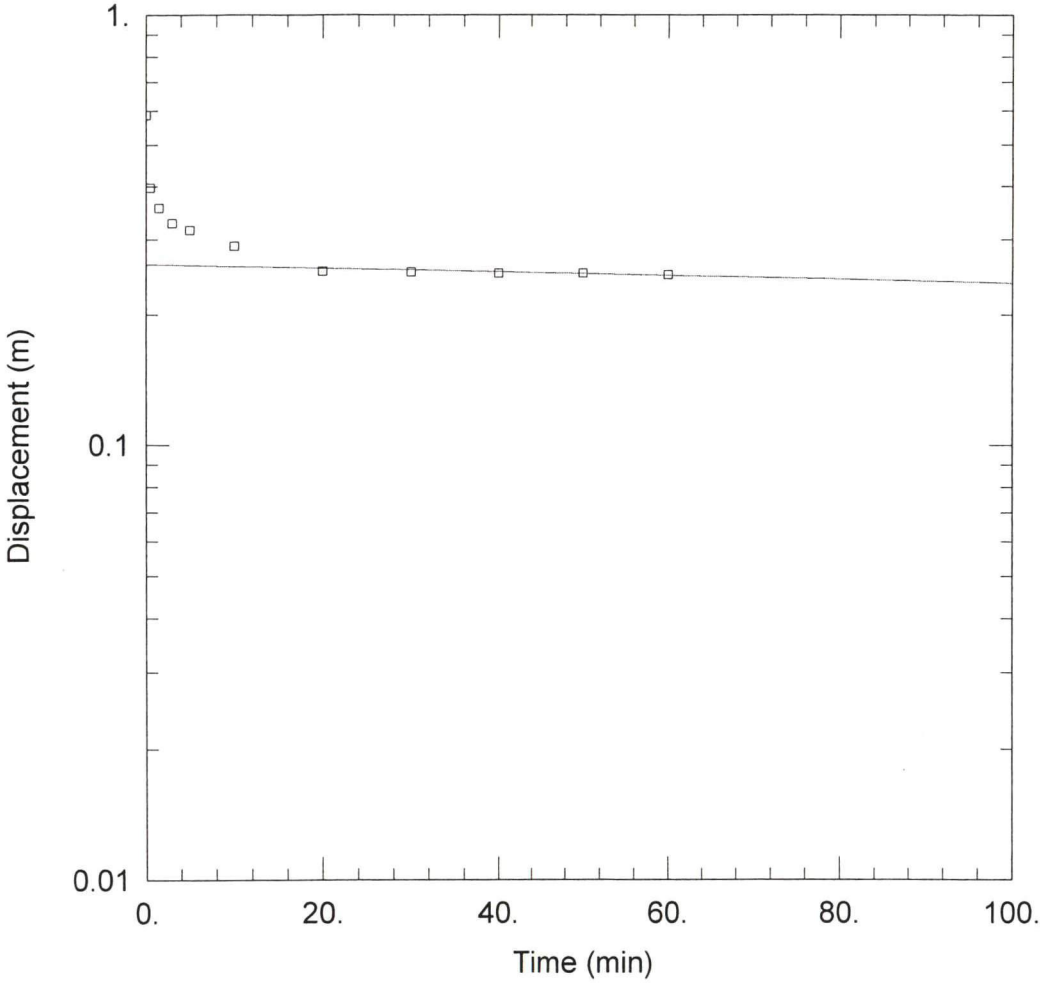
Saturated Thickness: 1.299 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 0.739 m
Casing Radius: 0.025 m
Screen Length: 3. m
Water Column Height: 1.299 m
Wellbore Radius: 0.1 m
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.104E-08 m/sec
y0 = 0.486 m



HYDRAULIC CONDUCTIVITY AT MW-35

Data Set: Q:\PROJECTS\PROJ_2~1\03937\K-TESTS\MW-35.AQT
Date: 10/20/03 Time: 10:13:15

PROJECT INFORMATION

Company: Aqua Terre Solutions
Client: Imperial Oil Limited
Project: 03937
Test Location: Red River Esso
Test Well: MW-35
Test Date: 11-Sep-03

AQUIFER DATA

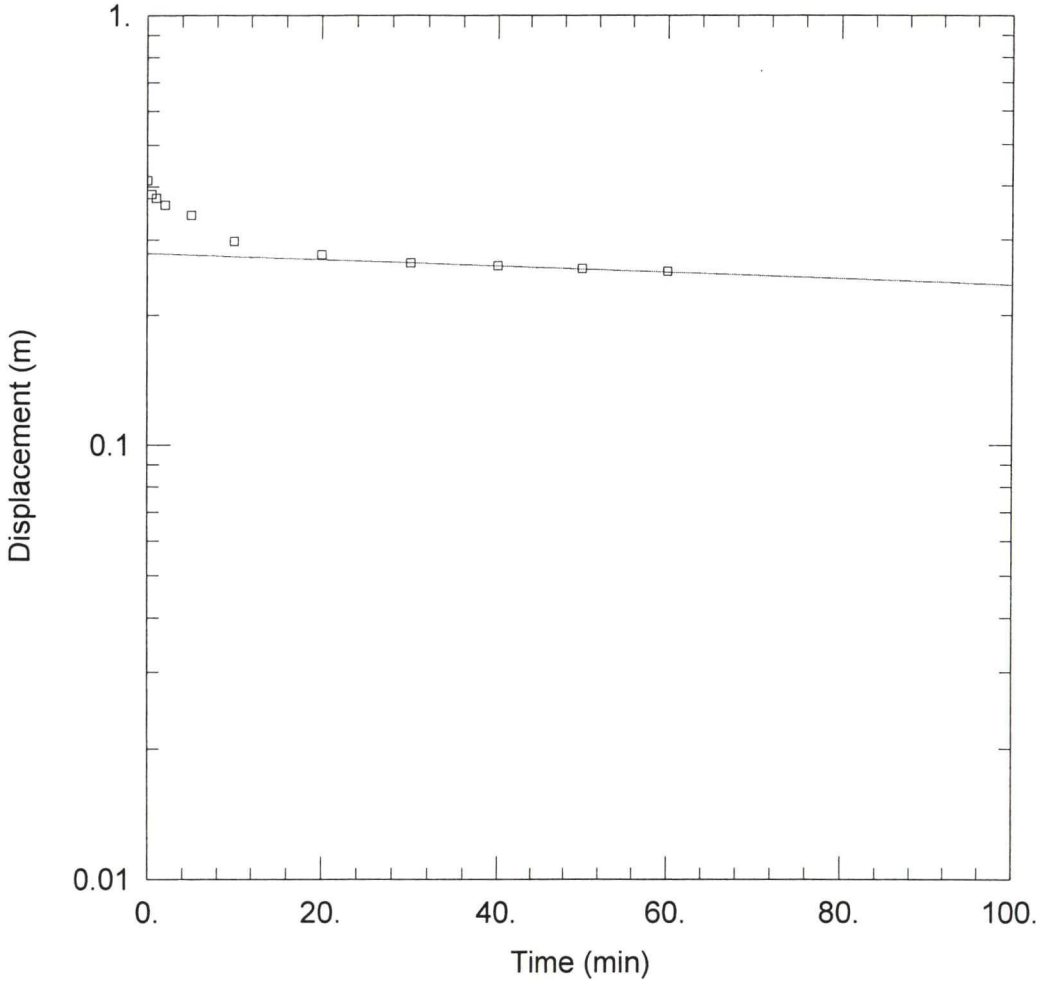
Saturated Thickness: 0.907 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 0.587 m
Casing Radius: 0.025 m
Screen Length: 3. m
Water Column Height: 0.907 m
Wellbore Radius: 0.1 m
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.463E-08 m/sec
y0 = 0.2624 m



HYDRAULIC CONDUCTIVITY AT MW-36

Data Set: Q:\PROJECTS\PROJ_2~1\03937\K-TESTS\MW-36.AQT
Date: 10/20/03 Time: 10:13:11

PROJECT INFORMATION

Company: Aqua Terre Solutions
Client: Imperial Oil Limited
Project: 03937
Test Location: Red River Esso
Test Well: MW-36
Test Date: 11-Sep-03

AQUIFER DATA

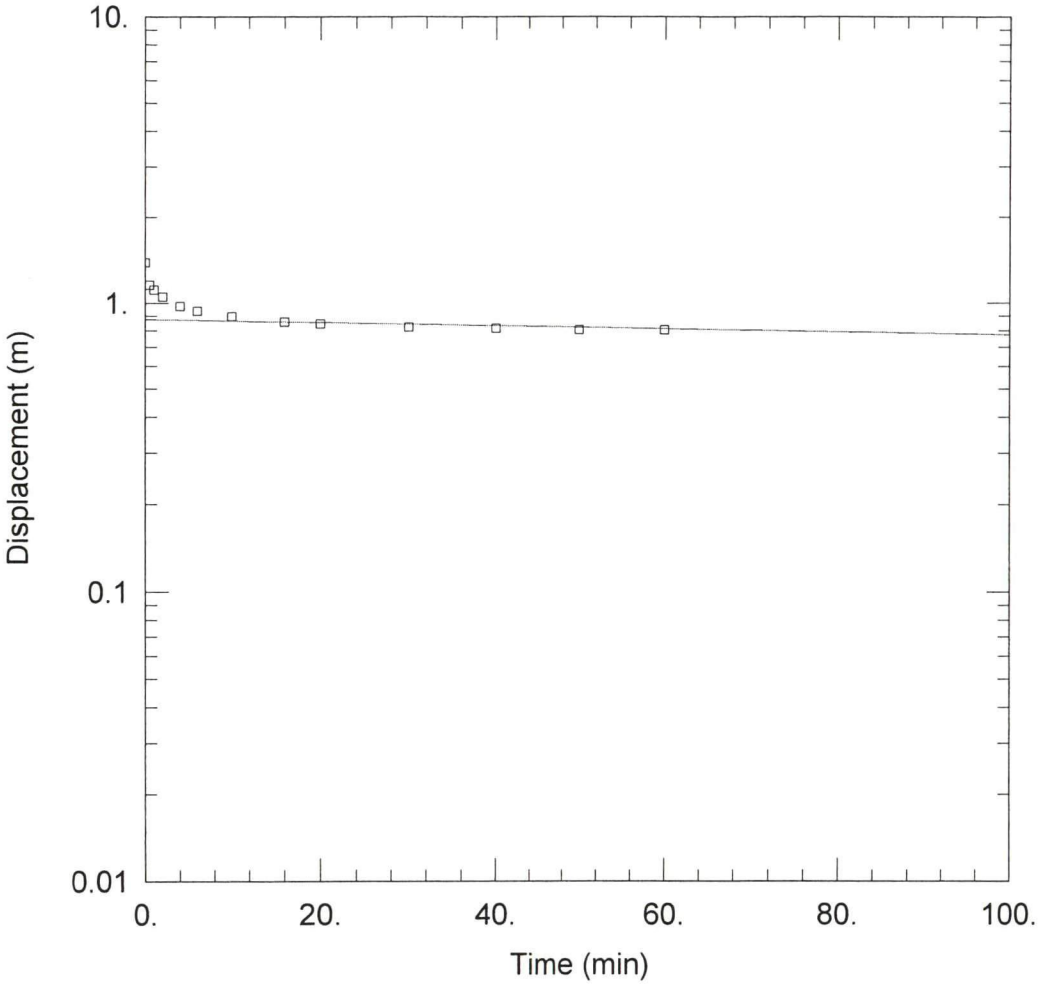
Saturated Thickness: 0.814 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 0.414 m
Casing Radius: 0.025 m
Screen Length: 3. m
Water Column Height: 0.814 m
Wellbore Radius: 0.1 m
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.376E-08 m/sec
y0 = 0.279 m



HYDRAULIC CONDUCTIVITY AT MW-37

Data Set: Q:\PROJECTS\PROJ_2~1\03937\K-TESTS\MW-37.AQT
Date: 10/20/03 Time: 10:13:06

PROJECT INFORMATION

Company: Aqua Terre Solutions
Client: Imperial Oil Limited
Project: 03937
Test Location: Red River Esso
Test Well: MW-37
Test Date: 11-Sep-03

AQUIFER DATA

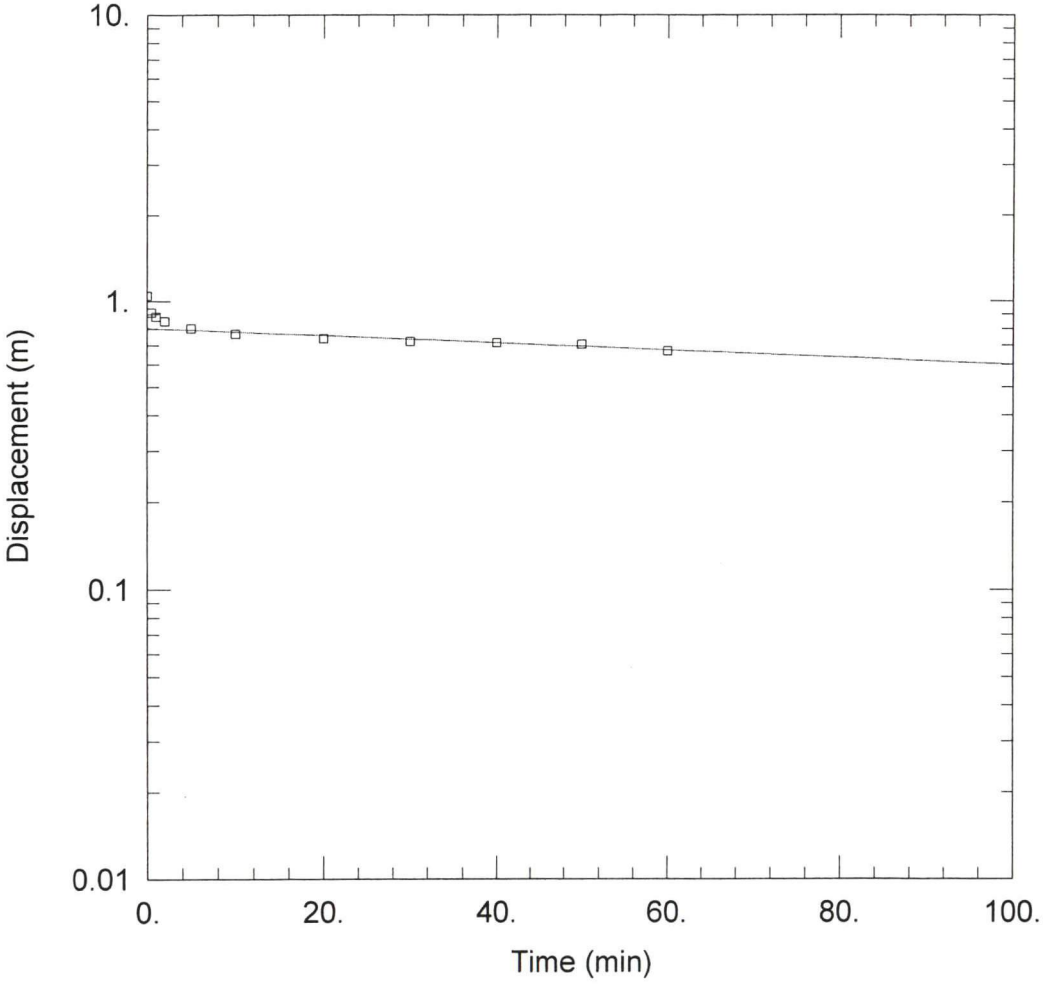
Saturated Thickness: 1.865 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 1.385 m
Casing Radius: 0.025 m
Screen Length: 3. m
Water Column Height: 1.865 m
Wellbore Radius: 0.1 m
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.296E-08 m/sec
y0 = 0.8753 m



HYDRAULIC CONDUCTIVITY AT MW-38

Data Set: Q:\PROJECTS\PROJ_2~1\03937\K-TESTS\MW-38.AQT
Date: 10/20/03 Time: 10:13:02

PROJECT INFORMATION

Company: Aqua Terre Solutions
Client: Imperial Oil Limited
Project: 03937
Test Location: Red River Esso
Test Well: MW-38
Test Date: 11-Sep-03

AQUIFER DATA

Saturated Thickness: 1.522 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 1.042 m
Casing Radius: 0.025 m
Screen Length: 3. m
Water Column Height: 1.522 m
Wellbore Radius: 0.1 m
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 5.112E-08 m/sec
y0 = 0.8026 m

APPENDIX C
SITE PHOTOGRAPHS

Photograph 1: View looking west. Monitoring well locations as shown above.

Photograph 2: View looking northeast. From front to back, monitoring wells MW-33, MW-34 & MW-36.

Photograph 3: Monitoring wells MW-34 & MW-36, as shown above, looking north.

Photograph 4: View looking east. Monitoring wells as shown above.

APPENDIX D
LABORATORY CERTIFICATES OF ANALYSES

SOIL

9619 42 Avenue
Edmonton, Alberta
Canada T6E 5R2
Tel 780 465 1212
Fax 780 450 4187

26-Aug-03

Certificate of Analysis

Reported To :

AQUA TERRE SOLUTIONS

Client Code 5Y

800, 736 - 8th AVENUE, SW
CALGARY, ALBERTA
T2P 1H4

Attention : MICHELLE WRIGHT
Phone : (403) 266-2555
FAX : (403) 266-2554

Project Information :

Project ID : 03937- RED RIVER ESSO
Submitted By: BRAD K.

Requisition Forms :

Form 42030734 shipped on 18-Aug-03 received on 19-Aug-03 logged on 20-Aug-03 completed on 26-Aug-03
Form 42030736 shipped on 18-Aug-03 received on 19-Aug-03 logged on 20-Aug-03 completed on 26-Aug-03

Remarks :

+ All blank values are reported. Associated data are not blank corrected.
+ 'MDL' = Method Detection Limit, '<' = Less than MDL, '---' = Not analyzed
+ Solids results are based on dry weight except Biota Analyses & Special Waste Oil & Grease
+ Organic analyses are not corrected for extraction recovery standards except for Isotope Dilution methods, (i.e. CARB 429 PAH, all PCDD/F and DBD/DBF analyses)
+ All CCME results met required criteria unless otherwise stated in the report.
  All data on final reports are validated by technical personnel. Signature on file at laboratory.
  Deviations from Reference Method for the Canadian-wide Standard for Petroleum Hydrocarbons in Soil - Tier 1 Method:
  - F1 data reported using validated headspace instrumentation method
  - F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction
+ All Groundwater samples except BTEX/VOC's or Purgeable Hydrocarbons are decanted and/or filtered prior to analysis unless otherwise mandated by regulatory agency
+ All analysis data reported was generated when the analytical methods were in statistical control and IOL criteria for spike recoveries, reference material recoveries, method blank data and duplicate precision were met unless otherwise stated
+

Methods used by Philip are based upon those found in 'Standard Methods for the Examination of Water and Wastewater', 20th Edition, published by the American Public Health Association, or on US EPA protocols found in the 'Test Methods For Evaluating Solid Waste, Physical/Chemical Method, SW846', 3rd Edition. Other procedures are based on methodologies accepted by the appropriate regulatory agency. Methodology briefs are available by written request.

All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies, quality assurance and quality control procedures except where otherwise agreed to by the client and testing company in writing. Liability for any and all use of these test results shall be limited to the actual cost of the pertinent analysis done. There is no other warranty expressed or implied.
Your samples will be retained at Philip for a period of 30 days from receipt of data or as per contract.

PHILIP Project Manager: Geraldlyn Gouthro

26-Aug-03

ANALYTICAL REPORT

Client : AQUA TERRE SOLUTIONS
Project : 03937- RED RIVER ESSO

Sparcode	Parameter	Unit	MDL	Philip ID : 33028854 Client ID : MW32-4	33028855 MW32-6	33028856 MW33-4	33028857 MW33-5
PHYSICAL							
TEMPARRI	Temperature Arrival	Celsius	0	1	1	1	1
00250760	Moisture	%(W/W)	0.3	29.3	33.9	23.7	36.6
METALS TOTAL							
PbMTMS20	Lead - Total	ug/g	5.0	13.7	10.8	11.3	15.3
HYDROCARBONS							
EX995149	PHC EXT F2 - 4	date		03/08/21	03/08/21	03/08/21	03/08/21
EX995170	Volat. Soil Extract.	date		03/08/21	03/08/21	03/08/21	03/08/21
PHC1PHCV	CCME PHC F1 C6-10	ug/g	10	< 10	< 10	< 10	< 10
HC1-CALC	CCME PHC F1-BTEX	ug/g		< 10	< 10	< 10	< 10
PHC2PHCS	CCME PHC F2 C10-16	ug/g	10	< 10	< 10	< 10	< 10
PHC3PHCS	CCME PHC F3 C16-34	ug/g	10	< 10	< 10	47	< 10
PHC4PHCS	CCME PHC F4 C34-50+	ug/g	10	< 10	< 10	40	< 10
BASEPHCS	PHC F2-4 BASELINE 0	Y/N	Yes	Yes	Yes	Yes	Yes
VOLATILE ORGANICS							
B020PT12	Benzene	ug/g	0.04	< 0.04	< 0.04	< 0.04	< 0.04
T001PT12	Toluene	ug/g	0.10	< 0.10	< 0.10	< 0.10	< 0.10
B021PT12	Ethylbenzene	ug/g	0.10	< 0.10	< 0.10	< 0.10	< 0.10
X003PT12	m+p - Xylene	ug/g	0.10	< 0.10	< 0.10	< 0.10	< 0.10
X002PT12	o - Xylene	ug/g	0.10	< 0.10	< 0.10	< 0.10	< 0.10
X_882_10	Xylenes	ug/g	0.1	< 0.1	< 0.1	< 0.1	< 0.1
SURROGATE RECOVERY							
VS01PT12	Bromofluorobenzene	%	0	108	110	108	104
VS03PT12	d8-Toluene	%	0	109	107	109	107
Ed10PT12	Ethylbenzene-d10	%	60	100	98	97	98
				Matrix : Soil	Soil	Soil	Soil
				Sampled on: 03/08/15 16:00	03/08/15 16:00	03/08/15 16:00	03/08/15 16:00

26-Aug-03

ANALYTICAL REPORT

Client : AQUA TERRE SOLUTIONS
Project : 03937- RED RIVER ESSO

Sparcode	Parameter	Unit	MDL	Philip ID : 33028858 Client ID : MW34-4	33028859 MW34-14	33028860 MW34-6	33028861 MW34-7
PHYSICAL							
TEMPARRI	Temperature Arrival	Celsius	0	1	1	1	1
00250760	Moisture	%(W/W)	0.3	33.3	36.6	31.0	20.3
003I0711	<200mesh or <0.075mm	%(W/W)	0.1	---	---	---	86.6
003E0710	>200mesh or >0.075mm	%(W/W)	0.1	---	---	---	13.4
METALS TOTAL							
PbMTMS20	Lead - Total	ug/g	5.0	15.2	14.6	8.8	---
HYDROCARBONS							
EX995149	PHC EXT F2 - 4	date		03/08/21	03/08/21	03/08/21	---
EX995170	Volat. Soil Extract.	date		03/08/21	03/08/21	03/08/21	---
PHC1PHCV	CCME PHC F1 C6-10	ug/g	10	370	470	69	---
HC1-CALC	CCME PHC F1-BTEX	ug/g		310	420	58	---
PHC2PHCS	CCME PHC F2 C10-16	ug/g	10	52	63	< 10	---
PHC3PHCS	CCME PHC F3 C16-34	ug/g	10	< 10	< 10	< 10	---
PHC4PHCS	CCME PHC F4 C34-50+	ug/g	10	< 10	< 10	< 10	---
BASEPHCS	PHC F2-4 BASELINE 0	Y/N	Yes	Yes	Yes	Yes	---
VOLATILE ORGANICS							
B020PT12	Benzene	ug/g	0.04	7.4	2.8	2.3	---
T001PT12	Toluene	ug/g	0.10	16	11	2.2	---
B021PT12	Ethylbenzene	ug/g	0.10	5.0	6.5	1.1	---
X003PT12	m+p - Xylene	ug/g	0.10	19	19	4.1	---
X002PT12	o - Xylene	ug/g	0.10	7.5	7.6	1.0	---
X_882_10	Xylenes	ug/g	0.1	27	27	5.1	---
SURROGATE RECOVERY							
VS01PT12	Bromofluorobenzene	%	0	105	107	106	---
VS03PT12	d8-Toluene	%	0	109	108	105	---
Ed10PT12	Ethylbenzene-d10	%	60	101	97	95	---
				Matrix : Soil	Soil	Soil	Soil
				Sampled on: 03/08/15 16:00	03/08/15 16:00	03/08/15 16:00	03/08/15 16:00

26-Aug-03
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ANALYTICAL REPORT

Client : AQUA TERRE SOLUTIONS
Project : 03937- RED RIVER ESSO

Sparcode	Parameter	Unit	MDL	Philip ID : 33028862 Client ID : MW35-3	33028863 MW35-5	33028864 MW35-6	33028865 MW36-5
PHYSICAL							
TEMPARRI	Temperature Arrival	Celsius	0	1	1	1	1
00250760	Moisture	%(W/W)	0.3	28.5	34.3	22.9	35.8
003I0711	<200mesh or <0.075mm	%(W/W)	0.1	99.8	---	---	---
003E0710	>200mesh or >0.075mm	%(W/W)	0.1	0.2	---	---	---
METALS TOTAL							
PbMTMS20	Lead - Total	ug/g	5.0	---	14.4	10.0	14.5
HYDROCARBONS							
EX995149	PHC EXT F2 - 4	date		---	03/08/22	03/08/22	03/08/22
EX995170	Volat. Soil Extract.	date		---	03/08/21	03/08/21	03/08/21
PHC1PHCV	CCME PHC F1 C6-10	ug/g	10	---	230	< 10	160
HC1-CALC	CCME PHC F1-BTEX	ug/g		---	220	< 10	150
PHC2PHCS	CCME PHC F2 C10-16	ug/g	10	---	26	< 10	60
PHC3PHCS	CCME PHC F3 C16-34	ug/g	10	---	29	20	45
PHC4PHCS	CCME PHC F4 C34-50+	ug/g	10	---	< 10	< 10	< 10
BASEPHCS	PHC F2-4 BASELINE 0	Y/N	Yes	---	Yes	Yes	Yes
VOLATILE ORGANICS							
B020PT12	Benzene	ug/g	0.04	---	1.1	0.13	2.6
T001PT12	Toluene	ug/g	0.10	---	< 0.10	< 0.10	0.48
B021PT12	Ethylbenzene	ug/g	0.10	---	2.4	< 0.10	2.5
X003PT12	m+p - Xylene	ug/g	0.10	---	3.7	< 0.10	5.6
X002PT12	o - Xylene	ug/g	0.10	---	< 0.10	< 0.10	0.90
X_882_10	Xylenes	ug/g	0.1	---	3.7	< 0.1	6.5
SURROGATE RECOVERY							
VS01PT12	Bromofluorobenzene	%	0	---	106	107	108
VS03PT12	d8-Toluene	%	0	---	107	108	109
Ed10PT12	Ethylbenzene-d10	%	60	---	97	104	99
				Matrix : Soil	Soil	Soil	Soil
				Sampled on: 03/08/15 16:00	03/08/15 16:00	03/08/15 16:00	03/08/15 16:00

26-Aug-03

ANALYTICAL REPORT

Client : AQUA TERRE SOLUTIONS
Project : 03937- RED RIVER ESSO

				Philip ID :	33028866	33028867	33028868	33028869
				Client ID :	MW36-15	MW36-6	MW37-6	MW37-7
Sparcode	**Parameter**	**Unit**	**MDL**					
PHYSICAL								
TEMPARRI	Temperature Arrival	Celsius	0		1	1	1	1
00250760	Moisture	%(W/W)	0.3		30.8	22.3	31.1	19.8
METALS TOTAL								
PbMTMS20	Lead - Total	ug/g	5.0		13.4	9.8	13.7	7.6
HYDROCARBONS								
EX995149	PHC EXT F2 - 4	date			03/08/22	03/08/22	03/08/22	03/08/22
EX995170	Volat. Soil Extract.	date			03/08/21	03/08/21	03/08/21	03/08/21
PHC1PHCV	CCME PHC F1 C6-10	ug/g	10		350	< 10	390	68
HC1-CALC	CCME PHC F1-BTEX	ug/g			320	< 10	370	59
PHC2PHCS	CCME PHC F2 C10-16	ug/g	10		64	< 10	55	< 10
PHC3PHCS	CCME PHC F3 C16-34	ug/g	10		22	28	18	< 10
PHC4PHCS	CCME PHC F4 C34-50+	ug/g	10		< 10	13	< 10	< 10
BASEPHCS	PHC F2-4 BASELINE 0	Y/N	Yes		Yes	Yes	Yes	Yes
VOLATILE ORGANICS								
B020PT12	Benzene	ug/g	0.04		2.6	0.89	1.7	1.5
T001PT12	Toluene	ug/g	0.10		1.0	< 0.10	0.19	< 0.10
B021PT12	Ethylbenzene	ug/g	0.10		6.4	< 0.10	3.9	0.73
X003PT12	m+p - Xylene	ug/g	0.10		16	0.15	7.9	4.9
X002PT12	o - Xylene	ug/g	0.10		2.9	< 0.10	1.6	1.4
X_882_10	Xylenes	ug/g	0.1		19	0.2	9.5	6.3
SURROGATE RECOVERY								
VS01PT12	Bromofluorobenzene	%	0		104	104	88	93
VS03PT12	d8-Toluene	%	0		112	109	93	91
Ed10PT12	Ethylbenzene-d10	%	60		103	101	87	82
				Matrix :	Soil	Soil	Soil	Soil
				Sampled on:	03/08/15 16:00	03/08/15 16:00	03/08/15 16:00	03/08/15 16:00

26-Aug-03

ANALYTICAL REPORT

Client : AQUA TERRE SOLUTIONS
Project : 03937- RED RIVER ESSO

Sparcode	Parameter	Unit	MDL	Philip ID : 33028870 Client ID : MW37-8	33028871 MW38-2	33028872 MW38-3	33028873 MW38-4
PHYSICAL							
TEMPARRI	Temperature Arrival	Celsius	0	1	1	1	1
00250760	Moisture	%(W/W)	0.3	23.9	17.2	26.1	32.2
003I0711	<200mesh or <0.075mm	%(W/W)	0.1	---	---	---	99.9
003E0710	>200mesh or >0.075mm	%(W/W)	0.1	---	---	---	0.1
METALS TOTAL							
PbMTMS20	Lead - Total	ug/g	5.0	9.6	9.7	14.0	---
HYDROCARBONS							
EX995149	PHC EXT F2 - 4	date		03/08/22	03/08/22	03/08/22	---
EX995170	Volat. Soil Extract.	date		03/08/21	03/08/21	03/08/21	---
PHC1PHCV	CCME PHC F1 C6-10	ug/g	10	< 10	< 10	< 10	---
HC1-CALC	CCME PHC F1-BTEX	ug/g		< 10	< 10	< 10	---
PHC2PHCS	CCME PHC F2 C10-16	ug/g	10	< 10	< 10	< 10	---
PHC3PHCS	CCME PHC F3 C16-34	ug/g	10	18	20	42	---
PHC4PHCS	CCME PHC F4 C34-50+	ug/g	10	< 10	< 10	16	---
BASEPHCS	PHC F2-4 BASELINE 0	Y/N	Yes	Yes	Yes	Yes	---
VOLATILE ORGANICS							
B020PT12	Benzene	ug/g	0.04	0.16	< 0.04	< 0.04	---
T001PT12	Toluene	ug/g	0.10	< 0.10	< 0.10	< 0.10	---
B021PT12	Ethylbenzene	ug/g	0.10	< 0.10	< 0.10	< 0.10	---
X003PT12	m+p - Xylene	ug/g	0.10	3.9	< 0.10	< 0.10	---
X002PT12	o - Xylene	ug/g	0.10	< 0.10	< 0.10	< 0.10	---
X_882_10	Xylenes	ug/g	0.1	3.9	< 0.1	< 0.1	---
SURROGATE RECOVERY							
VS01PT12	Bromofluorobenzene	%	0	90	93	86	---
VS03PT12	d8-Toluene	%	0	93	89	86	---
Ed10PT12	Ethylbenzene-d10	%	60	77	76	83	---
				Matrix : Soil	Soil	Soil	Soil
				Sampled on: 03/08/15 16:00	03/08/15 16:00	03/08/15 16:00	03/08/15 16:00

26-Aug-03

ANALYTICAL REPORT

Client : AQUA TERRE SOLUTIONS
Project : 03937- RED RIVER ESSO

Sparcode	Parameter	Unit	MDL	Philip ID: 33028874 Client ID: MW38-5	Philip ID: 33028875 Client ID: COMP
PHYSICAL					
TEMPARRI	Temperature Arrival	Celsius	0	1	1
FLPTPP99	Flashpoint	Celsius	23	---	> 61
00250760	Moisture	%(W/W)	0.3	29.5	---
METALS TOTAL					
PbMTMS20	Lead - Total	ug/g	5.0	13.9	---
HYDROCARBONS					
EX995149	PHC EXT F2 - 4	date		03/08/22	---
EX995170	Volat. Soil Extract.	date		03/08/21	---
PHC1PHCV	CCME PHC F1 C6-10	ug/g	10	< 10	---
HC1-CALC	CCME PHC F1-BTEX	ug/g		< 10	---
PHC2PHCS	CCME PHC F2 C10-16	ug/g	10	< 10	---
PHC3PHCS	CCME PHC F3 C16-34	ug/g	10	25	---
PHC4PHCS	CCME PHC F4 C34-50+	ug/g	10	< 10	---
BASEPHCS	PHC F2-4 BASELINE 0	Y/N	Yes	Yes	---
VOLATILE ORGANICS					
B020PT12	Benzene	ug/g	0.04	< 0.04	---
T001PT12	Toluene	ug/g	0.10	< 0.10	---
B021PT12	Ethylbenzene	ug/g	0.10	< 0.10	---
X003PT12	m+p - Xylene	ug/g	0.10	< 0.10	---
X002PT12	o - Xylene	ug/g	0.10	< 0.10	---
X_882_10	Xylenes	ug/g	0.1	< 0.1	---
SURROGATE RECOVERY					
VS01PT12	Bromofluorobenzene	%	0	90	---
VS03PT12	d8-Toluene	%	0	89	---
Ed10PT12	Ethylbenzene-d10	%	60	78	---
			Matrix :	Soil	Soil
			Sampled on:	03/08/15 16:00	03/08/15 16:00

26-Aug-03

DUPLICATE SUMMARY

Parameter	Client ID	Philip ID	Sample Conc.	Duplicate Conc.	MDL	Unit	Relative % Diff.
CCME PHC F1 C6-10	MW32-4	33028854	< 10	< 10	10	ug/g	0.00
CCME PHC F1 C6-10	MW34-14	33028859	470	480	10	ug/g	-2.11
Moisture	MW34-14	33028859	36.6	34.6	0.3	%(W/W)	5.62
Lead - Total	MW35-5	33028863	14.4	14.6	5.0	ug/g	-1.38
Moisture	MW35-6	33028864	22.9	25.0	0.3	%(W/W)	-8.77
Benzene	MW36-5	33028865	2.6	2.9	0.04	ug/g	-10.91
Toluene	MW36-5	33028865	0.48	0.59	0.10	ug/g	-20.56
Ethylbenzene	MW36-5	33028865	2.5	3.4	0.10	ug/g	-30.51
m+p - Xylene	MW36-5	33028865	5.6	6.5	0.10	ug/g	-14.88
o - Xylene	MW36-5	33028865	0.90	0.94	0.10	ug/g	-4.35
CCME PHC F2 C10-16	MW37-7	33028869	< 10	11	10	ug/g	-9.52
CCME PHC F3 C16-34	MW37-7	33028869	< 10	10	10	ug/g	0.00
CCME PHC F4 C34-50+	MW37-7	33028869	< 10	< 10	10	ug/g	0.00
PHC F2-4 BASELINE 0	MW37-7	33028869	Yes	Yes	Yes	Y/N	Undefine
Benzene	MW38-3	33028872	< 0.04	< 0.04	0.04	ug/g	0.00
Toluene	MW38-3	33028872	< 0.10	< 0.10	0.10	ug/g	0.00
Ethylbenzene	MW38-3	33028872	< 0.10	< 0.10	0.10	ug/g	0.00
m+p - Xylene	MW38-3	33028872	< 0.10	< 0.10	0.10	ug/g	0.00
o - Xylene	MW38-3	33028872	< 0.10	< 0.10	0.10	ug/g	0.00
CCME PHC F1 C6-10	MW38-5	33028874	< 10	< 10	10	ug/g	0.00

26-Aug-03
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SPIKE SUMMARY

Parameter	Client ID	Philip ID	Sample Conc.	Sample & Spike Conc.	Spike Amount	Unit	Percent Recovery
Lead - Total	Blank Spike. Batch :	34204090	< 5.0	256	250	ug/g	103
CCME PHC F2 C10-16	MW32-4	33028854	< 10	650	759	ug/g	85
CCME PHC F2 C10-16	Blank Spike. Batch :	35203021	< 10	420	536	ug/g	78
CCME PHC F3 C16-34	MW32-4	33028854	< 10	1600	1670	ug/g	96
CCME PHC F3 C16-34	Blank Spike. Batch :	35203021	< 10	1000	1180	ug/g	86
CCME PHC F1 C6-10	Blank Spike. Batch :	35203008	< 10	280	291	ug/g	95
Benzene	MW32-4	33028854	< 0.04	2.4	2.83	ug/g	86
Benzene	Blank Spike. Batch :	35203006	< 0.04	1.9	2	ug/g	93
Toluene	MW32-4	33028854	< 0.10	2.4	2.83	ug/g	87
Toluene	Blank Spike. Batch :	35203006	< 0.10	1.9	2	ug/g	94
Ethylbenzene	MW32-4	33028854	< 0.10	2.4	2.83	ug/g	85
Ethylbenzene	Blank Spike. Batch :	35203006	< 0.10	1.9	2	ug/g	93
m+p - Xylene	MW32-4	33028854	< 0.10	4.9	5.66	ug/g	87
m+p - Xylene	Blank Spike. Batch :	35203006	< 0.10	3.8	4	ug/g	95
o - Xylene	MW32-4	33028854	< 0.10	2.3	2.83	ug/g	83
o - Xylene	Blank Spike. Batch :	35203006	< 0.10	1.7	2	ug/g	86
CCME PHC F1 C6-10	MW32-6	33028855	< 10	410	441	ug/g	93
CCME PHC F1 C6-10	Blank Spike. Batch :	35203024	< 10	310	329	ug/g	92
CCME PHC F1 C6-10	MW34-6	33028860	69	500	477	ug/g	89
Lead - Total	MW35-5	33028863	14.4	63.1	50	ug/g	97
CCME PHC F2 C10-16	Blank Spike. Batch :	35203032	< 10	560	536	ug/g	103
CCME PHC F3 C16-34	Blank Spike. Batch :	35203032	< 10	1300	1180	ug/g	112
CCME PHC F1 C6-10	Blank Spike. Batch :	35203045	< 10	300	329	ug/g	89
Benzene	Blank Spike. Batch :	35203039	< 0.04	2.3	2	ug/g	117
Toluene	Blank Spike. Batch :	35203039	< 0.10	2.2	2	ug/g	112
Ethylbenzene	Blank Spike. Batch :	35203039	< 0.10	2.5	2	ug/g	124
m+p - Xylene	Blank Spike. Batch :	35203039	< 0.10	4.8	4	ug/g	121
o - Xylene	Blank Spike. Batch :	35203039	< 0.10	2.3	2	ug/g	114
Lead - Total	Blank Spike. Batch :	34204097	< 5.0	292	250	ug/g	117
Benzene	Blank Spike. Batch :	35203027	< 0.04	2.1	2	ug/g	104
Toluene	Blank Spike. Batch :	35203027	< 0.10	2.0	2	ug/g	99
Ethylbenzene	Blank Spike. Batch :	35203027	< 0.10	1.9	2	ug/g	93
m+p - Xylene	Blank Spike. Batch :	35203027	< 0.10	5.1	4	ug/g	126
o - Xylene	Blank Spike. Batch :	35203027	< 0.10	1.9	2	ug/g	94
Benzene	Blank Spike. Batch :	35203040	< 0.04	2.1	2	ug/g	105
Toluene	Blank Spike. Batch :	35203040	< 0.10	2.0	2	ug/g	99
Ethylbenzene	Blank Spike. Batch :	35203040	< 0.10	1.8	2	ug/g	88
m+p - Xylene	Blank Spike. Batch :	35203040	< 0.10	5.1	4	ug/g	128

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SPIKE SUMMARY

Parameter	Client ID	Philip ID	Sample Conc.	Sample & Spike Conc.	Spike Amount	Unit	Percent Recovery
o - Xylene	Blank Spike. Batch :	35203040	< 0.10	2.0	2	ug/g	101
Benzene	MW38-5	33028874	< 0.04	2.6	2.84	ug/g	93
Toluene	MW38-5	33028874	< 0.10	2.5	2.84	ug/g	87
Ethylbenzene	MW38-5	33028874	< 0.10	2.2	2.84	ug/g	78
m+p - Xylene	MW38-5	33028874	< 0.10	7.0	5.67	ug/g	123
o - Xylene	MW38-5	33028874	< 0.10	2.6	2.84	ug/g	90
Flashpoint	Blank Spike. Batch :	34404160	< 23	66	66	Celsius	100

ANALYSIS DATES

	Philip ID:	33028854	33028855	33028856	33028857
	Client ID:	MW32-4	MW32-6	MW33-4	MW33-5
00250760	Moisture	22-AUG-2003	22-AUG-2003	22-AUG-2003	22-AUG-2003
PbMTMS20	Lead - Total	25-AUG-2003	25-AUG-2003	25-AUG-2003	25-AUG-2003
PHC1PHCV	CCME PHC F1 C6-10	22-AUG-2003	22-AUG-2003	25-AUG-2003	25-AUG-2003
CCMEPHCS	CCMEPHCS	25-AUG-2003	25-AUG-2003	25-AUG-2003	25-AUG-2003
PKG-BT17	BTEX by P&T	21-AUG-2003	21-AUG-2003	21-AUG-2003	21-AUG-2003
	Matrix:	Soil	Soil	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003	15-AUG-2003	15-AUG-2003

	Philip ID:	33028858	33028859	33028860	33028861
	Client ID:	MW34-4	MW34-14	MW34-6	MW34-7
00250760	Moisture	22-AUG-2003	22-AUG-2003	22-AUG-2003	22-AUG-2003
MESH200	Particulate Mesh 200	---	---	---	25-AUG-2003
PbMTMS20	Lead - Total	25-AUG-2003	25-AUG-2003	25-AUG-2003	---
PHC1PHCV	CCME PHC F1 C6-10	25-AUG-2003	25-AUG-2003	25-AUG-2003	---
CCMEPHCS	CCMEPHCS	25-AUG-2003	25-AUG-2003	25-AUG-2003	---
PKG-BT17	BTEX by P&T	21-AUG-2003	21-AUG-2003	21-AUG-2003	---
	Matrix:	Soil	Soil	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003	15-AUG-2003	15-AUG-2003

	Philip ID:	33028862	33028863	33028864	33028865
	Client ID:	MW35-3	MW35-5	MW35-6	MW36-5
00250760	Moisture	22-AUG-2003	22-AUG-2003	25-AUG-2003	25-AUG-2003
MESH200	Particulate Mesh 200	25-AUG-2003	---	---	---
PbMTMS20	Lead - Total	---	25-AUG-2003	25-AUG-2003	25-AUG-2003
PHC1PHCV	CCME PHC F1 C6-10	---	26-AUG-2003	26-AUG-2003	26-AUG-2003
CCMEPHCS	CCMEPHCS	---	25-AUG-2003	25-AUG-2003	25-AUG-2003
PKG-BT17	BTEX by P&T	---	22-AUG-2003	22-AUG-2003	22-AUG-2003
	Matrix:	Soil	Soil	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003	15-AUG-2003	15-AUG-2003

ANALYSIS DATES

	Philip ID:	33028866	33028867	33028868	33028869
	Client ID:	MW36-15	MW36-6	MW37-6	MW37-7
00250760	Moisture	25-AUG-2003	25-AUG-2003	25-AUG-2003	25-AUG-2003
PbMTMS20	Lead - Total	25-AUG-2003	25-AUG-2003	25-AUG-2003	25-AUG-2003
PHC1PHCV	CCME PHC F1 C6-10	26-AUG-2003	26-AUG-2003	26-AUG-2003	26-AUG-2003
CCMEPHCS	CCMEPHCS	25-AUG-2003	25-AUG-2003	25-AUG-2003	25-AUG-2003
PKG-BT17	BTEX by P&T	22-AUG-2003	22-AUG-2003	22-AUG-2003	22-AUG-2003
	Matrix:	Soil	Soil	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003	15-AUG-2003	15-AUG-2003

	Philip ID:	33028870	33028871	33028872	33028873
	Client ID:	MW37-8	MW38-2	MW38-3	MW38-4
00250760	Moisture	25-AUG-2003	25-AUG-2003	25-AUG-2003	25-AUG-2003
MESH200	Particulate Mesh 200	---	---	---	25-AUG-2003
PbMTMS20	Lead - Total	25-AUG-2003	25-AUG-2003	25-AUG-2003	---
PHC1PHCV	CCME PHC F1 C6-10	26-AUG-2003	26-AUG-2003	26-AUG-2003	---
CCMEPHCS	CCMEPHCS	25-AUG-2003	25-AUG-2003	25-AUG-2003	---
PKG-BT17	BTEX by P&T	22-AUG-2003	22-AUG-2003	23-AUG-2003	---
	Matrix:	Soil	Soil	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003	15-AUG-2003	15-AUG-2003

	Philip ID:	33028874	33028875
	Client ID:	MW38-5	COMP
FLPTPP99	Flashpoint	---	21-AUG-2003
00250760	Moisture	25-AUG-2003	---
PbMTMS20	Lead - Total	25-AUG-2003	---
PHC1PHCV	CCME PHC F1 C6-10	26-AUG-2003	---
CCMEPHCS	CCMEPHCS	25-AUG-2003	---
PKG-BT17	BTEX by P&T	23-AUG-2003	---
	Matrix:	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003

BATCH NUMBERS

	Philip ID:	33028854	33028855	33028856	33028857
	Client ID:	MW32-4	MW32-6	MW33-4	MW33-5
00250760	Moisture	35104219	35104219	35104219	35104219
PbMTMS20	Lead - Total	34204090	34204090	34204090	34204090
PHC1PHCV	CCME PHC F1 C6-10	35203008	35203008	35203024	35203024
CCMEPHCS	CCMEPHCS	35203021	35203021	35203021	35203021
PKG-BT17	BTEX by P&T	35203006	35203006	35203006	35203006
	Matrix:	Soil	Soil	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003	15-AUG-2003	15-AUG-2003

	Philip ID:	33028858	33028859	33028860	33028861
	Client ID:	MW34-4	MW34-14	MW34-6	MW34-7
00250760	Moisture	35104219	35104231	35104231	35104231
MESH200	Particulate Mesh 200	---	---	---	34404175
PbMTMS20	Lead - Total	34204090	34204090	34204090	---
PHC1PHCV	CCME PHC F1 C6-10	35203024	35203024	35203024	---
CCMEPHCS	CCMEPHCS	35203021	35203021	35203021	---
PKG-BT17	BTEX by P&T	35203006	35203006	35203006	---
	Matrix:	Soil	Soil	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003	15-AUG-2003	15-AUG-2003

	Philip ID:	33028862	33028863	33028864	33028865
	Client ID:	MW35-3	MW35-5	MW35-6	MW36-5
00250760	Moisture	35104231	35104231	35104234	35104234
MESH200	Particulate Mesh 200	34404175	---	---	---
PbMTMS20	Lead - Total	---	34204090	34204097	34204097
PHC1PHCV	CCME PHC F1 C6-10	---	35203045	35203045	35203045
CCMEPHCS	CCMEPHCS	---	35203032	35203032	35203032
PKG-BT17	BTEX by P&T	---	35203039	35203039	35203039
	Matrix:	Soil	Soil	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003	15-AUG-2003	15-AUG-2003

26-Aug-03
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BATCH NUMBERS

	Philip ID:	33028866	33028867	33028868	33028869
	Client ID:	MW36-15	MW36-6	MW37-6	MW37-7
00250760	Moisture	35104234	35104234	35104234	35104234
PbMTMS20	Lead - Total	34204097	34204097	34204097	34204097
PHC1PHCV	CCME PHC F1 C6-10	35203045	35203045	35203045	35203045
CCMEPHCS	CCMEPHCS	35203032	35203032	35203032	35203032
PKG-BT17	BTEX by P&T	35203039	35203039	35203027	35203027
	Matrix:	Soil	Soil	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003	15-AUG-2003	15-AUG-2003

	Philip ID:	33028870	33028871	33028872	33028873
	Client ID:	MW37-8	MW38-2	MW38-3	MW38-4
00250760	Moisture	35104234	35104234	35104234	35104234
MESH200	Particulate Mesh 200	---	---	---	34404175
PbMTMS20	Lead - Total	34204097	34204097	34204097	---
PHC1PHCV	CCME PHC F1 C6-10	35203045	35203045	35203045	---
CCMEPHCS	CCMEPHCS	35203032	35203032	35203032	---
PKG-BT17	BTEX by P&T	35203027	35203027	35203040	---
	Matrix:	Soil	Soil	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003	15-AUG-2003	15-AUG-2003

	Philip ID:	33028874	33028875
	Client ID:	MW38-5	COMP
FLPTPP99	Flashpoint	---	34404160
00250760	Moisture	35104234	---
PbMTMS20	Lead - Total	34204097	---
PHC1PHCV	CCME PHC F1 C6-10	35203045	---
CCMEPHCS	CCMEPHCS	35203032	---
PKG-BT17	BTEX by P&T	35203040	---
	Matrix:	Soil	Soil
	Sampled on:	15-AUG-2003	15-AUG-2003

26-Aug-03
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BLANK SUMMARY

All method blanks were less than MDL

PSC ANALYTICAL SERVICES
9619 - 42nd Avenue
Edmonton, AB T6E 5R2
Phone: (780) 465-1212
Fax: (780) 450-4187
Toll Free: 1-877-465-8889

ESSO / PSC CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

ANALYSIS REQUEST 42030734

COMPANY NAME: Aqua Terre Solutions	PH. #: (403) 266-2555 FAX #: (403) 266-2554
COMPANY ADDRESS: 800, 736, -8th Ave SW Calgary, AB T2P 1H4	CLIENT PROJECT ID: (#) 03937 - Red River Esso
SAMPLER NAME (PRINT): Brad K.	PROJECT MANAGER: Michelle Wright

FIELD SAMPLE ID	PSC LAB # (Lab Use Only)	MATRIX: GROUND WATER	SURFACE WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE 2003	TIME	HEADSPACE VAPOUR	BTEX / LH	VOC____ VOC/LH____	TEH	PAH	CCME-PHC (FRACTIONS 1-4 PLUS BTEX)	CCME-PHCS (FRACTIONS 2-4)	CCME BTEX (FRACTION 1 PLUS BTEX)	LEAD	TOTALS METALS LEVEL ___	DISSOLVED METALS LEVEL___	MERCURY TOTAL___ DISSOLVED___	PHENOLS BY 4AAP_____ GCMS_____	TOTAL OIL & GREASE	MINERAL OIL & GREASE	TCLP METALS	TCLP LEAD	TCLP BTEX	FLASHPOINT	GRAIN SIZE (MESH 200)	pH_____ EC_____ ALKALINITY_____	TSS____ TDS____ TS____	NITRATE____ NITRITE____ AMMONIA____	CHLORIDE____ SULPHATE____ FLUORIDE____
1 MW32-4	28854			X		2	15-Aug		50p					X			X														
2 MW32-6	28855			X		2	15-Aug		75p					X			X														
3 MW33-4	28856			X		2	15-Aug		25p					X			X														
4 MW33-5	28857			X		2	15-Aug		75p					X			X														
5 MW34-4	28858			X		2	15-Aug		45%					X			X														
6 MW34-14	28859			X		2	15-Aug		45%					X			X														
7 MW34-6	28860			X		2	15-Aug		400p					X			X														
8 MW34-7	28861			X		1	15-Aug		50p																			X			
9 MW35-3	28862			X		1	15-Aug		125p																			X			
10 MW35-5	28863			X		2	15-Aug		6%					X			X														
11 MW35-6	28864			X		2	15-Aug		125p					X			X														
12 MW36-5	28865			X		2	15-Aug		20%					X			X														

Please be careful when taking samples out of boxes; labels would NOT stick.

TAT (Turnaround Time)

<5 DAY TAT MUST HAVE PRIOR APPROVAL

** some exceptions apply please contact lab*

- STANDARD 10 BUSINESS DAYS ☐
- STANDARD 5 BUSINESS DAYS ☒
- RUSH 2 BUSINESS DAYS ☐
- URGENT 1 BUSINESS DAY ☐

OTHER BUSINESS DAYS_____

CUSTODY RECORD

ESSO SITE LOCATION: 860 265

PSC SAP: 11040836

ESSO CONTACT: Emma Kirsh

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE

☐ ALBERTA TIER 1 ☐ CCME level_____
☒ PST
☐ CDWG ☐ OTHER_____

SPECIAL REPORTING OR BILLING INSTRUCTIONS

JARS USED

LAB USE ONLY

ARRIVAL TEMPERATURE °C: (1.1.0) 1°C

LAB INFORMATION: Aug 26/03 B.

RELINQUISHED BY SAMPLER: B. K.	DATE Aug. 18, 2003	TIME 11:40	RECEIVED BY: Fedex
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
RELINQUISHED BY: Fedex	DATE 8/[illegible]/03	TIME 10:35 Not Stated	RECEIVED BY LABORATORY: Ton

ORIGINAL - PSC YELLOW - PSC PINK - CLIENT

PSC ANALYTICAL SERVICES
9619 - 42nd Avenue
Edmonton, AB T6E 5R2
Phone: (780) 465-1212
Fax: (780) 450-4187
Toll Free: 1-877-465-8889

ESSO / PSC CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

ANALYSIS REQUEST 42030736

COMPANY NAME: Aqua Terre Solutions
PH. #: (403) 266-2555
FAX #: (403) 266-2554
COMPANY ADDRESS: 800, 736 - 8th Ave SW Calgary, AB T2P 1H4
CLIENT PROJECT ID: (#) 03937 - Red River Esso
SAMPLER NAME (PRINT): Brad K.
PROJECT MANAGER: Michelle Wright

	FIELD SAMPLE ID	PSC LAB # (Lab Use Only)	MATRIX: GROUND WATER	SURFACE WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE 2003	TIME	HEADSPACE VAPOUR
1	MW36-15	28866			X		2	15-Aug		20%
2	MW36-6	28867			X		2	15-Aug		150p
3	MW37-6	28868			X		2	15-Aug		9%
4	MW37-7	28869			X		2	15-Aug		6%
5	MW37-8	28870			X		2	15-Aug		75p
6	MW38-2	28871			X		2	15-Aug		130p
7	MW38-3	28872			X		2	15-Aug		75p
8	MW38-4	28873			X		1	15-Aug		25p
9	MW38-5	28874			X		2	15-Aug		30p
10	Comp.	28875			X		2	15-Aug		-
11		~~28876~~								
12		~~28877~~								

BTEX / LH	VOC ___ VOC/LH ___	TEH	PAH	CCME-PHC (FRACTIONS 1-4 PLUS BTEX)	CCME-PHCS (FRACTIONS 2-4)	CCME BTEX (FRACTION 1 PLUS BTEX)	LEAD	TOTALS METALS LEVEL ___	DISSOLVED METALS LEVEL ___	MERCURY TOTAL ___ DISSOLVED ___	PHENOLS BY 4AAP ___ GCMS ___	TOTAL OIL & GREASE	MINERAL OIL & GREASE	TCLP METALS	TCLP LEAD	TCLP BTEX	FLASHPOINT	GRAIN SIZE (MESH 200)	pH ___ EC ___ ALKALINITY ___	TSS ___ TDS ___ TS ___	NITRATE ___ NITRITE ___ AMMONIA ___	CHLORIDE ___ SULPHATE ___ FLUORIDE ___
				X			X														
				X			X														
				X			X														
				X			X														
				X			X														
				X			X														
				X			X														
				X			X														
																	X				
				X			X														
																	X				

Please be careful when taking samples out of boxes; labels would NOT stick.

TAT (Turnaround Time)
<5 DAY TAT MUST HAVE PRIOR APPROVAL
* some exceptions apply please contact lab

STANDARD 10 BUSINESS DAYS ☐
STANDARD 5 BUSINESS DAYS ☒
RUSH 2 BUSINESS DAYS ☐
URGENT 1 BUSINESS DAY ☐
OTHER BUSINESS DAYS ___

CUSTODY RECORD

ESSO SITE LOCATION: 860265
PSC SAP: 11040836
ESSO CONTACT: Emma Kirsh

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE
☐ ALBERTA TIER 1 ☐ CCME level ___
☒ PST ☐ OTHER ___
☐ CDWG

SPECIAL REPORTING OR BILLING INSTRUCTIONS

JARS USED

LAB USE ONLY
ARRIVAL TEMPERATURE °C (1, 1, 0)
LAB INFORMATION Aug 26/03 B.

RELINQUISHED BY SAMPLER:	DATE Aug. 18, 2003	TIME 11:00	RECEIVED BY: Fedex.
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
RELINQUISHED BY: FED	DATE 8/18/03	TIME 10:25	RECEIVED BY LABORATORY:

ORIGINAL - PSC YELLOW - PSC PINK - CLIENT

Last Revised

PSC

ANALYTICAL SERVICES

9619 42 Avenue
Edmonton, Alberta
Canada T6E 5R2
Tel 780 465 1212
Fax 780 450 4187

24-Sep-03
Page 1 of 9

Certificate of Analysis

Reported To :

AQUA TERRE SOLUTIONS

Client Code 5Y

800, 736 - 8th AVENUE, SW
CALGARY, ALBERTA
T2P 1H4

Attention : MICHELLE WRIGHT
Phone : (403) 266-2555
FAX : (403) 266-2554

Project Information :

Project ID : 03937-RED RIVER ESSO
Submitted By: BRAD K.

Requisition Forms :

Form 42030902 shipped on 11-Sep-03 received on 12-Sep-03 logged on 13-Sep-03 completed on 24-Sep-03

Remarks :

+ All blank values are reported. Associated data are not blank corrected.
+ 'MDL' = Method Detection Limit, '<' = Less than MDL. '—' = Not analyzed
+ Solids results are based on dry weight except Biota Analyses & Special Waste Oil & Grease
+ Organic analyses are not corrected for extraction recovery standards except for Isotope Dilution methods. (i.e. CARB 429 PAH. all PCDD/F and DBD/DBF analyses)
+ All CCME results met required criteria unless otherwise stated in the report.
  All data on final reports are validated by technical personnel. Signature on file at laboratory.
  Deviations from Reference Method for the Canadian-wide Standard for Petroleum Hydrocarbons in Soil - Tier 1 Method:
  - F1 data reported using validated headspace instrumentation method
  - F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction
+ All Groundwater samples except BTEX/VOC's or Purgeable Hydrocarbons are decanted and/or filtered prior to analysis unless otherwise mandated by regulatory agency
+ All analysis data reported was generated when the analytical methods were in statistical control and IOL criteria for spike recoveries, reference material recoveries, method blank data and duplicate precision were met unless otherwise stated
+ This report shall not be reproduced except in full, without the written approval of the laboratory

Methods used by Philip are based upon those found in 'Standard Methods for the Examination of Water and Wastewater', 20th Edition, published by the American Public Health Association, or on US EPA protocols found in the 'Test Methods For Evaluating Solid Waste, Physical/Chemical Method, SW846', 3rd Edition. Other procedures are based on methodologies accepted by the appropriate regulatory agency. Methodology briefs are available by written request.

All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies, quality assurance and quality control procedures except where otherwise agreed to by the client and testing company in writing. Liability for any and all use of these test results shall be limited to the actual cost of the pertinent analysis done. There is no other warranty expressed or implied. Your samples will be retained at Philip for a period of 30 days from receipt of data or as per contract.

PHILIP Project Manager: Geraldyn Couthro

ANALYTICAL SERVICES

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ANALYTICAL REPORT
Form 42030902

Client : AQUA TERRE SOLUTIONS
Project : 03937-RED RIVER ESSO

				Philip ID :	33032278	33032279	33032280	33032281
				Client ID :	MW-32	MW-33	MW-34	MW-134
Sparcode	**Parameter**	**Unit**	**MDL**					
PHYSICAL								
TEMPARRI	Temperature Arrival	Celsius	0		3	3	3	3
HYDROCARBONS								
EX995141	TEH Prep - Water	date			03/09/15	03/09/15	03/09/15	03/09/15
PHC1PHCX	CCME PHC F1 C6-10	mg/L	0.1		< 0.1	< 0.1	21.3	20.8
HC1-CAL1	CCME PHC F1-BTEX	mg/L			< 0.1	< 0.1	< 0.1	< 0.1
PHC2PHCW	CCME PHC F2 C10-16	mg/L	0.1		< 0.1	< 0.1	1.9	1.8
EXTRACTABLE HYDROCARBONS SURROGATE RECOVERY								
T140PHCW	o-Terphenyl	%	0		92	97	84	94
VOLATILE ORGANICS								
EX995160	VOC water prep	date			03/09/16	03/09/16	03/09/16	03/09/16
B020PT17	Benzene	ug/L	0.5		< 0.5	< 0.5	8940	8840
T001PT17	Toluene	ug/L	0.5		< 0.5	< 0.5	6520	6610
B021PT17	Ethylbenzene	ug/L	0.5		< 0.5	< 0.5	413	328
X003PT17	m+p - Xylene	ug/L	0.5		< 0.5	< 0.5	3800	3550
X002PT17	o - Xylene	ug/L	0.5		< 0.5	< 0.5	1590	1500
X_8842_5	Xylenes	ug/L	0.5		< 0.5	< 0.5	5400	5100
SURROGATE RECOVERY								
VS01PT17	Bromofluorobenzene	%	0		101	103	99	100
VS03PT17	d8-Toluene	%	0		98	100	100	99
				Matrix :	Water	Water	Water	Water
				Sampled on:	03/09/11 16:00	03/09/11 16:00	03/09/11 16:00	03/09/11 16:00

Sample 33032278 comment : FOUR OUT OF FIVE POINT QC CHART FAILURE FOR BENZENE
Sample 33032279 comment : FOUR OUT OF FIVE POINT QC CHART FAILURE FOR BENZENE
Sample 33032280 comment : FOUR OUT OF FIVE POINT QC CHART FAILURE FOR BENZENE
Sample 33032281 comment : FOUR OUT OF FIVE POINT QC CHART FAILURE FOR BENZENE

ANALYTICAL SERVICES

24-Sep-03
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ANALYTICAL REPORT
Form 42030902

Client : AQUA TERRE SOLUTIONS
Project : 03937-RED RIVER ESSO

Sparcode	Parameter	Unit	MDL	Philip ID : 33032282 Client ID : MW-35	33032283 MW-36	33032284 MW-37	33032285 MW-38
PHYSICAL							
TEMPARRI	Temperature Arrival	Celsius	0	3	3	3	3
HYDROCARBONS							
EX995141	TEH Prep - Water	date		03/09/15	03/09/15	03/09/15	03/09/15
PHC1PHCX	CCME PHC F1 C6-10	mg/L	0.1	3.3	0.3	4.9	< 0.1
HC1-CAL1	CCME PHC F1-BTEX	mg/L		< 0.1	0.2	1.2	< 0.1
PHC2PHCW	CCME PHC F2 C10-16	mg/L	0.1	0.4	< 0.1	1.4	< 0.1
EXTRACTABLE HYDROCARBONS SURROGATE RECOVERY							
T140PHCW	o-Terphenyl	%	0	95	93	95	94
VOLATILE ORGANICS							
EX995160	VOC water prep	date		03/09/16	03/09/16	03/09/16	03/09/16
B020PT17	Benzene	ug/L	0.5	2680	53.5	1220	< 0.5
T001PT17	Toluene	ug/L	0.5	178	0.5	165	< 0.5
B021PT17	Ethylbenzene	ug/L	0.5	131	4.9	299	< 0.5
X003PT17	m+p - Xylene	ug/L	0.5	179	4.8	1570	< 0.5
X002PT17	o - Xylene	ug/L	0.5	88.1	< 0.5	490	< 0.5
X_8842_5	Xylenes	ug/L	0.5	270	4.8	2100	< 0.5
SURROGATE RECOVERY							
VS01PT17	Bromofluorobenzene	%	0	103	96	96	101
VS03PT17	d8-Toluene	%	0	101	97	100	100
				Matrix : Water	Water	Water	Water
				Sampled on: 03/09/11 16:00	03/09/11 16:00	03/09/11 16:00	03/09/11 16:00

Sample 33032282 comment : FOUR OUT OF FIVE POINT QC CHART FAILURE FOR BENZENE
Sample 33032283 comment : FOUR OUT OF FIVE POINT QC CHART FAILURE FOR BENZENE
Sample 33032284 comment : FOUR OUT OF FIVE POINT QC CHART FAILURE FOR BENZENE
Sample 33032285 comment : FOUR OUT FIVE POINT QC CHART FAILURE FOR BENZENE

ANALYTICAL SERVICES

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ANALYTICAL REPORT
Form 42030902

Client : AQUA TERRE SOLUTIONS
Project : 03937-RED RIVER ESSO

Sparcode	Parameter	Unit	MDL	Philip ID : 33032286 Client ID : TRIP BLANK	Philip ID : 33032287 Client ID : EQUIPMENT BLANK
PHYSICAL					
TEMPARRI	Temperature Arrival	Celsius	0	3	3
HYDROCARBONS					
PHC1PHCX	CCME PHC F1 C6-10	mg/L	0.1	< 0.1	< 0.1
HC1-CAL1	CCME PHC F1-BTEX	mg/L		< 0.1	< 0.1
VOLATILE ORGANICS					
EX995160	VOC water prep	date		03/09/16	03/09/16
B020PT17	Benzene	ug/L	0.5	< 0.5	< 0.5
T001PT17	Toluene	ug/L	0.5	< 0.5	< 0.5
B021PT17	Ethylbenzene	ug/L	0.5	< 0.5	< 0.5
X003PT17	m+p - Xylene	ug/L	0.5	< 0.5	< 0.5
X002PT17	o - Xylene	ug/L	0.5	< 0.5	< 0.5
X_8842_5	Xylenes	ug/L	0.5	< 0.5	< 0.5
SURROGATE RECOVERY					
VS01PT17	Bromofluorobenzene	%	0	99	99
VS03PT17	d8-Toluene	%	0	99	101
			Matrix :	Water	Water
			Sampled on:	03/09/11 16:00	03/09/11 16:00

Sample 33032286 comment : FOUR OUT OF FIVE POINT QC CHART FAILURE FOR BENZENE
Sample 33032287 comment : FOUR OUT OF FIVE POINT QC CHART FAILURE FOR BENZENE

ANALYTICAL SERVICES

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DUPLICATE SUMMARY
Form 42030902

Parameter	Client ID	Philip ID	Sample Conc.	Duplicate Conc.	MDL	Unit	Relative % Diff.
CCME PHC F1 C6-10	EQUIPMENT BLANK	33032287	< 0.1	< 0.1	0.1	mg/L	0.00

ANALYTICAL SERVICES

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SPIKE SUMMARY
Form 42030902

Parameter	Client ID	Philip ID	Sample Conc.	Sample & Spike Conc.	Spike Amount	Unit	Percent Recovery
Benzene	Blank Spike. Batch :	35203504	0.5	26.5	22.7	ug/L	114
Toluene	Blank Spike. Batch :	35203504	0.5	24.7	22.7	ug/L	107
Ethylbenzene	Blank Spike. Batch :	35203504	< 0.5	20.2	22.7	ug/L	87
m+p - Xylene	Blank Spike. Batch :	35203504	0.9	42.7	45.4	ug/L	92
o - Xylene	Blank Spike. Batch :	35203504	< 0.5	20.7	22.7	ug/L	89
CCME PHC F2 C10-16	Blank Spike. Batch :	35203470	< 0.1	2.4	2.15	mg/L	112
CCME PHC F2 C10-16	MW-38	33032285	< 0.1	2.6	2.15	mg/L	122

ANALYTICAL SERVICES

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ANALYSIS DATES
Form 42030902

	Philip ID:	33032278	33032279	33032280	33032281
	Client ID:	MW-32	MW-33	MW-34	MW-134
PHC1PHCX	CCME PHC F1 C6-10	17-SEP-2003	17-SEP-2003	17-SEP-2003	17-SEP-2003
CCMEF2	CCME F2 Water	18-SEP-2003	18-SEP-2003	18-SEP-2003	18-SEP-2003
PKG-PT21	CCME BTEX Water	19-SEP-2003	19-SEP-2003	19-SEP-2003	19-SEP-2003
	Matrix:	Water	Water	Water	Water
	Sampled on:	11-SEP-2003	11-SEP-2003	11-SEP-2003	11-SEP-2003

	Philip ID:	33032282	33032283	33032284	33032285
	Client ID:	MW-35	MW-36	MW-37	MW-38
PHC1PHCX	CCME PHC F1 C6-10	17-SEP-2003	17-SEP-2003	17-SEP-2003	17-SEP-2003
CCMEF2	CCME F2 Water	18-SEP-2003	18-SEP-2003	18-SEP-2003	18-SEP-2003
PKG-PT21	CCME BTEX Water	19-SEP-2003	19-SEP-2003	19-SEP-2003	19-SEP-2003
	Matrix:	Water	Water	Water	Water
	Sampled on:	11-SEP-2003	11-SEP-2003	11-SEP-2003	11-SEP-2003

	Philip ID:	33032286	33032287
	Client ID:	TRIP BLANK	EQUIPMENT BLANK
PHC1PHCX	CCME PHC F1 C6-10	17-SEP-2003	17-SEP-2003
PKG-PT21	CCME BTEX Water	19-SEP-2003	19-SEP-2003
	Matrix:	Water	Water
	Sampled on:	11-SEP-2003	11-SEP-2003

ANALYTICAL SERVICES

BATCH NUMBERS
Form 42030902

	Philip ID:	33032278	33032279	33032280	33032281
	Client ID:	MW-32	MW-33	MW-34	MW-134
CCMEF2	CCME F2 Water	35203470	35203470	35203470	35203470
PKG-PT21	CCME BTEX Water	35203504	35203504	35203504	35203504
	Matrix:	Water	Water	Water	Water
	Sampled on:	11-SEP-2003	11-SEP-2003	11-SEP-2003	11-SEP-2003

	Philip ID:	33032282	33032283	33032284	33032285
	Client ID:	MW-35	MW-36	MW-37	MW-38
CCMEF2	CCME F2 Water	35203470	35203470	35203470	35203470
PKG-PT21	CCME BTEX Water	35203504	35203504	35203504	35203504
	Matrix:	Water	Water	Water	Water
	Sampled on:	11-SEP-2003	11-SEP-2003	11-SEP-2003	11-SEP-2003

	Philip ID:	33032286	33032287
	Client ID:	TRIP BLANK	EQUIPMENT BLANK
PKG-PT21	CCME BTEX Water	35203504	35203504
	Matrix:	Water	Water
	Sampled on:	11-SEP-2003	11-SEP-2003

ANALYTICAL SERVICES

24-Sep-03
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BLANK SUMMARY
Form 42030902

All method blanks were less than MDL, except the following:

Parameter	Batch	Sparcode	Blank Conc.	MDL	Unit
Benzene	35203504	B020PT17	0.5	0.5	ug/L
Toluene	35203504	T001PT17	0.5	0.5	ug/L
m+p - Xylene	35203504	X003PT17	0.9	0.5	ug/L

PSC ANALYTICAL SERVICES
9619 - 42nd Avenue
Edmonton, AB T6E 5R2
Phone: (780) 465-1212
Fax: (780) 450-4187
Toll Free: 1-877-465-8689

ESSO / PSC CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

ANALYSIS REQUEST 42030902

COMPANY NAME: Aqua Terra Solutions
PH. #: (403) 266-2555
FAX #: (403) 266-2554
COMPANY ADDRESS: 800, 736-8th Ave SW Calgary, AB T2P 1H4
CLIENT PROJECT ID: (#) 03937 - Red River Esso
SAMPLER NAME (PRINT): Brad K.
PROJECT MANAGER: Michelle Wright

FIELD SAMPLE ID	PSC LAB # (Lab Use Only)	MATRIX: GROUND WATER	SURFACE WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE 2003	TIME	HEADSPACE VAPOUR	BTEX / LH	VOC	VOC/LH	TEH	PAH	CCME-PHC (FRACTIONS 1-4 PLUS BTEX)	CCME-PHCS (FRACTIONS 2-4)	CCME BTEX (FRACTION 1 PLUS BTEX)	LEAD	TOTALS METALS LEVEL	DISSOLVED METALS LEVEL	MERCURY TOTAL / DISSOLVED	PHENOLS BY 4AAP / GCMS	TOTAL OIL & GREASE	MINERAL OIL & GREASE	TCLP METALS	TCLP LEAD	TCLP BTEX	FLASHPOINT	GRAIN SIZE (MESH 200)	pH / EC / ALKALINITY	TSS / TDS / TS	NITRATE / NITRITE / AMMONIA	CHLORIDE / SULPHATE / FLUORIDE
1 MW-32	32278	X				4	11-Sep		80p						X																		
2 MW-33	32279	X				4			70p						X																		
3 MW-34	32280	X				4			94%						X																		
4 MW-134	32281	X				4			94%						X																		
5 MW-35	32282	X				4			11%						X																		
6 MW-36	32283	X				4			6%						X																		
7 MW-37	32284	X				4			5%						X																		
8 MW-38	32285	X				4			75p						X																		
9 Trip.	32286				X	3			–								X																
10 Equip.	32287				X	3			–								X																
11																																	
12																																	

TAT (Turnaround Time)
<5 DAY TAT MUST HAVE PRIOR APPROVAL
* some exceptions apply please contact lab
STANDARD 10 BUSINESS DAYS ☐
STANDARD 5 BUSINESS DAYS ☒
RUSH 2 BUSINESS DAYS ☐
URGENT 1 BUSINESS DAY ☐
OTHER BUSINESS DAYS ____

CUSTODY RECORD

ESSO SITE LOCATION: 860265
PSC SAP: 1104 0836
ESSO CONTACT: Emma Kirsh

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE
☐ ALBERTA TIER I ☐ CCME level ____
☒ PST
☐ CDWG ☐ OTHER ____

SPECIAL REPORTING OR BILLING INSTRUCTIONS

JARS USED: 38

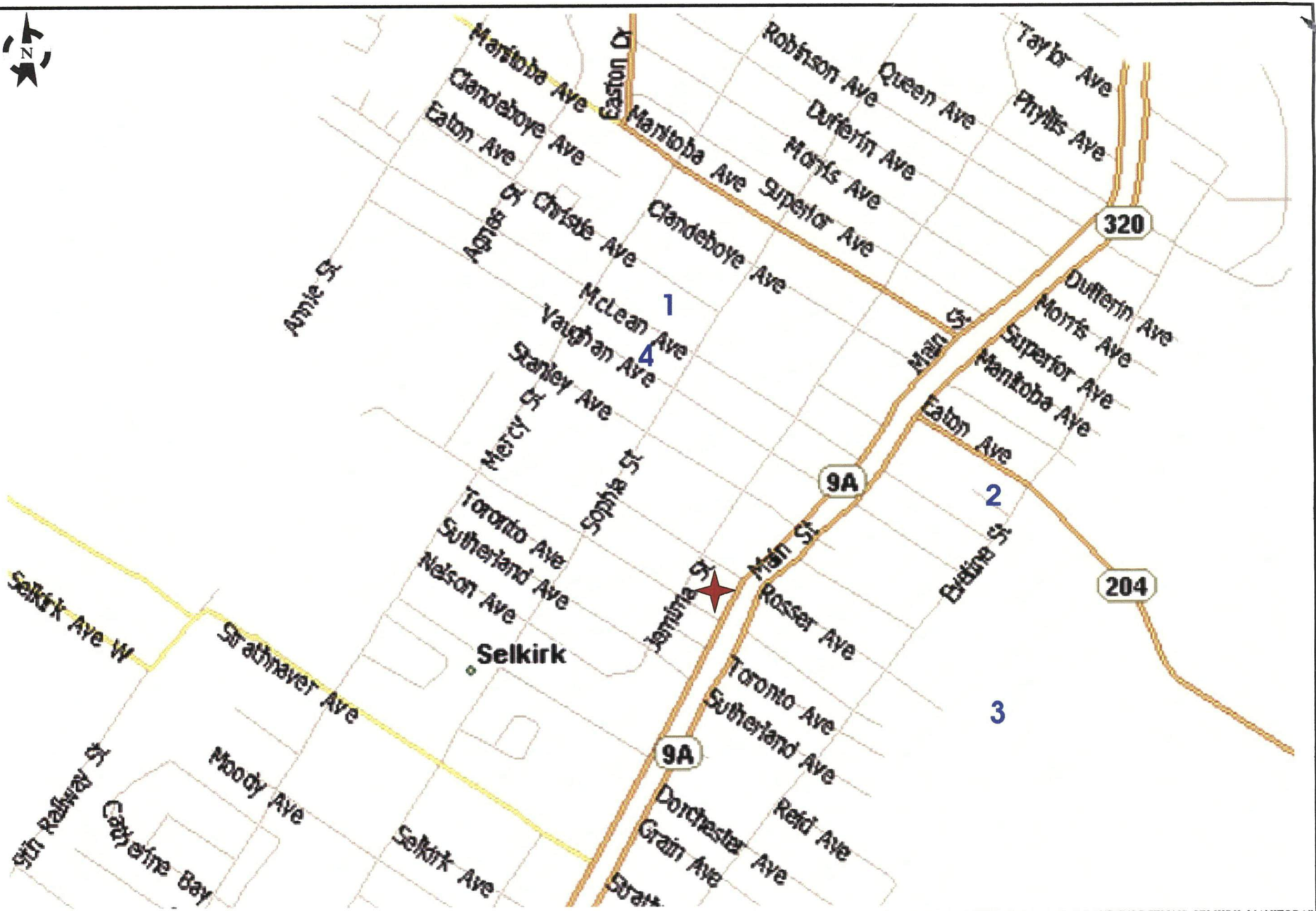
LAB USE ONLY
ARRIVAL TEMPERATURE °C: 2, 3, 5
LAB INFORMATION: Sept 19 T, T, T-Ts

RELINQUISHED BY SAMPLER: B.	DATE Sept. 11, 2003	TIME 5:30pm	RECEIVED BY: Fedex
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
RELINQUISHED BY: FDX	DATE 9 12 03	TIME 10 12	RECEIVED BY LABORATORY:

ORIGINAL - PSC YELLOW - PSC PINK - CLIENT

APPENDIX E

WATER WELL INFORMATION



BASE MAP PROVIDED BY MSN "MAPS AND DIRECTIONS, SELKIRK, MANITOBA"

LEGEND

1 -TOWER WELL, 26.5m TO INTAKE (SCREEN)
2 -CHRISTIE WELL, 64.0m TO INTAKE (SCREEN)
3 -ROSSER WELL, 64.0m TO INTAKE (SCREEN)
4 -MCLEAN WELL, 54.3m TO INTAKE (SCREEN)
✦ -RED RIVER ESSO SITE LOCATION

AQUA TERRE

IMPERIAL OIL LIMITED RED RIVER ESSO (860265) SELKIRK, MANITOBA		Title: **MUNICIPAL WATER WELL LOCATIONS**	
Project:: **03937**	Scale: **~1:8000**	Date: **OCTOBER 2003**	**APPENDIX E**
Drawn: **BB**	Approved: **CFS**	Filename: **Appendix e**	

F:\...\PROJ2003\03937\FIGURES\APPENDIX E.CDR