EVALUATION OF AQUIFER CHARACTERISTICS

Buffalo Terminal
Location No. 31-010
Buffalo, New York

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Prepared for:

EXXONMOBIL OIL CORPORATION
1001 Wampanoag Trail
Riverside, Rhode Island 02915

Prepared by:

ROUX ASSOCIATES, INC.
1377 Motor Parkway
Islandia, New York 11749

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1.0 INTRODUCTION

This report for the evaluation of aquifer characteristics at the Buffalo Terminal, Buffalo, New York (Site), located at 625 Elk Street, Buffalo, New York (Figure 1) was prepared by Roux Associates, Inc. (Roux Associates) on behalf of ExxonMobil Oil Corporation (ExxonMobil). The Site has been divided into nine geographic areas, which have been defined for the purpose of assessing environmental conditions and reporting the results of area-specific activities (Figure 2). The geographic areas are the following:

- Northeast Process and Storage Area (NPSA);
- Northern Tank Yard Area (NTYA);
- Former Refinery Area (FRA);
- Central Rail and Process Area (CRPA);
- Southern Tank Yard Area (STYA);
- Eastern Tank Yard Area (Former Disposal Area [ETYA]);
- Babcock Street Properties Area (BSPA);
- Administrative Offices and Operations Area (AOOA); and
- Elk Street Properties Area (ESPA).

This report focuses on two geographic areas of the Site (the STYA and ETYA) where separate-phase product plumes have been delineated (Plate 1). The purpose of the evaluation of aquifer characteristics is to develop the data necessary to determine the most effective and efficient way to protect the Buffalo River by containing and recovering groundwater, controlling the migration of separate-phase product and enhancing separate-phase product recovery.

This report describes current hydrogeologic conditions, summarizes separate-phase product recovery to date, presents the scope of work that was completed for the evaluation of aquifer characteristics and describes the data evaluation, groundwater and multi-phase modeling tasks that were performed. The field work for the evaluation included:

- Installing three test boreholes;
- Installing four recovery wells;

- Installing seven monitoring wells;
- Performing and analyzing four step tests; and
- Performing four constant-rate pumping tests.

The data collected during the above field work was used to:

- Determine the aquifer coefficients (i.e., hydraulic conductivity, transmissivity, and storativity) in the vicinity of each recovery well and specified monitoring well locations;
- Determine the configuration of the water table under pumping and non-pumping conditions;
- Verify that the values of aquifer coefficients determined at each well location agree with the geologic data that exists for this area;
- Develop and calibrate a groundwater flow model;
- Develop and calibrate a multi-phase model;
- Evaluate water quality under pumping conditions for use in design of treatment facilities; and
- Prepare a summary report of results.

The remainder of this report is organized as follows:

- Section 2.0 provides a summary of environmental conditions;
- Section 3.0 provides a summary of the Site environmental remediation history;
- Section 4.0 presents the scope of the field work that generated the necessary data;
- Section 5.0 provides a summary of the pump test data analyses;
- Section 6.0 presents a summary of the groundwater model;
- Section 7.0 presents a summary of the multi-phase model;
- Section 8.0 presents a summary of the major field activities and modeling tasks, as well as a brief description of the proposed remedial alternatives evaluation and selection process; and
- Section 9.0 presents references.

Included with this report are the following appendices:

- Appendix A: Geologic logs
- Appendix B: Results From Sieve Analysis
- Appendix C: Well Development Logs
- Appendix D: Hydrograph of Buffalo River
- Appendix E: Roux Associates, Inc. Standard Operating Procedure for Conducting a Constant-Rate (Pumping) Test and Recovery Test
- Appendix F: Results From Bail-Down Tests
- Appendix G: Hydrocarbon Characterization
- Appendix H: Pump Test Analysis

2.0 SUMMARY OF ENVIRONMENTAL CONDITIONS

Hydrogeologic conditions of the unconfined aquifer in the STYA and ETYA, including water-level elevations and separate-phase product occurrence, are monitored on a regular basis as part of the Site-wide monitoring program and product recovery efforts. Groundwater samples from selected monitoring wells are collected on a quarterly basis and analyzed to monitor groundwater quality. The following is a summary of recent results of these monitoring and sampling efforts.

2.1 Hydrogeology and Separate-Phase Product Occurrence

The following is a general description of the Site hydrogeology and occurrence of separate-phase product as a whole, and is not specifically related to any geographic area of the Site, except where noted. The description of groundwater flow direction presented below is based upon water-level and separate-product thickness data collected during the quarterly gauging round conducted in October 2002 (Table 1). The water-level and separate-phase product thickness data for the October 2002 quarterly gauging round are presented on Plate 1.

The depiction of the areal extent of separate-phase product thickness shown Plate 1 is based on all historical data collected at the Site. Therefore, even wells that currently do not show evidence of separate-phase product, but did in the past, are included in the depiction of the plume. Wells in which product was observed during only one gauging round are not shown, except at MW-16, located south of the active Tank Truck Loading Rack, where petroleum-related impacts were observed during soil boring and well installation.

2.1.1 Hydrogeology

The groundwater flow direction in the area of the Site west of the former Erie-Lackawanna Railroad is generally southwest toward the Buffalo River. The influence of the western leg of the Well Point System (WPS) in drawing down the water table and affecting the direction of groundwater flow can be seen in monitoring wells in the southern portion of the FRA and BSPA. The drawdown caused by the western leg of the WPS indicated that the system was operating efficiently during October 2002. The influence of the eastern leg of the WPS can be seen in monitoring wells in the STYA and the southwest portion of the ETYA.

The gauging data from the October 2002 quarterly round indicates that the Buffalo River level was higher than the water level observed in all wells located along the bulkhead, except monitoring well SB-39. Therefore, in general, the data demonstrates that pumping of the WPS depresses the water table sufficiently to induce recharge from the Buffalo River into the aquifer in the area between the WPS and the Buffalo River, except in the vicinity of SB-39.

In the area between the operating dual-phase recovery wells and the WPS, a groundwater flow divide is created between the cones of influence of the two pumping systems.

Finally, a groundwater divide, caused by the operation of the eastern leg of the WPS, exists in the southwestern portion of the ETYA. The groundwater flow direction east of the divide is generally southeast toward the Buffalo River. The groundwater flow direction west of the divide, in the southwestern portion of the ETYA, is generally west toward the WPS.

2.1.2 Separate-Phase Product Occurrence

Separate-phase product exists throughout much of the southern portion of the Site. The main separate-phase product plume (Main Plume) extends from the east side of the Babcock Street sewer in the BSPA through the southern portion of the FRA and the southern portion of the STYA. The eastern limit of the product plume in the STYA is approximately to the Erie-Lackawanna Railroad, which separates the STYA from the ETYA.

The separate-phase product is shown as a continuous plume extending through all three of these areas of the Site. However, it is likely that the product observed in the BSPA in the vicinity of the former Truck Loading Rack, and extending along the eastern side of the Babcock Street sewer to MW-27, is separate from the remainder of the plume. This localized plume is likely attributable to releases at the former Truck Loading Rack.

To the east of the former Barrel House in the BSPA, it is not possible to conclusively determine the configuration of the plume(s) based upon available information. The product observed in the eastern portion of the BSPA may be one of the following:

- A localized plume, separate from the main portion of the plume on the FRA, attributable to former tanks and railcar unloading facilities located on the east side of the former Barrel House.
- A co-mingled plume comprised of product attributable to former tanks and railcar unloading facilities located on the east side of the former Barrel House and product from the main portion of the product plume on the FRA.
- Product from the main portion of the plume on the FRA that has migrated onto the BSPA.

Finally, in the BSPA, the product is shown to extend beneath the One Babcock Street Offices (former Barrel House). Based upon the available information from existing wells, it is not possible to determine if product exists beneath the building.

Product was observed for the first time on the west side of the Babcock Street sewer during the July 2002 gauging round in MW-24 and SB-37. Product has not been observed in SB-37 since late August 2002 and in MW-24 since November 5, 2002.

Localized product plumes are shown in the following areas of the site:

- around SB-37 in the BSPA;
- around well MW-7 in the FRA;
- around SB-12, MW-6 and Well Point 23 in the FRA (it is possible that the product observed at MW-6 is part of the main product plume); and
- around MW-38 in the NPSA.

In addition, a localized plume is also shown around MW-16, south of the active Tank Truck Loading Rack based upon the observance of product during one gauging round (April 2001). Product has not been observed in this location since that round, however petroleum-related impacts were observed soil boring installation in this area conducted in 2001. Based upon the soil boring results, two new wells (MW-36 and MW-37) were added in 2001. MW-36 was destroyed during snowplowing activities during the December 24 through 28, 2001 storm and was replaced with MW-36R in May 2002. No product has been observed in either of these wells since they were installed. These wells will continue to be monitored to determine any changes in separate-phase product occurrence in this area of the Site.

In the ETYA, a localized plume of separate-phase product (ETYA Plume) extends from beneath the containment area for Tank 176 in the ETYA southward to MW-28. The plume extends from LF-3 to the west to LF-4 to the east.

As a note, monitoring well LF-7 located in the ETYA showed evidence of separate-phase product for the first time during the October 2002 gauging round but not when gauged on January 10, 2003 or during the January 2003 quarterly gauging round (January 21, 2003). Therefore, it is likely that the product recorded during the October 2002 gauging round could be attributed to an erroneous reading.

Separate-phase product has only been observed in one well in the northern portion of the site, MW-38 in the NPSA. No product has been observed in the remainder of the northern portion of the Site, including north of well MW-31 in the FRA, the entire NTYA, the entire AOOA and the majority of the CRPA.

2.2 Groundwater Quality

Water quality sampling of groundwater from the selected wells is conducted on a quarterly basis. The groundwater samples are analyzed for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) according to United States Environmental Protection Agency (USEPA) Methods SW846 8021 and 8270 for New York State Department of Environmental Conservation (NYSDEC) STARS list compounds, respectively.

The analytical results from October 2002 are presented in Table 2 for VOCs and Table 3 for SVOCs. Groundwater quality data for benzene, toluene, ethylbenzene and xylenes (BTEX), MTBE, total VOCs, and total SVOCs collected from the wells sampled during the October 2001, January, April, July and October 2002 quarterly sampling rounds are presented on Plate 2.

The groundwater sampling results generally indicate lower concentrations of VOCs and SVOCs at the upgradient or northern edge of the Site and higher concentrations towards the center and southern areas.

The areas of the Site where the highest concentrations of VOCs and SVOCs were observed were in the vicinity of former and/or current tanks, former and active Loading/Filling Racks and some of the former waste handling areas. In the vicinity of the former Main In-Ground Oil/Water Separator, where relatively high concentrations of VOCs and SVOCs were observed in soil, groundwater was not collected due to the presence of separate-phase product.

3.0 SITE ENVIRONMENTAL REMEDIATION HISTORY

To date the environmental remediation activities at the Site have focused on control of groundwater flow beneath the Site and recovery of separate-phase product. Two groundwater extraction systems are currently operating at the Site, the WPS and the Dual-Phase Recovery System. The groundwater recovered by these systems is treated by the Site's Water Treatment System, installed in the Remediation Building in the FRA and operational since 1993. Treated water is discharged to the Buffalo Sewer Authority (BSA) municipal sewer system. The following is a description of these systems and their history. The dual phase recovery systems also recovery separate-phase product. In addition, several product-only pumping systems are currently operating at the site.

3.1 Well Point System

The WPS was installed and operational in 1971. It consists of approximately 123 well points located parallel to the Buffalo River and is configured in two legs, eastern (EWPS) and western (WWPS). The western leg consists of 23 well points and the eastern leg consists of over 100 well points. The eastern leg has run continuously since its installation, however, the western leg had not operated from 1992 through August 1999.

Each leg has an independent header collection pipe and discharge pipe to the Water Treatment System, as well as a totalizing flow meter. Each well point is approximately 25 feet deep and 2.5 inches in diameter with a drop tube assembly within the well. Most points have been modified with a riser to the surface so that the well can be accessed. Each well has a valve connecting it to the 6-inch collection header pipe.

The well points are connected in series to the header pipe that leads to a dual-phase liquid ring pump vacuum system for each leg of the WPS. Each leg has an independent pump. The eastern leg has one operating pump and one standby pump. The western leg has one operating pump. The pumps provide a vacuum that extracts fluid from all of the well points tied into each header. Total fluids pulled from the WPS are pumped directly into the piping system and transmitted to the Site's Water Treatment System.

The western leg of the WPS was rehabilitated between August 1998 and April 1999. The rehabilitation included accessing and inspecting each well point drop tube, isolation valve and connection piping to the collection header. The collection header was observed to be in poor condition and was replaced with new pipe and connections to the well points. In addition, each well point was pressure cleaned. The rehabilitation also included the purchase and installation of a new liquid ring vacuum pump. The western leg of the WPS was reactivated on August 23, 1999 and has been operated since then with only relatively short periods of downtime.

3.2 Dual-Phase Recovery System

A dual-phase recovery system was installed at the Terminal between 1991 and 1993 to recover product. The dual-phase recovery system was activated in September 1993. The five recovery wells currently operating (RW-1 through RW-5) are located in the STYA within the separate phase product plume. RW-2 currently recovers groundwater only with manual bailing of product. A sixth recovery well had been installed in RW-6 in the STYA, but is no longer in use due to insufficient product recovery.

Associated with each recovery well are product and water recovery pumps, liquid level probes, a product storage tank, product and water transfer piping and a control panel. A groundwater pump is located near the bottom of the well and the product pump is located above it. By pumping water out of the recovery well, the water level is lowered in the surrounding area, creating a “cone of depression,” which is used to capture floating product and maximize its recovery. Recovered water is pumped to the Water Treatment System and recovered product is pumped to an above ground storage tank for later disposal off site.

3.3 Treatment and Discharge Systems

The Site’s Water Treatment System was installed and operational by 1993. The Water Treatment System is located in the Remediation Building in the FRA. The treatment system handles all extracted groundwater (from the dual-phase recovery systems and the WPS), as well as storm water not associated with the lined active tank farm drainage system, prior to discharge to the BSA sewer system.

An upgrade of the Water Treatment System was completed in March 2000. The Water Treatment System currently consists of two treatment trains. Treatment Train 1 handles all groundwater sources described above, as well as dry-weather flow from the storm-water lift station. Treatment Train 2 handles wet weather flow from the storm-water lift station. Flow from the storm-water lift station to Train 1 or Train 2 is controlled by a manually operated valve.

Treatment Train 1 consists of a 500 gallons per minute (gpm) oil/water separator followed in series by a 300 gpm oil/water separator to remove separate-phase product and air sparging tanks to remove dissolved phase constituents. Treatment Train 2 consists of a 1,500 gpm oil/water separator followed by a 500 gpm oil/water separator in series. Train 2 is configured so that wet weather flow in excess of the capacity of the 500 gpm separator is automatically bypassed after passing through the 1,500 gpm separator. Following treatment and flow monitoring by an ultrasonic flow meter, water is discharged to the BSA sewer system. The Site's Water Treatment System is currently discharging to the BSA under BPDES Permit No. 97-05-BU045.

Water collected from the active lined tank farm for the above ground storage tanks is pumped from the dedicated lift station located in the STYA to the Lined Tank Farm Above Ground Oil/Water Separator located along the dock in the STYA prior to discharge to the Buffalo River under State Pollution Discharge Elimination System (SPDES) permit No. NY-0204480, first issued in April 1992.

3.4 Product-Only Pumping Systems

Several product-only pumping systems are operating at the Site. A permanent product-only pumping system is installed in monitoring well MW-14 in the STYA. In addition, there are three mobile solar-powered product-only pumping systems that can be moved from well to well to address product across the site. One is currently deployed in the ETYA, the second is deployed in the BSPA and the third is deployed in the STYA.

3.5 Separate-Phase Product Recovery To Date

Cumulative product recovered from the dual-phase recovery systems, product-only pumping systems, WPS, main In-Ground Oil/Water Separator and manual/passive product bailing since September 1993 is approximately 42,809 gallons. Approximately 32,814 gallons were recovered from automated product recovery systems (RW-1 through RW-5 and product-only pumping systems); approximately 9,036 gallons were recovered from the main In-Ground Oil/Water Separator, the water treatment system oil/water separators and the Site sewer system; and 959 gallons were recovered from manual/passive bailing of wells.

4.0 FIELD ACTIVITIES

Aquifer tests were performed at four locations to develop the data necessary to conduct the evaluation of aquifer characteristics in the unconfined aquifer beneath the Buffalo Terminal. Two tests were located within the main separate-phase product plume in the Southern Tank Yard Area (STYA) and two tests were located in the Eastern Tank Yard Area (ETYA). The four aquifer testing networks consisted of:

- Recovery Well RW-7 (located in the STYA) and monitoring wells MW-18, MW-32, MW-40, MW-41, and MW-45;
- Recovery Well RW-8 (located in the ETYA) and monitoring wells LF-3, LF-5, LF-6, LF-1S, MW-3URS, and P-15;
- Recovery Well RW-8R (located in the ETYA) and monitoring wells LF-3, LF-5, LF-6, LF-1S, MW-3URS, and P-15;
- Recovery Well RW-9 (located in the STYA) and monitoring wells ESI-4, MW-14, MW-20, MW-21, MW-42, and MW-43.

The location of wells in each aquifer test network is shown in Figure 3. Well construction details for newly-installed wells are summarized in Table 4. The three recovery wells were installed at locations that were anticipated to be part of a groundwater containment and separate-phase product recovery system. In addition, recovery wells were placed such that existing monitoring wells could be used as part of the aquifer testing networks.

The goals of the aquifer testing were to:

- Determine the aquifer coefficients (i.e., hydraulic conductivity) in the vicinity of each aquifer testing network;
- Determine the configuration of the water table under pumping and non-pumping conditions;
- Verify that the aquifer coefficients determined at each well location agree with the geologic data that exists for this area; and
- Evaluate the effectiveness of each recovery well network to propagate a capture zone large enough to control the groundwater flow direction and control migration of the separate-phase product by inducing the flow of separate-phase product to the recovery well.

To accomplish these objectives, the following field activities were performed:

- Installed test boreholes at three locations (TB-1, TB-2, and TB-3);
- Performed sieve analyses for soil samples collected during the installation of the three test boreholes;
- Collected Shelby tubes of soil samples during the installation of the three test boreholes;
- Installed and developed six monitoring wells (MW-40 through MW-45);
- Installed and developed four recovery wells (RW-7, RW-8, RW-8R, and RW-9);
- Shut down of all existing groundwater/separate-phase product recovery systems (EWPS and WWPS and RW-1 through RW-5) to allow aquifer recharge;
- Collected fluid elevation measurements in existing and newly-installed wells over a period of time to determine static conditions;
- Performed four step-drawdown tests (RW-7, RW-8, RW-8R, and RW-9);
- Performed four constant-rate pumping tests (RW-7, RW-8, RW-8R, and RW-9); and
- Performed four separate-phase product bail-down tests (ESI-1, MW-14, MW-15, and SB-17).

Field task procedures are described below.

4.1 Test Borehole Installation

In accordance with ExxonMobil and Roux Associate’s ground disturbance protocols, each location was cleared to a depth of five feet below land surface (ft bls) using an ExxonMobil approved method (i.e., air knife or hand digging). Three 4-inch diameter test boreholes (TB-1, TB-2, and TB-3) were installed prior to installation of monitoring wells and recovery wells. Two test boreholes (TB-1 and TB-2) were installed within the main plume in the STYA and one test borehole was installed in the ETYA (TB-3). Monitoring wells MW-40 and MW-42 and recovery well RW-8 were installed at test boring locations TB-1, TB-2, and TB-3, respectively (Figure 3). The geologic logs for the three test borings included in Appendix A.

Test boreholes were drilled using the hollow-stem auger method. Continuous split-spoon sampling was performed from five feet bls to approximately five feet into the clay layer. Split-spoon soil samples below the water table were collected for laboratory sieve analyses.

Sieve analyses were completed for samples from the 15 to 17 ft bls interval at TB-1, 17 to 19 ft bls interval at TB-2, and 25 to 27 ft bls interval at TB-3. Results from the sieve analysis are presented in Appendix B.

Three undisturbed soil cores from approximately six inches below the water table were collected using Shelby-tube samplers at each test borehole location. However, all three cores did not maintain their internal structures and were not analyzable by the laboratory.

4.2 Monitoring Well Installation

All monitoring wells were completed in 8-inch diameter boreholes drilled using the hollow-stem auger method. Continuous split-spoon sampling was performed from five feet bls to approximately five feet into the clay layer.

Monitoring wells MW-40 through MW-45 are constructed of 4-inch diameter polyvinyl chloride (PVC) casing and riser with 4-inch diameter 20-slot PVC screen and a 2-foot PVC sump below the screen. The screened intervals include the entire saturated thickness of the aquifer from approximately eight feet above the water table to the top of the clay layer. Well construction details are summarized in Table 4 and boring logs are presented in Appendix A.

The gravel pack for all monitoring wells extends from the bottom of the sump to approximately two feet above the top of the screen zone. Above each gravel pack, a 1- to 2-foot thick bentonite pellet seal was placed and hydrated for a minimum of two hours. The borehole was completed with cement/bentonite grout using a tremie pipe to within two feet of land surface and finished with a concrete cap sloped to divert precipitation away from the well. Each monitoring well was finished either as a stick-up with protective steel casing or flush-mounted with an 8-inch diameter steel curb box.

Monitoring wells were developed by surging and pumping. Each well was developed adequately to minimize the amount of sediment entering the well during pumping and to maximize the specific capacity (i.e., gallons per minute per foot of drawdown). Well development logs are presented in Appendix C.

4.3 Recovery Well Installation

Recovery wells were completed in 16-inch diameter boreholes installed using the hollow stem auger method. Continuous split-spoon sampling was performed. Recovery wells RW-7 and RW-9 are located within the main plume in the STYA and recovery well RW-8R is located in the ETYA south of Tank #176 (Figure 3).

During the installation of RW-8, the drilling with the hollow stem augers may have smeared the borehole with the silts and clays encountered at the bottom of the borehole. Several attempts were made to adequately develop RW-8 but the attempts were not successful. Insufficient specific capacity was observed during development and subsequent step testing and constant rate pump testing of the well. The well materials (i.e., riser, screen, and sump) were removed and the borehole was grouted. The well materials were decontaminated and pressure washed to remove debris from the screen area and re-used for the replacement recovery well for RW-8. Recovery well RW-8R was installed approximately 30 feet north of RW-8.

The recovery wells were constructed of 10-inch diameter carbon steel (black steel) casing with 10-inch diameter 20-slot 304 stainless steel continuous-wrap wire-wound screen and a 2-foot carbon steel sump below the screen. The screened intervals include the entire saturated thickness of the aquifer from approximately eight feet above the water table to the top of the clay layer. The gravel pack for each recovery well extends from the bottom of the sump to approximately five feet above the top of the screen zone. Above each gravel pack, a 1- to 2-foot thick bentonite pellet seal was placed and hydrated for a minimum of two hours. The borehole was completed with cement/bentonite grout using a tremie pipe to within two feet of land surface.

Screen slot sizes for each recovery well were selected based on the results of the lithologic descriptions and sieve analyses for test boreholes completed in the vicinity, as discussed in Section 4.1. The observations and sieve analysis results from TB-1 were assumed to be representative of conditions in the area of the Site that included recovery well RW-7, which is located 30 feet from TB-1. Similarly, the results from TB-2 were used for selection of well construction materials for recovery well RW-9, which is located 25 feet from TB-2. TB-3 was completed in the exact location of RW-8. The results from TB-3 were also used for the selection of well construction materials of recovery well RW-8R, the replacement well for RW-8.

The screen slot sizes, gravel pack sizes and screened intervals used at each recovery well are summarized in Table 4.

Each recovery well was developed similarly to the monitoring wells. Development logs are presented in Appendix C.

Monitoring and recovery wells were surveyed for horizontal coordinates relative to the New York State Plane Coordinate System and vertical (i.e., top of casing and land surface) elevation relative to National Geodetic Vertical Datum 1929 (NGVD 1929). Surveying was performed by Nussbaumer & Clarke, Inc. of Buffalo, New York. Horizontal coordinates are accurate to ±0.1 feet and vertical coordinates are accurate to ±0.01 feet.

4.4 Fluid-level Measurements

Fluid level measurements were collected from existing and newly installed monitoring wells, recovery wells and the Buffalo River staff gauge.

A round of water level and separate-phase product thickness measurements was collected under pumping conditions. All groundwater extraction systems were then shutdown for a period of two days to allow fluid levels to recover. The gauging data indicated that fluid levels were still recovering at the end of the two-day period (i.e., static conditions in the aquifer were not reached). However, the duration of down time for the EWPS and WWPS had to be limited to prevent migration of dissolved and separate-phase constituents.

During the recovery period, water level and separate-phase product thickness measurements were collected twice a day for two days. The last round of water-level and separate-phase product thickness measurements was considered representative of non-pumping (i.e., near static) conditions for aquifer testing, and was used to define the non-pumping configuration of the water table and separate-phase product plume.

4.5 Aquifer Testing

To support the development of the groundwater and multi-phase models, Roux Associates conducted aquifer testing at the four newly installed recovery wells. Aquifer testing was performed at each of the four new recovery well networks and consisted of two phases:

- a step-drawdown test; and
- a constant-rate pumping test.

A temporary 2-inch diameter Schedule 40 PVC piezometer with 20-slot screen was installed within each monitoring well and recovery well in the test network and secured at the top of the well. The piezometers' screened interval was placed far enough below the water table to prevent separate-phase product accumulation in the piezometer during aquifer testing. The piezometers were removed following the aquifer testing.

For each aquifer test, a stainless steel submersible pump was installed and the intake was set approximately one to three feet above the bottom of the test well such that only groundwater was pumped (i.e., the pump intake was maintained below the oil-water interface).

The four aquifer testing networks consisted of the following wells:

- Recovery Well RW-7 and monitoring wells MW-18, MW-32, MW-40, MW-41, and MW-45;
- Recovery Well RW-8 and monitoring wells LF-3, LF-5, LF-6, LF-1S, MW-3URS, and P-15;
- Recovery Well RW-8R and monitoring wells LF-3, LF-5, LF-6, LF-1S, MW-3URS, and P-15;
- Recovery Well RW-9 and monitoring wells ESI-4, MW-14, MW-20, MW-21, MW-42, and MW-43.

4.5.1 Purge Water Handling and Treatment

Groundwater pumped from RW-7 was discharged to the Site's storm water collection system where it flowed to the storm water lift station and was ultimately pumped to the on-site water treatment system. Groundwater pumped from RW-8R was transferred to a frac tank for temporary containment and then transferred from the frac tank to the on-site water treatment system. Groundwater pumped from RW-9 was transferred to the on-site water treatment system through a temporary 2-inch layflat hose.

4.5.2 Step Testing and Analyses

Step-drawdown tests were performed at recovery wells RW-7, RW-8, RW-8R, and RW-9. The step-drawdown tests were used to determine the approximate specific capacity and maximum sustainable rate (Q_{max}) of each recovery well. Q_{max} was initially estimated for each location based on data from existing recovery wells and data generated during the development of the new recovery wells. Each step test, with the exception of the RW-8 test, was divided into four steps based on the initial estimate of Q_{max}. Only three steps were performed in RW-8. The initial estimates of Q_{max} were:

- RW-7 = 13.3 gallons per minute (gpm)
- RW-8 = 3.3 gpm
- RW-8R = 8.5 gpm
- RW-9 = 13.0 gpm

Each of the steps consisted of pumping at a constant rate until drawdown reached near asymptotic conditions. The pumping rate was then increased to the next step. The last step of the test was determined to be when drawdown in the recovery well was approximately 80 percent of the static water column. Q_{max} was defined as the pumping rate during the step immediately prior to the last step.

Water level fluctuations during the step tests were recorded in monitoring wells and the recovery well using In-Situ, Inc., continuous recording pressure transducers (miniTROLLs™). Water level fluctuations in monitoring wells outside each aquifer test network were periodically measured with an electronic inter-face probe. The Buffalo River water level was monitored continuously for a 15 day period using an In-Situ, Inc. Hermit 1000 data logger and pressure transducer (Appendix D).

After each step test, the pump in the recovery well was shut down and water levels were monitored during recovery.

Step Test Schedule

The order in which the step tests were conducted was designed to minimize the down time of the EWPS and WWPS. The dual-phase recovery systems were off throughout the entire aquifer testing period.

The following schedule was observed during the step tests:

- June 15, 2002 – EWPS and WWPS shutdown;
- June 17, 2002 – RW-7 step test;
- June 18, 2002 – RW-9 step test;
- June 18, 2002 – startup of EWPS and WWPS following RW-9 step test;
- June 27, 2002 – RW-8 step test; and
- August 7, 2002 – RW-8R step test.

The EWPS and WWPS were off throughout the step tests at RW-7 and RW-9 and were operating during the RW-8 and RW-8R tests since water levels in the ETYA are relatively unaffected by the well point system operation. The data collected from the step tests were analyzed and specific capacities (Q_{max}) for each recovery well was determined and used for the constant-rate pump tests.

4.5.3 Constant-Rate Pumping Tests

Constant-rate pump tests were performed at each newly-installed recovery well (i.e., RW-7, RW-8, RW-8R, and RW-9) after the 2-day system shutdown period and immediately following the step-drawdown tests. Each constant-rate pumping test was performed by pumping the recovery well at Q_{max} for approximately 24 hours or until the drawdown stabilized to near asymptotic conditions. The pump was then shut off and water level recovery following the test was monitored. The tests were performed in accordance with Roux Associates' Standard

Operating Procedures for conducting constant-rate drawdown tests, with minor modifications (Appendix E).

During each constant-rate pumping test, time versus drawdown data were collected at logarithmic intervals in each aquifer test network well using miniTROLLs™. Manual water-level measurements were collected from wells in the vicinity and within the aquifer test network to confirm the miniTROLL™ data. Where present, separate-phase product thickness was also measured periodically using an electronic interface probe. The manual separate-phase product thickness data were used to calculate corrected groundwater elevations.

The discharge rate of the recovery well during each test was measured continuously using a flow meter and totalizer. Readings from the flow meter was obtained on a regular basis and recorded in a field book. Deviations from Q_{max} were recorded in the field book prior to adjusting the flow rate back to Q_{max}.

<u>Discharge Sampling and Analysis</u>

During each of the four constant-rate pumping tests, one sample of the discharged water was collected for laboratory analyses at the end of the test. Each sample was delivered to Test America, Inc. of Nashville, Tennessee for the following analyses:

- VOCs by Method SW846 8021 for NYSDEC STARS list compounds;
- SVOCs by Method 8270 for NYSDEC STARS list compounds;
- Total iron by Method 6010;
- Total manganese by Method 6010;
- Total magnesium by Method 6010;
- Alkalinity by Method 310.1;
- Total calcium by Method 6010;
- Total suspended solids (TSS) by Method 160.2; and
- Total dissolved solids (TDS)

Results of these analyses are presented in Table 5 and will be utilized as part of the evaluation of the remedial treatment alternatives. Temperature and pH were measured during sample collection.

<u>Recovery</u>

At the end of the constant-rate pumping test, the miniTROLLs^{TM} were reset to record water level recovery data. Post-test water-level measurements continued until water levels recovered to 95 percent of their pre-test levels. Recovery data was evaluated and analyzed to confirm pumping data.

Upon completion of the post-test monitoring period, data were downloaded from the miniTROLLs^{TM} for computer-assisted analysis.

<u>Constant-Rate Pump Test Schedule</u>

The order in which the constant-rate pump tests were conducted was designed to minimize the down time of the EWPS and WWPS. The Buffalo River was inspected daily along the entire length of the bulkhead for evidence of sheen during all periods when the EWPS and WWPS were not operating.

The following schedule was observed during the constant rate tests:

- June 22, 2002 – EWPS and WWPS shutdown;
- June 24, 2002 – RW-7 test;
- June 26, 2002 – RW-9 test;
- June 28, 2002 – RW-8 test;
- June 28, 2002 startup of EWPS and WWPS following RW-8 test; and
- August 8, 2002 – RW-8R test.

4.5.4 Bail-Down Testing

Bail-down tests were performed in four monitoring wells (ESI-1, MW-14, MW-15, and SB-17) that contained significant (i.e., greater than 0.5 foot) separate-phase product thicknesses. The initial depth to water and depth to product were measured using an electronic oil/water interface probe, and the product thickness determined. Product was bailed from the well as quickly as possible with minimal disturbance of the oil/water interface using a 1-gallon PVC bailer. Depth to water and depth to product measurements were then collected repeatedly as rapidly as possible (averaging four measurements per minute). The frequency of measurements was then gradually decreased until the test was concluded. The results from the bail-down testing are included in Appendix F.

4.5.5 Free-Product Characterization Sampling

Three representative samples of separate-phase product and groundwater present beneath the BSPA/FRA/STYA separate-phase product plume (Main Plume) and ETYA separate-phase product plume (ETYA Plume) were obtained and submitted for analysis to determine fluid properties in June 2002. Eight additional samples were obtained in March 2003. These fluid properties were used for the multi-phase flow modeling input parameters and are summarized in Table 6 and presented in Appendix G.

Separate-phase product from each well was collected with a new polyethylene bailer attached to a new polyethylene rope. Free-product collected in the bailer was transferred from the top of the bailer to three 40-milliliter (mL) brown glass containers. Head-space in the sample containers was minimized. Groundwater collected in the bailer was transferred from the bottom of the bailer to three 40-mL brown glass containers. The containers with groundwater were sealed with zero head-space. Excess fluids from each well were poured back into the respective wells.

Samples were packed on ice in a cooler and sent to Torkelson Geochemistry, Inc. of Tulsa, Oklahoma for analysis. Samples were analyzed for density (specific gravity), viscosity, surface tension, interfacial tension, and hydrocarbon characterization. Separate-phase product density was analyzed using American Standard for Testing and Materials (ASTM) Method 4052. Viscosity was analyzed according to the Brookfield DV-II method. Separate-phase product surface tension and interfacial tension between groundwater and separate-phase product were analyzed using ASTM Method D971. All samples were analyzed at a temperature of 60 degrees Fahrenheit. Results from the geotechnical fluid analysis are summarized in Table 6.

Hydrocarbon characterization (High Resolution Capillary Gas Chromatography with Flame Ionization Detector) analyses are included in Appendix G.

5.0 PUMPING TEST DATA ANALYSIS

Pumping test data from the RW-7 and RW-9 aquifer test network were evaluated and analyzed to determine estimated hydraulic conductivity for the unconfined aquifer beneath the STYA. Monitoring well data from the RW-8R pump test were not analyzable due to hydraulic interference from the Buffalo River. However, the early-time data from the recovery well RW-8R was analyzed to estimate hydraulic conductivity in the ETYA.

5.1 Pumping Test Analyses

The pump test data were analyzed utilizing the methodology developed by Theis (1935) for unconfined aquifers. The pump test analyses were performed using a computer program (Aqtesolv™) developed by HydroSOLVE, Inc (2000).

The drawdown data collected using miniTROLLs™ were subsequently downloaded to a computer. The data files were manipulated to establish the proper data format required by Aqtesolv™. The well and aquifer characteristics were also entered into Aqtesolv™ as required by each model input parameter. The data for the well and aquifer geometry were obtained from monitoring well construction logs (Appendix A).

Once the input parameters were entered into Aqtesolv™, log-drawdown versus time plots were generated for each analysis. A pumping curve solution for an unconfined aquifer solved by the Theis (1935) method was manually fitted to the early time-drawdown data for each test to acquire a best-fit match. Aqtesolv™ then calculated the transmissivity for each test.

Results from the pump test analyses are summarized in Table 7. The computer plots and aquifer and well geometry inputs are summarized in Appendix H.

5.2 RW-7 Pump Test Results

RW-7 was pumped for approximately 29 hours at an average rate of 15.5 gpm. The maximum drawdown observed in the pumping well was 2.85 feet. The drawdown data from RW-7 indicated a hydraulic conductivity of 63 ft/d. The drawdown data from the monitoring wells indicated hydraulic conductivities ranging from 128 to 160 ft/d. Average hydraulic conductivity determined from the RW-7 pump test (monitoring wells MW-40, MW-41, and MW-45 and recovery well RW-7) was 129.7 ft/d; consistent with the medium sand matrix encountered during drilling in this portion of the STYA. Two monitoring wells, MW-18 and MW-32, did not show drawdown influences from the RW-7 pumping.

5.3 RW-8R Pump Test Results

RW-8R was pumped for approximately 10.3 hours at an average rate of 11.0 gpm. The maximum drawdown observed in the pumping well was 10.35 feet. Due to the lack of a barrier between the groundwater and surface water (i.e., bulkhead), the hydraulic influence of the Buffalo River in the ETYA masked any drawdown effects in the monitoring wells from the pumping at RW-8R. However, early drawdown data from the pumping well were not affected by fluctuations in the Buffalo River. Once drawdown in the pumping well stabilized (after 35 minutes), the influence of the Buffalo River was evident. Based on the analysis of the early drawdown data in RW-8R, the hydraulic conductivity was estimated to be approximately 7.7 ft/d; consistent with the silty matrix encountered during drilling in the ETYA.

5.4 RW-9 Pump Test Results

RW-9 was pumped for approximately 23.5 hours at an average rate of 13.0 gpm. The maximum drawdown observed in the pumping well was 7.87 feet. Approximately 30 minutes into the RW-9 pump test, separate-phase product was measured in RW-9. The amount of product overwhelmed the attempts at manual hand-bailing to keep the product thickness constant. Therefore, the drawdown data from RW-9 was not analyzed.

The drawdown data from monitoring wells ESI-4 and MW-43 indicated hydraulic conductivities of 47.5 ft/d and 43.9 ft/d, respectively. The drawdown data from MW-42 indicated a hydraulic conductivity of 135.5 ft/d, which is not consistent with the data from the other wells in the network, nor with the description of the subsurface materials from the geologic log of silt, clay and fine to medium sand. Results from multiple gauging rounds indicate that the groundwater elevation at MW-42 is on the average five feet higher than the wells in the area. While the average hydraulic conductivity determined from the RW-9 pump test (monitoring wells MW-42, MW-43, and ESI-4) was 75.3 ft/d, the data from ESI-4 and MW-43 are more indicative of the hydraulic conductivity in the area. Excluding the results from MW-42, the average hydraulic conductivity in the vicinity of RW-9 is approximately 45.2 ft/day. Three monitoring wells, MW-14, MW-20, and MW-21, did not show drawdown influences from the RW-9 pumping.

6.0 GROUNDWATER MODELING

This section summarizes the groundwater modeling task that was performed as part of the evaluation of aquifer characteristics at the Site.

6.1 Groundwater Modeling Objective

The objective of the groundwater modeling task summarized in this report was to develop a calibrated model that can be used to simulate water-table elevations under static (i.e., non-pumping) and simulated pumping conditions. This groundwater model will subsequently be used to evaluate alternatives for groundwater containment and enhancement of separate-phase product recovery that will be summarized in a separate report.

6.2 Modeling Tasks

To accomplish the above objective, the following modeling tasks were performed:

- Construction of a groundwater model grid;
- Model calibration to non-pumping conditions and sensitivity analyses; and
- Simulation of the current pumping conditions at the Site.

6.3 Model Codes and Software

The groundwater modeling task was performed using the Modular Three-Dimensional Finite-Difference Ground-Water Flow Model, widely known as MODFLOW (McDonald and Harbaugh 1988). MODFLOW was originally distributed by the United States Geological Survey (USGS). The version of MODFLOW used in this modeling task was MODFLOWwin32.

Particle tracking for visualization of groundwater flowpaths was performed using MODPATH (Pollock 1989). MODPATH is a three-dimensional particle-tracking model that works with MODFLOW and was developed by the USGS. The version of MODPATH used in this modeling task was MODPATH win32.

The graphical pre- and post-processing software that was used for the modeling task was Groundwater Vistas (Version 3.0, Environmental Simulations, Inc. 2001). Groundwater Vistas is a graphical design system for MODFLOW, MODPATH and MT3D, as well as other models not used here.

6.4 Conceptual Model

Figure 4 presents a summary cross section that illustrates the conceptual model for the modeled area. The aquifer beneath the Site is characterized as a wedge-shaped unit that increases in thickness from north to south. The aquifer consists of fill overlying unconsolidated overburden that includes sand, silt and clay. A continuous clay unit underlies the saturated portion of the overburden. This underlying clay unit was utilized to represent the lower boundary for flow in the model, and was designated a no-flow boundary at the base of the model grid.

Recharge input was operative over the top layer of the model grid. Constant head cells were used to represent inflow along the northern portion of the model grid. River cells were used to represent the Buffalo River along the southern portion of the model grid. No-flow boundaries were assigned to portions of the model grid that were considered outside of the area that contributes flow to the aquifer beneath the Site.

6.5 Model Grid Construction

The groundwater flow component of the model was performed using MODFLOW (McDonald and Harbaugh 1988). MODFLOW is a block-centered finite-difference numerical model that is a widely-used, well-tested, industry-and government-accepted standard for this purpose (USEPA, 1994).

6.5.1 Model Grid Extent and Layers

The MODFLOW model grid consisted of 4 layers and 69,920 cells (95 rows and 184 columns [Figure 5]). The model grid covers a 220-acre region encompassing the Site that is 3,990 feet long (i.e., in the general northwest-southeast direction) and 2,400 feet wide (i.e., in the general southwest-northeast direction). The active portion of the model grid (i.e., not including no-flow cells) encompasses an area representing 128 acres, or 58 percent of the total model grid. The model grid was rotated 30 degrees clockwise to align the principal flow axis with the dominant groundwater flow direction of the Site towards the Buffalo River. Layer 1 represents the fill unit. Layers 2 through 4 represent the sand and silt unconsolidated overburden aquifer. The bottom of the model was defined based on the elevation of the top of the clay unit that underlies the Site.

6.5.2 Model Grid Layer Bottom Elevations

Elevations for the bottoms of each of the model grid layers were based upon a review of soil boring and monitoring well logs and survey data. The survey data were used to define the top elevation (i.e., land surface) of Layer 1. The logs were reviewed to provide data on the elevation of the bottom of the fill unit, which corresponds to the bottom of Layer 1, and the top of the underlying clay unit, which corresponds to the bottom of Layer 4. Layer 2 thickness was defined based on the presence of a semi-continuous low permeability silt unit beneath the fill. Layers 3 and 4 were created by dividing the thickness between the bottom of Layer 2 and the top of the underlying clay unit by two. Layer bottom elevations are shown in Figure 6.

6.5.3 Model Grid Boundary Conditions

Four types of boundary conditions were used in the model grid:

- Constant-head boundaries;
- River boundaries;
- No-flow boundaries; and
- Specified flux (i.e., pumping well cells) boundaries.

Figure 5 summarizes the boundary conditions used in the model grid by layer.

<u>Constant-Head Boundaries</u>

Constant-head boundary cells were used along the northern portion of the Site in the model grid. The assigned hydraulic head elevation of the constant-head cells was estimated based on a review of groundwater level elevations in the vicinity of the boundary cells.

River Boundaries

River boundary condition cells were used to represent the Buffalo River. The following parameters were used to define the conditions within each cell:

- A uniform stage of the river of 572 feet above mean seal level (ft amsl) was used based on gauging data obtained during the static gauging round;
- A uniform bottom elevation of 560 ft amsl was used based on the average depth of the river;
- The width of the river was assigned a constant value of 230 feet;
- The hydraulic conductivity of the riverbed was designated as 1 foot per day (ft/d) where the bulkhead is absent and 0.01 ft/d where the bulkhead is present.

River cell conductance was calculated as the product of the length and width of the river reach in each river cell, multiplied by the hydraulic conductivity of the river bed and divided by the thickness of the river bed. The length and width of the river reach in each cell is calculated by Groundwater Vistas. The thickness of the bed was assumed to be 1 foot. Since the values for the riverbed parameters were assumed, and not known explicitly, a sensitivity analysis was performed on river cell conductance (discussed in Section 6.6.2). It is standard modeling practice to assume values for the riverbed conductance, and to adjust these values if necessary during calibration (McDonald and Harbaugh, 1988). Based on a review of calibration and sensitivity analysis results, no adjustment was made to the riverbed conductance terms during calibration.

No-Flow Boundaries

No-flow boundaries were used in the following portions of the model grid that were considered outside of the flow region beneath the Site:

- North of the constant head boundary cells;
- South of the river boundary cells; and
- Along the eastern and western boundaries of the model grid in the regions were there is limited or no water level data.

Specified Flux Boundaries

Specified flux (i.e., pumping well cells) boundaries were used during the simulation of existing pumping conditions to represent groundwater withdrawal points via pumping wells. The values assigned to the pumping wells cells, specified in cubic feet per day (ft^3/d) were based on average pumping rates for the dual phase recovery wells, the EWPS and the WWPS from July 2002.

6.5.4 Model Grid Parameters

Parameters input into the model grid included recharge and hydraulic conductivity.

Recharge

Four recharge zones were used in the model grid (Figure 7). The recharge values used in each zone were initially based on long-term average annual precipitation data for the Buffalo area. The data indicated that the average annual precipitation is 36 inches per year (in/y), or 0.0082 feet per day (ft/d). The evapotranspiration rate is approximately 0.0029 ft/d and the average annual amount of runoff is approximately 0.0015 ft/d. This yields an average annual recharge rate of 0.0038 ft/d. The actual recharge rates used were modified during the calibration process. The recharge rates were assigned in zones ranging in value from 0 ft/d to 0.006 ft/d. Areas of zero recharge were assigned to portions of the Site underlain by shallow silt and clay. Areas of high recharge were assigned to unpaved areas of the Site where high spots were observed on the water table, indicating recharge areas. These areas were assigned recharge rates of 0.006 ft/day. The southern 40 percent of the model grid adjacent to the Buffalo River was assigned a reduced recharge rate of 0.002 ft/d to account for relatively impervious ground cover (i.e., tank berms, paved areas, etc.) and the assumed reduced recharge as a discharge boundary (i.e., the river) is approached. The average recharge input into the model over the entire active portion of the grid was 0.0034 ft/d, which is within 10 percent of the average annual recharge data.

Hydraulic Conductivity

Hydraulic conductivity values for the model were based on the following:

- Pump test data;
- Estimated values based a review of Site boring logs and scientific judgment; and
- Model calibration and sensitivity analysis.

The hydraulic conductivity zones in the model grid are shown in Figure 8. Hydraulic conductivity values used in most of the model grid ranged from 0.01 ft/d to represent low permeability materials (i.e., silt) to 150 ft/d to represent permeable materials (i.e., coarse sand and gravel).

The following summarizes the major hydraulic conductivity zones used in the model grid:

- The fill unit was assigned a uniform hydraulic conductivity of 110 ft per day;
- The low permeability fine sand and silt zone that traverses the Site from west to east was assigned a hydraulic conductivity of 4 ft/d; and
- The region representing the Babcock Street sewer bedding was assigned a hydraulic conductivity of 5,000 ft/d.

Hydraulic conductivity values from pump tests were used as initial values in the model during the calibration process but were then adjusted to lower the residual mean of the model. Aquifer test data from three monitoring wells (MW40, MW-41, and MW-45) for the RW-7 pump test indicated that the hydraulic conductivity averages approximately 151.9 ft/d. The aquifer test data from RW-7 indicated a hydraulic conductivity of 63.2 ft/d. Average hydraulic conductivity of 129.7 ft/d was initially assigned to cells in the vicinity of RW-7 but after the calibration process, a hydraulic conductivity of 110 ft/d was assigned in the calibrated model grid.

Aquifer test data from three monitoring wells for the RW-9 pump test indicated that the hydraulic conductivity averages approximately 75.3 ft/d. However, data from two of the wells (ESI-4 and MW-43) averaged 45.2 ft/d and data from one well (MW-42) indicated a hydraulic conductivity of 135.5 ft/d. As discussed in Section 5.4, the hydraulic conductivity derived from analysis of pump test data at MW-42 was not consistent with the data from ESI-4 and MW-43 or with the description of subsurface materials from the geologic log of silt, clay and medium sand. In addition, multiple gauging rounds have indicated that the groundwater elevation in MW-42 is approximately five feet higher than other wells in the vicinity. Therefore, hydraulic conductivity value from MW-42 was excluded from the average hydraulic conductivity of 45.2 ft/d that was initially assigned in the calibrated model grid in the vicinity of RW-9. After calibration, the hydraulic conductivity value in this area was adjusted to 30 ft/d.

Aquifer test data from the pumping well for the RW-8R pump test indicated that the hydraulic conductivity was approximately 7.7 ft/d. Based on the calibration process, a hydraulic conductivity of 4 ft/d was assigned in the calibrated model grid in the vicinity of RW-8R.

6.6 Flow Model Calibration

Flow model calibration was achieved using both iterative trial and error and automated sensitivity analyses to achieve the lowest target residuals. A steady-state flow model calibration was performed.

6.6.1 Calibration Target Heads

The calibration target heads for the MODFLOW groundwater flow model were based on the June 17, 2002 static gauging event. A summary of calibration target head residuals by layer and for the whole model is shown in Table 8. The results of the calibration were evaluated by use of the residual mean and absolute residual mean as calibration criteria. These criteria compare the modeled hydraulic heads with the actual measured hydraulic heads in monitoring wells and piezometers. The goal of the calibration process is to reduce the residual and absolute residual mean to the extent practicable. The goal of the calibration process was to achieve residual and absolute residual means less than 1 foot, while yielding a model with horizontal and vertical flow directions that approximate those observed in the field.

The flow model calibration results were evaluated by the following criteria:

- comparison of modeled and measured hydraulic heads; and
- sensitivity analyses.

Figure 9 summarizes the resulting calibrated hydraulic heads and calibration residuals for each layer from the groundwater flow model. Provided below is a summary of the calibration residuals by layer:

Layer	Number of Targets	Absolute Residual Mean (feet)
1	1	0.22
2	2	0.05
3	28	0.72
4	19	0.78

The residual mean (average of the difference between modeled and observed hydraulic heads) for the calibrated model under simulated non-pumping conditions was 0.16 feet with an observed total range in hydraulic head from the entire model grid of 13.5 feet. The absolute residual mean (average of the absolute value of the difference between modeled and observed hydraulic heads) was 0.70 feet. The model was found to be an accurate representation of the flow system at the Site.

6.6.2 Sensitivity Analyses

According to Anderson and Woessner (1992):

> *"The purpose of a sensitivity analysis is to quantify the uncertainty in the calibrated model caused by uncertainty in the estimates of aquifer parameters, stresses and boundary conditions."*

Sensitivity analyses were performed on the calibrated flow model grid for the following parameters:

- Horizontal hydraulic conductivity zones;
- River cell conductance; and
- Recharge zones.

The sensitivity analyses were performed by systematically varying the value of a particular parameter by cell, reach or zone via use of a multiplier (Anderson and Woessner, 1992). A multiplier of 1 indicates the value for the parameter in a cell, reach or zone that was used in the calibrated model. The results of the sensitivity analyses are presented as the sum of squared residuals, and are presented in Figures 10 through 12. The sensitivity analysis plots were also used to indicate whether the parameters used in the model resulted in the minimum, or near minimum, sum of squared residuals. This was also used during the calibration process to determine whether significant improvement could be made to the calibrated model by modifying the parameter as indicated in the sensitivity analysis results.

Sensitivity Analysis of Horizontal Hydraulic Conductivity

Figure 10 presents a summary of the results of sensitivity analyses performed on 10 of the major horizontal hydraulic conductivity zones used in the model. A review of the results indicates that the model is most sensitive to horizontal hydraulic conductivity zones 3, 6, 12 and 13. Hydraulic conductivity zone 3 represents and area of low-permeability material trending from the central portion of the Site toward the west, and was assigned a hydraulic conductivity of 1 foot per day. Hydraulic conductivity zone 6 is a large zone trending across the entire site that represents fine to medium sand and silt, and was assigned a hydraulic conductivity of 4 feet per day. Hydraulic conductivity zone 12 represents the aquifer beneath Tanks 87, 104, and 105 and was assigned a value of 20 ft/d. Hydraulic conductivity zone 13 represents the aquifer in the vicinity of RW-9 and was assigned a value of 30 ft/d. Based upon the sensitivity analysis, the model calibration cannot be significantly improved by reducing or increasing the values used for these parameters, and the sum of the squared residuals is at or near a minimum with the values used in the calibrated model.

Sensitivity Analysis of River Cell Conductance

A sensitivity analysis was performed on river cell conductance (Figure 11). River cell conductance is equal to the area of the river cell times the hydraulic conductivity and thickness of the river bed. Since this value is not frequently measured, river cell conductance is a value that is typically modified during calibration (McDonald and Harbaugh, 1988).

The model calibration is sensitive to river cell conductance for the river reaches 6, 7, 8 and 10, which are near the ETYA. This reflects the greater degree of hydraulic interaction between the

Buffalo River in the area, which does not contain a bulkhead, versus the ETYA, where a bulkhead exists.

Based upon the sensitivity analysis, reducing or increasing the values used for these parameters cannot significantly improve the model calibration, and the sum of the squared residuals is at or near a minimum with the values used in the calibrated model.

Sensitivity Analysis of Recharge Zones

A sensitivity analysis was performed on the four recharge zones (Zone 1, Zone 2, Zone 4, and Zone 6) used in the model (Figure 12). Recharge Zone 1 covers most of the northern portion of the model grid and recharge Zone 2 covers most of the southern portion. Recharge Zone 4 covers the open areas of the Site and recharge Zone 6 covers the paved areas of the Site. As a note, Zones 3 and 5 do not exist in the model. The sensitivity analyses indicate that the calibration is relatively insensitive to increases in the recharge rates for Zones 1, 2 and 4, but somewhat sensitive to decreases. The calibration is not sensitive to the value used for recharge Zone 6. As discussed above, the average recharge used for the model grid is consistent with local precipitation, recharge and runoff data.

Based upon the sensitivity analysis, the model calibration cannot be significantly improved by reducing or increasing the values used for recharge, and the sum of the squared residuals is at or near a minimum with the values used in the calibrated model.

6.7 Simulation of Current Remedial System Pumping

This section summarizes the pumping simulation (Simulation 1) of the current pumping conditions of the Site's remedial systems including the dual-phase recovery systems, the EWPS and the WWPS that was performed using the calibrated MODFLOW model in the vicinity of the main separate-phase product plume in the BSPA, FRA and STYA.

The analyses of the results of the pumping simulation included a particle tracking analysis to determine whether the modeled hydraulic head distribution resulted in groundwater flowpaths that led to complete capture of particles originating within the boundaries of the current and historic main separate-phase product plume as shown in Site Monitoring reports for 2002. Particle tracking was performed using MODPATH.

6.7.1 Simulation 1 – Current Pumping Conditions

Pumping conditions as of July 2002 were simulated by using pumping well cells in Layer 4 of the model grid to simulate Recovery Wells RW-1 through RW-5, the WWPS and the EWPS. The pumping rates used in the model grid are summarized below:

Recovery Well	Pumping Rate (gpm)	Pumping Rate (ft^3/d)
RW-1	8.3	1597.9
RW-2	0.5	96.26
RW-3	0.2	38.5
RW-4	1.6	308
RW-5	0.9	173.3
WWPS	36	6,930.5
EWPS	55	10,588.2
Total	102.5	19,732.6

The resulting hydraulic head distribution is shown contoured in Figure 13 with the particle tracking flowpaths superimposed. A review of Figure 13 and the results of Simulation 1 indicated the following:

- the current pumping system provides complete capture of particles originating within the area of the main separate-phase product plume;
- the overall configuration of the water table under the simulated pumping conditions is similar to the water table as observed based on actual hydraulic head measurements made during system operation, with the exception of in the vicinity of the Babcock Street sewer.
- the river cells representing the Buffalo River input approximately 60 gpm into the model grid as flow induced by the well point system and recovery wells, which represents approximately 58 percent of the total volume of water withdrawn by the remedial system.

A review of Plate 1 in the Third Quarter Site Monitoring Report for 2002, (Roux Associates, 2002) indicates that water levels in the vicinity of the Babcock Street sewer by the One Babcock Street Offices (former Barrel House) are below 570 ft amsl due to the pumping influence of the WWPS. A review of Figure 13 (this report) indicates that the simulated water levels in the same vicinity are between 571 and 572 ft amsl. Roux Associates was unable to resolve this discrepancy during model calibration. One explanation for the discrepancy is that the distribution of pumping influence for the WWPS is not uniform, and some individual well points may be exerting greater influence on drawdown than others. The effect of this discrepancy on the interpretation of model results is that the pumping simulations that will be performed as part of the evaluation of remedial alternatives will tend to underestimate drawdown in the vicinity of the Babcock Street sewer.

7.0 MULTI-PHASE FLOW MODEL DEVELOPMENT

This section summarizes the multi-phase modeling task that was performed as part of the evaluation of aquifer characteristics at the Site.

7.1 Multi-phase Modeling Objectives

The objectives of the multi-phase modeling task were to:

- Develop a qualitative calibrated model that can be used to simulate water-table elevations and separate-phase product elevations under static (i.e., non-pumping) and simulated pumping conditions in the BSPA/FRA/STYA separate-phase product plume (Main Plume) and ETYA separate-phase product plume (ETYA Plume); and

- Estimate the volume of separate-phase product beneath the Main Plume and the ETYA Plume.

This multi-phase model will then be used to evaluate pumping well configurations (i.e., locations and rates) that result in enhanced separate-phase product recovery at the Site. These evaluations will be summarized in a separate report.

7.2 Modeling Tasks

To accomplish the above objectives, the following modeling tasks were performed:

- Construction of a two-dimensional finite-element model grid;

- Simulation of the current observed groundwater elevations (i.e., model calibration); and

- Simulation of the current observed extent and thickness of separate-phase product (i.e., model calibration).

7.3 Model Codes and Software

Roux Associates performed the modeling task using BIOSLURP™ (Resource & Systems International, 2002). The multi-phase flow modeling was performed in accordance with the Scope of Work described in the May 2002 Work Plan (Roux Associates, 2002). The horizontal and vertical extents of the Main Plume and the ETYA Plume determined during this and past investigations were used to provide the basis for creation of a multi-phase flow model of the plumes.

BIOSLURP™ is a two-dimensional (2-D) finite-element computer model that can simulate three-phase (water, oil, and gas) flow and multi-dissolved phase transport in groundwater. BIOSLURP™ can be used to simulate the extent of separate-phase product and dissolved phases in groundwater, and vapor phases in soil gas. BIOSLURP™ simulates heterogeneous, anisotropic porous media or fractured media. It allows use of isoparametric elements to accurately represent material and physical/hydraulic boundaries. BIOSLURP™ can be used to design and optimize separate-phase product recovery and hydraulic containment systems for a separate-phase hydrocarbon plume and dissolved phase plume under complex hydrogeological conditions. Recovery scenarios may be simulated using separate-phase, water, and soil vapor extraction points.

BIOSLURP™ creates a mesh consisting of a rectangular and/or 2-D isoparametric quadrilateral elements to accurately model irregular domain and material boundaries, hydraulic boundaries, and physical boundaries. A computationally-efficient matrix solution is obtained through the application of a conjugate gradient method with preconditioning. Using the interactive graphical mesh design with BIOSLURP's™ native pre-processor (MeshEdit), areal distribution of hydrocarbon is continuously updated and used to compute the interphase mass transfers between water, oil, and gas phases and to estimate transient contaminant loading to groundwater and vadose zone. Physical variables such as recharge, multiple pumping and/or injection wells, specified head, specified concentration, fractured media or granular porous media, and flux conditions for flow and transport can be simulated with BIOSLURP™.

The BIOSLURP™ input parameters include the following:

- Initial conditions: oil-water and air-oil interface elevation distribution;
- Boundary conditions for flow: specified head and flux boundaries;
- van Genuchten soil parameters: hydraulic conductivity distribution, porosity, residual saturation, anisotropy angle;
- Fluid properties: air-oil and oil-water scaling parameters, viscosity, and density; and
- Source/sink boundaries.

The BIOSLURP™ output after model simulations include the following:

- Spatial distribution of fluid pressure with time;
- Spatial distribution of fluid saturation with time;
- Fluid velocity distribution with time;
- Fluid pumping/injection rates versus volume and time;
- Spatial distribution of species concentration in water and gas phases; and
- Species mass in water, oil, gas, and solid phases versus time.

7.4 Overview of Multi-Phase Fluid Dynamics

The presence of two immiscible fluids, such as separate-phase product and groundwater, in direct contact with each other in the subsurface forms a multi-phase system that is governed by the principles of multi-phase fluid dynamics. Multi-phase fluid dynamics in the subsurface are dependent on both hydrogeologic properties and properties of the fluids involved. Hydrogeologic properties include soil texture, grain size distribution, porosity, wettability, and intrinsic permeability. Fluid properties include density, viscosity, surface tension, and interfacial tension. The combination of these properties in the subsurface determines the capillary pressure, or pressure difference between the two fluids in the subsurface. With regards to a separate-phase product/groundwater system, the magnitude of this capillary pressure determines the vertical distribution of separate-phase product in the subsurface.

Capillary pressure is a function of the saturation of the fluid phases that are present (Charbeneau *et al*, 1999). The saturation of a particular fluid at a certain location in the subsurface is defined as the ratio of the volume of that fluid that is present in the soil pore space to the total volume of the soil pore space. Capillary pressure is inversely proportional to fluid saturation; therefore when the capillary pressure is low, the saturation of a particular fluid in the subsurface is high and vice versa. Capillary pressure is also inversely proportional to grain size. Thus, fine-grained soils exhibit higher capillary pressures than coarse-grained soils. Therefore, in a separate-phase product/groundwater system, the high capillary pressures limit the saturation of separate-phase product within fine-grained soils. This explains why separate-phase product does not migrate through the silt and clay layer, but rather flows around the layer and through the sandy deposits where the capillary pressure is significantly lower.

The thickness of separate-phase product observed in a monitoring well does not directly correspond to the thickness of separate-phase product present in the subsurface immediately adjacent to the well. Due to capillary forces, the amount of separate-phase product present, or separate-phase product saturation in the subsurface, varies with depth over the elevations that separate-phase product is measured in the well. This relationship is illustrated on Figure 14. This has led to significant over- and under-estimating of separate-phase product plume volumes in the past due to the use of various simplified relationships that did not fully account for these capillary forces. In order to better describe the occurrence and migration of separate-phase product in the subsurface, the currently accepted practice for determining separate-phase product/groundwater system characteristics utilizes the capillary pressure relationship models developed by Brooks and Corey (1964) and van Genuchten (1981), as modified for use with separate-phase product/groundwater systems and monitoring well apparent separate-phase product thicknesses by Farr *et al* (1990) and Lenhard and Parker (1990). The separate-phase product volume estimates and multi-phase flow model developed during this investigation were based on the method developed by Lenhard and Parker (1990), utilizing the van Genuchten capillary pressure model.

The basis of the capillary pressure relationships for separate-phase product/groundwater systems is that separate-phase product volume and its permeability, relative to that of water (relative permeability), is a function of separate-phase product saturation in the subsurface. In addition, these models identify minimum saturations of the fluids involved that must be exceeded before the respective fluid can become mobile in the subsurface. These saturations, called *residual saturation* when referring to separate-phase product and *irreducible saturation* when referring to water, are a function of soil type. Residual saturation and irreducible saturation are indicative of the amount of separate-phase product or water, respectively, immobilized within the soil matrix by capillary forces. When a particular fluid, such as separate-phase product, exists in the subsurface at saturations greater than residual, it becomes *mobile* and moves within the subsurface in response to the existing hydraulic gradient.

Mobile separate-phase product is also sometimes described as *recoverable* separate-phase product; however, these terms are not synonymous. Mobile separate-phase product refers to the portion of separate-phase product that exists in the subsurface at saturations greater than residual. As mobile separate-phase product moves away from a particular location (i.e., in response to natural or pumping-induced hydraulic gradients), separate-phase product saturation at that location decreases and a portion of the separate-phase product becomes trapped at residual saturation. Recoverable separate-phase product is therefore the amount of mobile separate-phase product that can be removed, or recovered, after allowing for the entrapment of separate-phase product in the soil matrix.

In general, the measured volume of separate-phase product in the subsurface increases with increasing separate-phase product saturation in a non-linear relationship that is roughly exponential in nature. This saturation is estimated from the monitoring well apparent separate-phase product thickness via the above-referenced capillary pressure models. The relative permeability of separate-phase product in the subsurface, and thus the recovery rate for a separate-phase product recovery system, also increases with increasing separate-phase product saturation in a similar, non-linear relationship, with relative permeability approximately proportional to the square of the separate-phase product saturation (Charbeneau *et al*, 1999). An important corollary to the above statement is that as separate-phase product is recovered from a plume, its volume, and hence its saturation, decreases and causes a subsequent decrease in relative permeability. Thus, the separate-phase product recovery rate for any system can be expected to decrease over time. Since the relationship follows that of a second-order function, the separate-phase product recovery rate trend will eventually become asymptotic as it approaches zero.

7.5 Conceptual Model

The aquifer beneath the Site is characterized as a wedge-shaped unit that increases in thickness from north to south. The aquifer consists of fill overlying unconsolidated overburden that includes sand, silt and clay. A continuous clay unit underlies the saturated portion of the overburden. This underlying clay unit was utilized to represent the lower boundary in the model, and was designated a no-flow boundary at the base of the model grid.

Recharge input was operative over the top of the model grid. Constant head cells were used to represent inflow along the northern portion of the model grid and were used to represent the Buffalo River along the southern portion of the model grid. No-flow boundaries were assigned to the four sides of the model grid that were considered outside of the area that contributes flow to the aquifer beneath the Site.

7.6 Model Grid Construction

The BIOSLURP™ model grid for the Main Plume and the ETYA Plume consists of one layer and 4,200 grid nodes. The model grid covers a region that is 3,500 feet wide (i.e., in the general east-west direction) and 3,000 feet long (i.e., in the general north-south direction). The Main Plume model has a uniform grid node spacing of 50 ft (Figure 15). The grid node spacing for the ETYA Plume model ranges from 20 ft to 50 ft in the X and Y direction (Figure 16). The grid node spacing in the ETYA Plume model was adapted from the Main Plume's model with grid node spacing refined in the area of the ETYA Plume. The extent of the model grid encompasses 10.5 million square feet (approximately 241 acres). There are 60 rows and 70 columns (Figure 15). The model grid origin was set to be 0 ft (east-west, or X direction) and 0 ft (north-south, or Y direction). The surveyed base map and all spatial coordinates were moved to the model grid origin by subtracting 1,079,670 ft and 1,041,989 ft from the X and Y coordinates, respectively (Figure 15). The model grid was not rotated.

The bottom of the model grid was defined by the elevations of the top surface of the clay beneath the Site. Bottom elevations for the entire model grid were obtained by interpolation from boring data.

7.6.1 Boundary Conditions

Boundary conditions defined in the model include Type I (i.e., constant head) and Type II (i.e., specified flux). The four edges of the model grid were defined as no-flow boundaries. The Buffalo River was simulated in the model as a Type I boundary with a constant hydraulic head of

571.96 ft amsl based on the static gauging round. The initial head at a Type I boundary was maintained for the duration of the simulations.

To simulate the groundwater entering the Site from the northern portion of the grid, a Type I boundary with hydraulic heads ranging from 583 to 586 ft amsl was assigned to nodes in this area (Figure 17). The heads at this boundary were based on the average hydraulic gradients in this area measured during the static gauging round.

During the simulation of various recovery scenarios that will be conducted during the evaluation of remedial alternatives for the Site, recovery wells will be simulated as Type II boundaries at their respective locations. At each Type II boundary, the groundwater withdrawal rate and separate-phase product recovery rate will be specified in cubic feet per day (ft^3/d). BIOSLURP™ maintains each specified pumping rate at a Type II node as long as there is sufficient groundwater or separate-phase product in the model to support the pumping. If there is insufficient fluid for pumping (i.e., a grid node "dries out"), Type II boundary will become inactive until sufficient fluid is available again.

7.6.2 Model Input Parameters

Input parameters for BIOSLURP™ include soil and fluid properties, as summarized below.

<u>Soil Properties</u>

- hydraulic conductivity;
- porosity;
- irreducible water saturation (vadose zone);
- irreducible water saturation (saturated zone);
- residual water saturation; and
- van Genuchten soil parameters (α and N).

<u>Fluid Properties</u>

- specific gravity;

- oil to water dynamic viscosity ratio;
- fluid scaling parameters (functions of surface tension and interfacial tension);
- hydraulic head distribution; and
- separate-phase product thickness distribution.

7.6.2.1 Soil Properties

Soil properties for both the Main Plume model and ETYA Plume model were the same.

Hydraulic conductivity values in the multi-phase model are generally consistent with the calibrated groundwater model discussed in Section 6. However, some hydraulic conductivity values/zones from the 3-dimensional groundwater model were merged (i.e., values were averaged) in the 2-dimensional multi-phase model in order to simplify the model calculations. For example, the groundwater model utilizes two hydraulic conductivity zones in the vicinity tanks 87, 104 and 105 (20 ft/day) and RW-9 (30 ft/d), but only one hydraulic conductivity zone (25 ft/d) was used in the multi-phase model to represent this entire area. The six hydraulic conductivity zones used in the multi-phase models are summarized in Table 9 and their spatial distribution is shown in Figure 18.

The porosity distribution in the multi-phase model is summarized in Table 9. Porosity values were recommended values from Carsel and Parrish (1988) for corresponding soil types corresponding to those observed at the Site.

Irreducible water saturation is the trapped water in a porous media. The irreducible water saturation values used in the models are summarized in Table 9 and were recommended values from Carsel and Parrish (1988).

The maximum residual oil (separate-phase product) saturation is the trapped oil in either the vadose zone or the saturated zone. The maximum residual oil saturations in the saturated zone (S_{or}) and the vadose zone (S_{og}) used in the models are summarized in Table 9 for various soil types. S_{or} values used in the multi-phase model were recommended values from Carsel and Parrish (1988). S_{og} values used in the multi-phase model were recommended by Ashok Katyal (personal communication, 2002).

Van Genuchten soil retention parameters α and N were based on recommended values from Carsel and Parish (1988) for corresponding soil types. Van Genuchten parameters for the modeled soil types are summarized in Table 9.

7.6.2.2 Fluid Properties

Groundwater and free-product samples from 11 wells were collected during the investigation. Fluid properties of specific gravity (density), viscosity, surface tension and interfacial tension were analyzed using ASTM-approved methods. Results from the geotechnical fluid properties analyses are summarized in Table 6. Hydrocarbon characterization (High Resolution Capillary Gas Chromatography with Flame Ionization Detector) analyses are included in Appendix G. Results from MW-15, MW-18, MW-25, MW-41, MW-43, MW-46, RW-5, RW-7 and RW-9 were used to represent the fluid properties in the Main Plume model (except for specific gravity) and results from LF-6 and LF-1S were used to represent the fluid properties in the ETYA Plume model (except for specific gravity).

Unlike the soil properties, which can be spatially distributed (2-dimensional) in BIOSLURP™, the fluid properties can only be modeled as a one-dimensional value. Therefore, in order to estimate the entire Main Plume as a single separate-phase product plume, an average value for fluid properties of all the samples in the Main Plume was applied to the multi-phase model.

The average specific gravity value used in the Main Plume model and the ETYA Plume model was 0.841 and 0.883, respectively. The specific gravity values used are the average of all specific gravity analyses available from the BSPA, FRA, and STYA for the Main Plume and all specific gravity analyses for the ETYA for the ETYA Plume. The specific gravity data available for the Site are summarized in Table 10.

Scaling parameters in BIOSLURP™ account for the variations in scale when modeling from an air-water system to an oil-water system. Surface tension and interfacial tension relationships between air, oil, and water were used to calculate air-oil (B_{ao}) and oil-water (B_{ow}) scaling parameters.

Main Plume Model Scaling Parameters

B_{ao} (2.414) was calculated from the average surface tension of the air-water interface (58.554) divided by the average surface tension of the air-oil interface (24.260). B_{ow} (6.502) was calculated from the average surface tension of the air-water interface (58.554) divided by the average interfacial tension of the oil-water interface (9.006). Average values of specific gravity (0.846) and viscosity (3.034 centipoise) were entered directly into multi-phase model.

ETYA Plume Model Scaling Parameters

B_{ao} (2.423) was calculated from the average surface tension of the air-water interface (63.985) divided by the average surface tension of the air-oil interface (26.405). B_{ow} (3.893) was calculated from the average surface tension of the air-water interface (63.985) divided by the average interfacial tension of the oil-water interface (16.435). Average values of specific gravity (0.883) and viscosity (4.295centipoise) were entered directly into multi-phase model.

It is common industry practice (Ashok Katyal, personal communication, 2002) to assume that the sum of the inverse of B_{ao} and B_{ow} should be equal to approximately 1 (i.e., $[1/ B_{ao}] + [1/B_{ow}] \sim 1$). Substituting the applicable interfacial and surface tensions for the values of B_{ao} and B_{ow} (i.e., $B_{ao} = \sigma_{aw}/\sigma_{ao}$ and $B_{ow} = \sigma_{aw}/\sigma_{ow}$), the above relationship reverts to the form in which the air-water surface tension equals the sum of the air-oil surface tension and the oil-water interfacial tension (i.e., $\sigma_{aw} = \sigma_{ao} + \sigma_{ow}$). Since interfacial tension (or surface tension) is defined as the amount of work (energy) necessary to separate a unit area of one substance from another (Fetter, 1993), the above relationship is actually an expression for describing the conservation of energy between an air-water system and an air-oil-water system.

Typical values for B_{ao} and B_{ow} reported in the literature are calculated from interfacial and surface tension measurements conducted on relatively pure liquids (i.e., distilled water and relatively fresh refined petroleum hydrocarbons) and generally illustrate the relationship discussed above where the sum of the inverse of each scaling parameter is approximately equal to 1. However, this relationship occurs when soluble hydrocarbons have a negligible effect on the surface tension of water (Lenhard and Parker, 1990). The values for B_{ao} and B_{ow} used in the Main Plume and ETYA Plume models do not have this relationship. The sum of their inverses is 0.568 and 0.670, respectively, based on empirical data. This deviation of the empirical data from the ideal case reported in the literature is most likely attributed to the quantity of dissolved hydrocarbons observed in groundwater in the Main Plume. Therefore, the dissolved hydrocarbons may account for the difference in scaling parameters between laboratory conditions (i.e., clean water/fresh hydrocarbon) and Site-specific conditions (i.e., petroleum hydrocarbon contaminated water/older hydrocarbon). Due to the significant differences between the values of the scaling parameters measured in the field and those typically calculated, model simulations were run for each set of scaling parameters in order to determine the model's sensitivity to these parameters, as discussed below.

7.6.3 Model Representation of Initial Conditions

Data from the static gauging round were used as the initial groundwater elevation and separate-phase product thickness conditions for the model. Prior to conducting the static gauging round, the EWPS and WWPS were shut off for two days to allow the aquifer to equilibrate to static conditions (although as noted in Section 4.4, a true static condition was not attained during this period). Groundwater elevation and separate-phase product thickness data for input into the model grid were interpolated from monitoring well gauging data. The model calculated an initial separate-phase product volume and an interpolated groundwater potentiometric surface for the water-table based on all necessary input parameters for BIOSLURP™. The model-simulated and observed groundwater elevations are shown in Figures 19 and 20, respectively. The model-simulated and observed separate-phase product thicknesses are shown in Figures 21 and 22, respectively. The model calculated separate-phase product volumes for the Main Plume and the ETYA Plume are presented in Section 7.9.

7.7 Model Calibration

Model calibration is the process of adjusting the multi-phase model input parameters within physically reasonable limits to achieve a good match between the simulated and observed conditions. This model calibration process was similar for both the Main Plume and ETYA Plume models, however, only the Main Plume Model is discussed below. Model calibration for this investigation was accomplished based on the following criteria:

- A qualitative comparison between measured groundwater elevations and separate-phase product thicknesses obtained during the static gauging round and model-simulated elevations; and
- A qualitative comparison between measured hydraulic gradients for groundwater beneath the Main Plume and ETYA Plume and model-simulated gradients.

A qualitative comparison between the model-calculated estimate of total, recoverable and trapped separate-phase product volume, and historical recovery rates was not possible due the lack of continuous product recovery data for the existing recovery system. Calibration for these parameters can be achieved once continuous product recovery data are available.

Initially, model-simulated non-pumping (static) groundwater elevations were compared to the measured non-pumping groundwater elevations (Figures 19 and 20, respectively) and model-simulated non-pumping separate-phase product thicknesses were compared to measured non-pumping separate-phase product thicknesses (Figures 21 and 22, respectively). A qualitative comparison of model-simulated versus measured groundwater elevations, hydraulic gradients and separate-phase product thicknesses indicated that the model was sufficiently accurate to be used for obtaining estimates of separate-phase product volume and for future predictive simulations. Once it was determined that the model was able to reproduce actual initial conditions with an acceptable degree of accuracy, hydraulic gradients induced by typical pumping in the Main Plume, as described in Section 6.7.1, were compared to model-simulated pumping conditions . Overall, the model-simulated hydraulic gradients are similar to observed hydraulic gradients.

7.8 Sensitivity Analyses

A sensitivity analysis is the process of identifying the model parameters that have the most significant effect on the model calibration or predictions. The purpose of a sensitivity analysis is to quantify the uncertainty in the model results caused by uncertainty in the estimates of input parameters. During a sensitivity analysis, values for parameters and boundary conditions are systematically changed within the ranges identified during the review of the existing data. The magnitude of the resulting change in the model output relative to the calibrated solution is a measure of sensitivity of the model to the uncertainty in a particular parameter. Sensitivity analyses were performed on the air-oil scaling parameter (B_{ao}) and the oil-water scaling parameter (B_{ow}). The sensitivity analysis for both the Main Plume and ETYA Plume models was similar, however only the Main Plume model is discussed below.

7.8.1 Air-Oil and Oil-Water Scaling Parameters

The model-calculated estimate of separate-phase product volume showed the greatest sensitivity to changes in the air-oil (B_{ao}) and oil-water (B_{ow}) scaling parameters. Relatively small changes (5 to 10 percent) to these parameters caused volume estimates to fluctuate more than 50 percent (depending on the degree of change in the scaling parameter). This sensitivity is to be expected since these parameters are, as the term implies, used to scale-up the van Genuchten soil characteristic parameter, α, determined for an air-water system to a corresponding air-oil-water system in order to estimate the capillary pressure relationships within that air-oil-water system.

During this investigation it was found that there was a significant difference between model-simulated volumes and recoverability obtained using empirically-derived scaling parameters and those calculated using published values or calculated using the relationship described in Section 7.6.2.2. While the measured values of the air-water and air-oil surface tensions were very similar to those published in reference literature, the measured value of the oil-water interfacial tension was significantly lower than the published values for the various types of product that comprise the Main Plume (i.e., ranging from gasoline to diesel to heavy-end petroleum distillates). Various sources indicated that the value of the oil-water interfacial tension for gasoline, diesel and petroleum distillates should be approximately 50 dynes/cm compared to the average measured value of 9.0 dynes/cm from Main Plume wells sampled. The use of the empirical data for oil-water interfacial tension resulted in higher volume and recovery estimates for the Main Plume compared to those calculated using a literature-derived value.

As discussed previously, the values used for the scaling parameters in the model were based on empirical data obtained from Site-specific separate-phase product and groundwater samples. Therefore, there is a higher degree of certainty associated with the model-predicted estimate of separate-phase product volume than would be obtained if literature-derived values for the scaling parameters were used. If the scaling parameter relationship described in Section 7.6.2.2 was used for this modeling task with the measured values of the air-oil and air-water surface tension (since these values were nearly the same as those found in reference literature), B_{ao} would equal 2.414 and would yield a value of B_{ow} equal to 1.707. The resulting model-calculated separate-phase product volume would thus be approximately 77,000 gallons. However, when the empirical data are used, then the sum of the inverse of B_{ao} and B_{ow} equals 0.568 and the model-calculated separate-phase product volume is approximately 299,000 gallons. Based on this difference in volume estimates, the relationship described in Section 7.6.2.2 would have resulted in an inaccurate description of the conservation of energy between in-situ air-water and in-situ air-oil-water systems in the Main Plume. This, in turn, would have resulted in an inaccurate estimate of separate-phase product volume. Therefore, the empirically-derived scaling parameters were used throughout the multi-phase models.

7.9 Separate-Phase Product Volume Estimates

Fluid elevations measured during the static gauging round were used to estimate separate-phase product volumes based on the calibrated BIOPSLURP™ model representation of the Main Plume and the ETYA Plume. The apparent separate-phase product thickness is calculated by BIOSLURP™ using the following relationship:

$$H_o = (Z_{ao} - Z_{aw}) / (1 - r)$$

where,

H_o = apparent separate-phase product thickness (ft);

Zao = model-simulated elevation of the air-oil interface (i.e., top of the separate-phase product surface in the well) (ft);

Zaw = model-simulated elevation of the air-water interface (i.e., groundwater elevation corrected for separate-phase product density) (ft); and

r = specific gravity of separate-phase product.

The water-level and separate-phase product thickness were not measured in nine wells during the static gauging round (Table 11). Therefore, separate-phase product thicknesses in these wells were inferred from historic measurements or measurements collected after the aquifer tests.

Once the models were considered calibrated and sensitivity analyses were performed on the model input parameters, they were run to determine the volume of product within the Main Plume and the ETYA Plume. Using the monitoring well gauging data collected after shutting the EWPS and WWPS down and allowing fluid elevations to recover to near static levels (static gauging round) as the initial conditions for the model, the total volume of free-product was determined to be approximately 299,000 gallons and 1,900 gallons within the Main Plume and ETYA Plume, respectively.

Results from the separate-phase product sampling indicate that the Main Plume consists of various types of hydrocarbons with specific gravity values ranging from 0.81 (RW-7) to 0.86 (RW-5) and viscosity values ranging from 1.51 (RW-7) centipoise to 4.9 (RW-5) centipoise. In general, the separate-phase product beneath the western portion of the Main Plume is heavier than the separate-phase product beneath the eastern portion of the Main Plume. If average fluid property values for western portion of the Main Plume (wells MW-25, MW-43, MW-46, and RW-5) were used to estimate the volume of the Main Plume, the total volume is approximately 225,000 gallons. If average fluid property values for the eastern portion of the Main Plume (wells MW-15, MW-18, MW-41, RW-7, and RW-9) were used to estimate the volume of the Main Plume, the total volume is approximately 355,000 gallons. These volumes are the sum of the potentially-recoverable separate-phase (i.e., the maximum amount of separate-phase that can theoretically be recovered by manipulating the hydraulic gradient) and the residual (trapped) separate-phase product in the subsurface.

It is important to note that these volumes exclude any residual contamination that exists below the zone of separate-phase product defined by the monitoring well data collected during the static gauging round. However, although separate-phase product is trapped at or below residual saturation below the region of mobile free-product, a portion of it can become re-mobilized as the water-table is depressed by pumping. In general, apparent separate-phase product thickness increases in response to water-table depression caused by the operation dual-phase pumping. The increase in monitoring well thickness indicates a corresponding increase in the total volume. Thus, operation of a dual-phase pumping system increases the volume of recoverable separate-phase product by remobilizing free-product that would otherwise have been trapped at residual saturation. Eventually the entire vertical extent of separate-phase product in the subsurface is reduced to its residual saturation and separate-phase product can no longer be recovered through manipulation of the hydraulic gradient.

The separate-phase product that is present in the subsurface at the Site is the result of multiple releases of various types of product throughout the long history of the Site. The historical practices in the eastern portion and western portion of the Main Plume correspond to the results obtained from the separate-phase product sampling with respect to specific gravity and viscosity. For example, the former tanks that had existed in the southwestern portion of the Site in the BSPA and FRA had generally been used for storage of heavier petroleum products including lube oil, diesel and fuel oil. In addition, the former Main Inground Oil/Water Separator that had existed in the southern portion of the FRA had been used to handle various former refinery process streams, as well as storm water from all areas of the site that may have contained a variety of petroleum products. These historical Site practices are consistent with the heavier and more viscous product types encountered in this area. The former and current tanks that have existed in the eastern portion of the Main Plume in the STYA have generally been used for storage of lighter petroleum products including various grades of gasoline. These historical and current Site practices are consistent with the lighter and less viscous product types encountered in this area.

8.0 SUMMARY

This section includes a summary of the work completed for the evaluation of aquifer characteristics at the Site, as well as the proposed work that will be conducted to evaluate, select and design an appropriate remedial alternative to control migration of the separate-phase product and petroleum-impacted groundwater and to enhance product recovery at the Site. The purpose of the evaluation of aquifer characteristics was to develop the data necessary to determine the most effective and efficient way to protect the Buffalo River by containing and recovering groundwater, controlling the migration of separate-phase product and enhancing separate-phase product recovery.

8.1 Summary of Field Work Completed

The field activities performed to accomplish the objectives for the evaluation of aquifer characteristics, included the following:

- Installed test boreholes at three locations (TB-1, TB-2, and TB-3);
- Performed sieve analyses for soil samples collected during the installation of the three test boreholes;
- Collected Shelby tubes of soil samples collected during the installation of the three test boreholes;
- Installed and developed six monitoring wells (MW-40 through MW-45);
- Installed and developed four recovery wells (RW-7, RW-8, RW-8R, and RW-9);
- Shut down of all existing groundwater/separate-phase product recovery systems (EWPS and WWPS and RW-1 through RW-5) to allow aquifer recharge;
- Collected fluid elevation measurements in existing and newly-installed wells over a period of time to determine static conditions;
- Performed four step-drawdown tests (RW-7, RW-8, RW-8R, and RW-9);
- Performed four constant-rate pumping tests (RW-7, RW-8, RW-8R, and RW-9); and
- Performed four separate-phase product bail-down tests (ESI-1, MW-14, MW-15, and SB-17).

8.2 Summary of Pump Test Results

Pumping test data from the RW-7 and RW-9 aquifer test network were evaluated and analyzed to determine estimated hydraulic conductivity for the unconfined aquifer beneath the STYA. Monitoring well data from the RW-8R pump test were not analyzable due to hydraulic interference from the Buffalo River. However, the early-time data from the recovery well RW-8R was analyzed to estimate hydraulic conductivity in the ETYA.

RW-7 Pump Test Results

RW-7 was pumped for approximately 29 hours at an average rate of 15.5 gpm. The maximum drawdown observed in the pumping well was 2.85 feet. The drawdown data from RW-7 indicated a hydraulic conductivity of 63 ft/d. The drawdown data from the monitoring wells indicated hydraulic conductivities ranging from 128 to 160 ft/d. Average hydraulic conductivity determined from the RW-7 pump test (monitoring wells MW-40, MW-41, and MW-45 and recovery well RW-7) was 129.7 ft/d; consistent with the medium sand matrix encountered during drilling in this portion of the STYA. Two monitoring wells, MW-18 and MW-32, did not show drawdown influences from the RW-7 pumping.

RW-8R Pump Test Results

RW-8R was pumped for approximately 10.3 hours at an average rate of 11.0 gpm. The maximum drawdown observed in the pumping well was 10.35 feet. Due to the lack of a barrier between the groundwater and surface water (i.e., bulkhead), the hydraulic influence of the Buffalo River in the ETYA masked any drawdown effects in the monitoring wells from the pumping at RW-8R. However, early drawdown data from the pumping well were not affected by fluctuations in the Buffalo River. Once drawdown in the pumping well stabilized (after 35 minutes), the influence of the Buffalo River was evident. Based on the analysis of the early drawdown data in RW-8R, the hydraulic conductivity was estimated to be approximately 7.7 ft/d; consistent with the silty matrix encountered during drilling in the ETYA.

RW-9 Pump Test Results

RW-9 was pumped for approximately 23.5 hours at an average rate of 13.0 gpm. The maximum drawdown observed in the pumping well was 7.87 feet. Approximately 30 minutes into the RW-9 pump test, separate-phase product was measured in RW-9. The amount of product overwhelmed the attempts at manual hand-bailing to keep the product thickness constant. Therefore, the drawdown data from RW-9 was not analyzed.

The drawdown data from monitoring wells MW-14 and MW-43 indicated hydraulic conductivities of 47.5 ft/d and 43.9 ft/d, respectively. The drawdown data from MW-42 indicated a hydraulic conductivity of 135.5 ft/d, which is not consistent with the data from the other wells in the network, nor with the description of the subsurface materials from the geologic log of silt, clay and fine to medium sand. While the average hydraulic conductivity determined from the RW-9 pump test (monitoring wells MW-42, MW-43, and ESI-4) was 75.3 ft/d, the data from ESI-4 and MW-43 are more indicative of the hydraulic conductivity in the area. The average hydraulic conductivity excluding the value from MW-42 is 45.2 ft/day. Three monitoring wells, MW-14, MW-20, and MW-21, did not show drawdown influences from the RW-9 pumping.

8.3 Summary of Groundwater Modeling

A numerical groundwater flow model was created for the Site using the Modular Three-Dimensional Finite-Difference Ground-Water Flow Model, widely known as MODFLOW (McDonald and Harbaugh 1988). The objective of the groundwater modeling task summarized in this report was to develop a calibrated model that can be used to simulate water-table elevations under static (i.e., non-pumping) and simulated pumping conditions.

To accomplish the above objective, the following modeling tasks were performed:

- Construction of a groundwater model grid;
- Model calibration to non-pumping conditions and sensitivity analyses;
- Simulation of the current pumping conditions at the Site.

The residual mean (average of the difference between modeled and observed hydraulic heads) for the calibrated model under simulated non-pumping conditions was 0.16 feet with an observed total range in hydraulic head from the entire model grid of 13.5 feet. The absolute residual mean (average of the absolute value of the difference between modeled and observed hydraulic heads) was 0.70 feet. The model was found to be an accurate representation of the flow system at the Site.

This calibrated groundwater model will be used to evaluate alternatives for groundwater containment and enhancement of separate-phase product recovery that will be summarized in a separate report, as described below.

8.4 Summary of Multi-Phase Modeling

A two-dimensional multi-phase model was created for the site using BIOSLURP™ (Resource & Systems International, 2002). The objectives of the multi-phase modeling task were to:

- Develop a qualitative calibrated model that can be used to simulate water-table elevations and separate-phase product elevations under static (i.e., non-pumping) and simulated pumping conditions in the BSPA/FRA/STYA separate-phase product plume (Main Plume) and ETYA separate-phase product plume (ETYA Plume); and
- Estimate the volume of separate-phase product (total and recoverable) beneath the Main Plume and the ETYA Plume.

To accomplish these objectives, the following modeling tasks were performed:

- Construction of a two-dimensional finite-element model grid;
- Simulation of the current observed groundwater elevations (i.e., model calibration); and
- Simulations of the current observed extent and thickness of separate-phase product (i.e., model calibration).

A qualitative comparison of model-simulated versus measured groundwater elevations, hydraulic gradients and separate-phase product thicknesses indicated that the model was sufficiently accurate to be used for obtaining estimates of separate-phase product volume and for future predictive simulations. This multi-phase model will then be used to evaluate pumping well configurations (i.e., locations and rates) that result in enhanced separate-phase product recovery at the Site. These evaluations will be summarized in a separate report, as discussed below.

Separate-Phase Product Volume Estimates

Initial separate-phase plume volumes for the Main Plume and the ETYA Plume were estimated from the multi-phase model as follows:

Once the models were considered calibrated and sensitivity analyses were performed on the model input parameters, they were run to determine the volume of product within the Main Plume and the ETYA Plume. Using the monitoring well gauging data collected after shutting the EWPS and WWPS down and allowing fluid elevations to recover to near static levels (static gauging round) as the initial conditions for the model, the total volume of free-product was determined to be approximately 299,000 gallons and 1,900 gallons within the Main Plume and ETYA Plume, respectively. These volumes are based upon average fluid properties from the samples collected from various locations within the two plumes. The variation in these fluid properties across the Site is indicative of historical site operations that resulted in numerous releases of a variety of different product types throughout the history of the Site. The fluid properties of the product in the western portion of the Main Plume are indicative of the heavier and more viscous product types that were stored in this portion of the Site, as well as the mixture of product types that was handled by the former Main Inground Oil/Water Separator. Similarly, the fluid properties of the product in the eastern portion of the Main Plume are indicative of the lighter and less viscous product types that were/are stored in this portion of the Site.

8.5 Proposed Development, Evaluation, Selection and Design of the Remedial Action for Groundwater Containment and Product Recovery Enhancement

The results of this evaluation of aquifer characteristics described in this report are being used to develop, evaluate and select an appropriate remedial action for groundwater containment and product recovery enhancement at the Site. The results of the alternatives evaluation will be presented in a Remedial Action Selection (RAS) Report.

The basic activities that will be conducted to evaluate remedial alternatives that may be employed at the Site to control the migration of impacted groundwater and enhance separate-phase product recovery are as follows:

- Evaluate pumping well configurations (i.e., locations and rates) that result in complete capture of dissolved phase constituents emanating from the Main Plume by performing multiple simulations using the groundwater model;

- Evaluate placement and pumping rates for wells to mitigate dissolved-phase and separate-phase product migration along the Babcock Street sewer by performing simulations using the groundwater model;

- Provide the pumping well configuration data for use in the multi-phase product simulation model (BIOSLURP™ model) developed for the Site;

- Evaluate pumping well configurations (i.e., locations and rates) that result in enhanced separate-phase product recovery by performing multiple simulations using the multi-phase model with selected groundwater containment scenarios from the groundwater model;

- Evaluate remedial alternatives that may not require groundwater and/or multi-phase model simulation (i.e., containment/encapsulation);

- Estimate capital and long-term operations and maintenance costs for selected remedial alternatives to provide a basis of comparison;

The results of the alternatives evaluation will be used to select a cost-effective remedial action that meets the remedial objectives for the Site.

Respectfully submitted,

ROUX ASSOCIATES, INC.

Sin Senh
Project Hydrogeologist

Nathan Epler, Ph.D.
Principal Hydrogeologist

Noelle Clarke, P.E.
Principal Engineer/
Project Manager

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Table 1. Summary of Water-Level, Product Thickness and Product Bailing Data Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Well Designation	Date	Measuring Point Elevation (ft msl)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Specific Gravity	Corrected Elevation (ft msl)	Product Bailed (gal)	Comments
ADMINISTRATIVE OFFICES AND OPERATIONS AREA (AOOA)									
B-5MW(RR)	10/18/02	587.54		5.21		0.8	582.33		BOTTOM 12.00
BABCOCK STREET PROPERTIES AREA (BSPA)									
B-3MW	10/17/02	586.82		7.55		0.8	579.27		BOTTOM 13.4
B-4MW	10/17/02	587.05		9.48		0.8	577.57		BOTTOM 16.02
MW-1	10/17/02	582.13		13		0.8	569.13		BOTTOM 18.75
MW-2	10/17/02	583.09		9.74		0.8	573.35		BOTTOM 16.51
MW-22	10/10/02	582.36		14.6		0.8	567.76		ADSORBENT SOCK PRESENT
MW-22	10/16/02	582.36				0.8			DID NOT GAUGE- ACCESS BLOCKED
MW-22	10/17/02	582.36		14.53		0.8	567.83		BOTTOM 19.3; SHEEN PRESENT
MW-22	11/05/02	582.36		15.32		0.8	567.04		ADSORBENT SOCK PRESENT
MW-22	11/13/02	582.36		15.3		0.8	567.06		ADSORBENT SOCK PRESENT
MW-22	11/26/02	582.36		13.23		0.8	569.13		ADSORBENT SOCK PRESENT
MW-22	12/04/02	582.36		13.79		0.8	568.57		ADSORBENT SOCK PRESENT
MW-22	12/17/02	582.36	13.32	13.32	0	0.8	569.04		ADSORBENT SOCK PRESENT
MW-22	12/31/02	582.36		13.33		0.8	569.03		ADSORBENT SOCK PRESENT
MW-23	10/17/02	586.14		18.14		0.8	568.00		BOTTOM 23.28
MW-24	10/10/02	583.67		15.08		0.8	568.59		ADSORBENT SOCK PRESENT
MW-24	10/16/02	583.67		14.13		0.8	569.54		ADSORBENT SOCK PRESENT
MW-24	10/17/02	583.67		14.13		0.8	569.54		
MW-24	11/05/02	583.67	14.32	14.33	0.01	0.8	569.35		ADSORBENT SOCK INSTALLED
MW-24	11/13/02	583.67		14.46		0.8	569.21		ADSORBENT SOCK INSTALLED
MW-24	11/26/02	583.67		13.86		0.8	569.81		ADSORBENT SOCK PRESENT
MW-24	12/17/02	583.67	13.22	13.22	0	0.8	570.45		
MW-24	12/31/02	583.67		13.71		0.8	569.96		
MW-25	10/10/02	583.28	13.76	14.41	0.65	0.8	569.39	0.5	
MW-25	10/16/02	583.28	13.79	14.93	1.14	0.8	569.26	0.5	
MW-25	10/17/02	583.28	14.53	14.94	0.41	0.8	568.67		
MW-25	11/05/02	583.28	14.35	14.85	0.5	0.8	568.83	0.5	
MW-25	11/13/02	583.28	14.24	14.26	0.02	0.8	569.04		
MW-25	11/26/02	583.28	12.4	12.42	0.02	0.8	570.88		
MW-25	12/04/02	583.28		12.66		0.8	570.62		
MW-25	12/17/02	583.28				0.8			NOT GAUGED- BURIED UNDER SNOW
MW-25	12/31/02	583.28	11.5	11.52	0.02	0.8	571.78		
MW-26	10/17/02	584.87		0.37		0.8	584.50		BOTTOM 7.4
MW-27	10/04/02	582.69		14.13		0.8	568.56		PASSIVE BAILER IN WELL SINCE 12/12/01
MW-27	10/10/02	582.69		14.27		0.8	568.42		PASSIVE BAILER IN WELL SINCE 12/12/01; ADSORBENT SOCK PRESENT
MW-27	10/16/02	582.69	14.71	14.72	0.01	0.8	567.98		PASSIVE BAILER IN WELL SINCE 12/12/01
MW-27	10/17/02	582.69	14.71	14.72	0.01	0.8	567.98		PASSIVE BAILER IN WELL SINCE 12/12/01
MW-27	11/05/02	582.69	15.01	15.03	0.02	0.8	567.68	0.06	PASSIVE BAILER IN WELL SINCE 12/12/01
MW-27	11/13/02	582.69		15.41		0.8	567.28		PASSIVE BAILER IN WELL SINCE 12/12/01
MW-27	11/26/02	582.69		13.72		0.8	568.97	0.125	PASSIVE BAILER IN WELL SINCE 12/12/01

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Well Designation	Date	Measuring Point Elevation (ft msl)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Specific Gravity	Corrected Elevation (ft msl)	Product Bailed (gal)	Comments
MW-27	12/04/02	582.69		13.9		0.8	568.79	0.25	PASSIVE BAILER IN WELL SINCE 12/12/01
MW-27	12/17/02	582.69				0.8			NOT GAUGED- ACCESS BLOCKED
MW-27	12/31/02	582.69		13.51		0.8	569.18	0.06	PASSIVE BAILER IN WELL SINCE 12/12/01
MW-3	10/17/02	581.72		13.14		0.8	568.58		BOTTOM 20.46
MW-46	10/04/02	582.87				0.8			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 7/12/02; DTP 1.44
MW-46	10/10/02	582.87				0.8			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 7/12/02; DTP 1.42
MW-46	10/16/02	582.87				0.8			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 7/12/02; DTP 1.40
MW-46	10/17/02	582.87	12.5	12.52	0.02	0.8	570.37		SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 7/12/02; DTP 1.40
MW-46	11/05/02	582.87				0.8			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 7/12/02; DTP 1.33
MW-46	11/13/02	582.87				0.8			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 7/12/02; DTP 1.29
MW-46	11/26/02	582.87				0.8			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 7/12/02; DTP 1.25
MW-46	12/04/02	582.87				0.8			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 7/12/02; DTP 1.24
MW-46	12/17/02	582.87				0.8			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 7/12/02; DTP 1.15
MW-46	12/31/02	582.87				0.8			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 7/12/02; DTP 1.05
SB-11/LB-1	10/17/02	582.08		13.49		0.8	568.59		BOTTOM 20.90
SB-14	10/17/02	584.79		7.01		0.8	577.78		BOTTOM 24.75
SB-16	10/10/02	583.81		13.26		0.8	570.55		ADSORBENT SOCK PRESENT
SB-16	10/16/02	583.81		13.27		0.8	570.54		ADSORBENT SOCK PRESENT
SB-16	10/17/02	583.81		13.27		0.8	570.54		
SB-16	11/05/02	583.81	13.3	13.32	0.02	0.8	570.51		NEW ADSORBENT SOCK INSTALLED
SB-16	11/13/02	583.81		13.57		0.8	570.24		ADSORBENT SOCK PRESENT
SB-16	11/26/02	583.81				0.8			NOT GAUGED- ACCESS BLOCKED
SB-16	12/04/02	583.81				0.8			NOT GAUGED- ACCESS BLOCKED
SB-16	12/17/02	583.81				0.8			NOT GAUGED- BURIED UNDER SNOW
SB-16	12/31/02	583.81		11.67		0.8	572.14		ADSORBENT SOCK PRESENT
SB-17	10/04/02	583.53	14.04	14.45	0.41	0.8	569.41	0.125	
SB-17	10/10/02	583.53	14.03	14.34	0.31	0.8	569.44	0.25	
SB-17	10/16/02	583.53	13.98	14.05	0.07	0.8	569.54	0.1	
SB-17	10/17/02	583.53	13.97	14	0.03	0.8	569.55		
SB-17	11/05/02	583.53	14.8	15.1	0.3	0.8	568.67	0.25	
SB-17	11/13/02	583.53	14.91	15.12	0.21	0.8	568.58	0.125	
SB-17	11/26/02	583.53	13.25	13.5	0.25	0.8	570.23	0.25	
SB-17	12/17/02	583.53	12.97	14.03	1.06	0.8	570.35	2	
SB-17	12/31/02	583.53	12.64	14.8	2.16	0.8	570.46	2.75	
SB-19	10/17/02	583.13				0.8			NOT GAUGED- UNDER WATER

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Well Designation	Date	Measuring Point Elevation (ft msl)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Specific Gravity	Corrected Elevation (ft msl)	Product Bailed (gal)	Comments
SB-20	10/10/02	583.46	10.38	10.39	0.01	0.8	573.08		
SB-20	10/16/02	583.46	10.62	10.63	0.01	0.8	572.84		
SB-20	10/17/02	583.46		16.76		0.8	566.70		
SB-20	11/05/02	583.46	10.32	10.32	0	0.8	573.14		NEW ADSORBENT SOCK INSTALLED
SB-20	11/13/02	583.46	10.82	10.83	0.01	0.8	572.64		
SB-20	11/26/02	583.46		8.76		0.8	574.70		
SB-20	12/04/02	583.46				0.8			NOT GAUGED- ACCESS BLOCKED
SB-20	12/17/02	583.46				0.8			NOT GAUGED- BURIED UNDER SNOW
SB-20	12/31/02	583.46				0.8			NOT GAUGED- ACCESS BLOCKED
SB-28	10/17/02	588.13		4.15		0.8	583.98		BOTTOM 18.4
SB-31	10/17/02	581.92		12.16		0.8	569.76		BOTTOM 14.4
SB-37	10/10/02	583.1		14.6		0.8	568.50		BOTTOM DRY
SB-37	10/16/02	583.1		14.03		0.8	569.07		
SB-37	10/17/02	583.1		14.03		0.8	569.07		BOTTOM DRY
SB-37	11/05/02	583.1				0.8			WELL DRY
SB-37	11/13/02	583.1		14.2		0.8	568.90		WELL DRY
SB-37	11/26/02	583.1		12.42		0.8	570.68		WELL DRY
SB-37	12/04/02	583.1		13.41		0.8	569.69		
SB-37	12/17/02	583.1				0.8			NOT GAUGED- BURIED UNDER SNOW
SB-37	12/31/02	583.1				0.8			NOT GAUGED- ACCESS BLOCKED
SB-39	10/17/02	581.73		9.42		0.8	572.31		BOTTOM 19.66
WP-11	10/17/02	586.26		17.4		0.8	568.86		BOTTOM DRY
WP-2	10/17/02	585.18		16.73		0.8	568.45		BOTTOM 30.34
WP-23	10/17/02	587.01		19.34		0.8	567.67		BOTTOM 30.9
WP-3	10/17/02	585.63		16.86		0.8	568.77		BOTTOM 28.25
RIVER	10/01/02	586.18		14.96		0.8	571.22		
RIVER	10/02/02	586.18		14.92		0.8	571.26		
RIVER	10/04/02	586.18		15		0.8	571.18		
RIVER	10/07/02	586.18		12.85		0.8	573.33		
RIVER	10/08/02	586.18		15.14		0.8	571.04		
RIVER	10/09/02	586.18		14.89		0.8	571.29		
RIVER	10/10/02	586.18		14.76		0.8	571.42		
RIVER	10/11/02	586.18		14.81		0.8	571.37		
RIVER	10/14/02	586.18		15.11		0.8	571.07		
RIVER	10/15/02	586.18		14.89		0.8	571.29		
RIVER	10/16/02	586.18		14.84		0.8	571.34		
RIVER	10/17/02	586.18		14.89		0.8	571.29		
RIVER	10/17/02	586.18		14.65		0.8	571.53		
RIVER	10/18/02	586.18		14.63		0.8	571.55		
RIVER	10/21/02	586.18		14.9		0.8	571.28		
RIVER	10/23/02	586.18		15.3		0.8	570.88		
RIVER	10/24/02	586.18		15.33		0.8	570.85		
RIVER	10/25/02	586.18		15.37		0.8	570.81		
RIVER	10/28/02	586.18		15.53		0.8	570.65		
RIVER	10/29/02	586.18		16.03		0.8	570.15		
RIVER	10/30/02	586.18		16.55		0.8	569.63		
RIVER	10/31/02	586.18		15.45		0.8	570.73		
RIVER	11/01/02	586.18		14.82		0.8	571.36		
RIVER	11/04/02	586.18		14.94		0.8	571.24		
RIVER	11/05/02	586.18		16.02		0.8	570.16		
RIVER	11/06/02	586.18		15.65		0.8	570.53		
RIVER	11/07/02	586.18		15.95		0.8	570.23		
RIVER	11/08/02	586.18		15.07		0.8	571.11		
RIVER	11/11/02	586.18		14.26		0.8	571.92		
RIVER	11/12/02	586.18		15.1		0.8	571.08		
RIVER	11/13/02	586.18		14.95		0.8	571.23		
RIVER	11/14/02	586.18		14.13		0.8	572.05		
RIVER	11/15/02	586.18		15.8		0.8	570.38		
RIVER	11/18/02	586.18		15.05		0.8	571.13		
RIVER	11/19/02	586.18		15.72		0.8	570.46		
RIVER	11/20/02	586.18		15.69		0.8	570.49		

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Well Designation	Date	Measuring Point Elevation (ft msl)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Specific Gravity	Corrected Elevation (ft msl)	Product Bailed (gal)	Comments
RIVER	11/21/02	586.18		15.1		0.8	571.08		
RIVER	11/26/02	586.18		15.24		0.8	570.94		
RIVER	11/27/02	586.18		15.62		0.8	570.56		
RIVER	12/02/02	586.18		16.21		0.8	569.97		
RIVER	12/05/02	586.18		16.01		0.8	570.17		RIVER FROZEN
RIVER	12/06/02	586.18		15.89		0.8	570.29		RIVER FROZEN
RIVER	12/10/02	586.18		16.3		0.8	569.88		RIVER FROZEN
RIVER	12/11/02	586.18		16.3		0.8	569.88		RIVER FROZEN
RIVER	12/12/02	586.18		16.04		0.8	570.14		RIVER FROZEN
RIVER	12/13/02	586.18		16.16		0.8	570.02		RIVER FROZEN
RIVER	12/16/02	586.18		15.87		0.8	570.31		RIVER FROZEN
RIVER	12/17/02	586.18		16.51		0.8	569.67		RIVER FROZEN
RIVER	12/19/02	586.18		15.87		0.8	570.31		RIVER FROZEN
RIVER	12/20/02	586.18		13.65		0.8	572.53		RIVER FROZEN
RIVER	12/23/02	586.18		13.11		0.8	573.07		
RIVER	12/26/02	586.18		14.87		0.8	571.31		RIVER FROZEN
RIVER	12/27/02	586.18		15.42		0.8	570.76		RIVER FROZEN
RIVER	12/31/02	586.18		16.07		0.8	570.11		RIVER FROZEN
CENTRAL RAIL AND PROCESS AREA (CRPA)									
MH-22	10/10/02			4.73		0.8			
MH-22	10/16/02			4.69		0.8			
MH-22	10/18/02			4.69		0.8			
MH-22	11/13/02			4.71		0.8			
MH-22	11/26/02			4.78		0.8			
MH-22	12/04/02					0.8			NOT GAUGED- ACCESS BLOCKED
MH-22	12/31/02			4.73		0.8			SHEEN PRESENT
MH-47	10/10/02			3.85		0.8			
MH-47	10/16/02			3.85		0.8			
MH-47	10/18/02			3.85		0.8			
MH-47	11/13/02			3.86		0.8			
MH-47	11/26/02			3.87		0.8			
MH-47	12/04/02			3.87		0.8			
MH-47	12/31/02		3.88	3.89	0.01	0.8			THICK STICKY PRODUCT PRESENT
MW-13	10/18/02	584.37		0.44		0.8	583.93		BOTTOM 17.9
MW-13	11/27/02	584.37		0.69		0.8	583.68		
MW-13	12/27/02	584.37		0.67		0.8	583.70		
MW-15	10/04/02	586.65	16.48	17.66	1.18	0.8265	569.97	1	
MW-15	10/10/02	586.65	16.74	17.62	0.88	0.8265	569.76	0.5	
MW-15	10/16/02	586.65	16.65	17.55	0.9	0.8265	569.84	0.5	
MW-15	10/18/02	586.65	16.97	17.57	0.6	0.8265	569.58		
MW-15	11/05/02	586.65	16.81	17.83	1.02	0.8265	569.66	1	
MW-15	11/13/02	586.65	16.65	18.16	1.51	0.8265	569.74	1.25	
MW-15	11/26/02	586.65	16.29	17.9	1.61	0.8265	570.08	1.5	
MW-15	12/04/02	586.65	16.15	17.3	1.15	0.8265	570.30	1	
MW-15	12/17/02	586.65	16.05	17.4	1.35	0.8265	570.37		
MW-15	12/31/02	586.65	15.41	16.67	1.26	0.8265	571.02	2.25	
MW-16	10/18/02	589.15		4.13		0.8	585.02		BOTTOM 17.65
MW-17	10/18/02	588.39		4.64		0.8	583.75		BOTTOM 17.80
MW-36R	10/18/02	589.65		5.85		0.8	583.80		BOTTOM 16.00
MW-37	10/18/02	589.8		6.98		0.8	582.82		BOTTOM 12.9
MW-9	10/18/02	588.5		5.54		0.8	582.96		BOTTOM 19.5
RW-6	10/18/02	581.99		3.53		0.8	578.46		
EASTERN TANK YARD AREA (ETYA)									
B-6MW	10/18/02	596.35		25.37		0.8	570.98		BOTTOM 29.4
B-6MW	11/27/02	596.35		25.66		0.8	570.69		
B-6MW	12/27/02	596.35		25.29		0.8	571.06		
LF-1S	10/18/02	596.27	25.2	25.78	0.58	0.884	571.00		
LF-1S	11/05/02	596.27	25.52	27.37	1.85	0.884	570.54	0.5	
LF-1S	11/13/02	596.27	25.47	26.9	1.43	0.884	570.63	0.125	
LF-1S	11/26/02	596.27	25.54	27.32	1.78	0.884	570.52		
LF-1S	12/04/02	596.27	25.54	26.36	0.82	0.884	570.63	0.125	
LF-1S	12/17/02	596.27	25.68	26.67	0.99	0.884	570.48		
LF-1S	12/31/02	596.27		25.27		0.884	571.00		
LF-2D	10/18/02	581.83		12.44		0.8	569.39		BOTTOM 33.08
LF-2S	10/18/02	581.77		12.54		0.8	569.23		BOTTOM 19.15

Table 1. Summary of Water-Level, Product Thickness and Product Bailing Data Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Well Designation	Date	Measuring Point Elevation (ft msl)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Specific Gravity	Corrected Elevation (ft msl)	Product Bailed (gal)	Comments
LF-3	10/18/02	596.17		25.08		0.883	571.09		
LF-4	10/18/02	594.87		23.73		0.8	571.14		BOTTOM 34.9
LF-5	10/18/02	597.62		26.65		0.8	570.97		BOTTOM 38.1
LF-6	10/18/02	598.14	27.11	27.22	0.11	0.883	571.02		
LF-7	10/18/02	598.28	26.89	27.15	0.26	0.8	571.34		
LF-8	10/18/02	596.99		22.64		0.8	574.35		BOTTOM 37.8
MW-1URS	10/18/02	594.82		14.38		0.8	580.44		BOTTOM 22.53
MW-1URS	11/27/02	594.82		14.11		0.8	580.71		
MW-1URS	12/27/02	594.82		13.78		0.8	581.04		
MW-28	10/04/02	599.91				0.883			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 8/6/02; DTP 1.57
MW-28	10/10/02	599.91				0.883			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 8/6/02; DTP 1.53
MW-28	10/16/02	599.91				0.883			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 8/6/02; DTP 1.5
MW-28	10/18/02	599.91	28.82	28.84	0.02	0.883	571.09		SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 8/6/02; DTP 1.49
MW-28	11/05/02	599.91				0.883			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 8/6/02; DTP 1.40
MW-28	11/13/02	599.91	28.66	28.68	0.02	0.883	571.25		SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 8/6/02; DTP 1.31
MW-28	11/26/02	599.91	29.12	29.15	0.03	0.883	570.79		SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 8/6/02; DTP 1.14
MW-28	12/04/02	599.91	28.81	28.82	0.01	0.883	571.10		SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 8/6/02; DTP 1.23
MW-28	12/17/02	599.91				0.883			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 8/6/02; DTP 1.06
MW-28	12/31/02	599.91				0.883			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 8/6/02; DTP 1.04
MW-2URS	10/18/02	581.83		13.76		0.8	568.07		BOTTOM 18.2
MW-39	10/18/02	596.21		21.1		0.8	575.11		BOTTOM 30.05
MW-3URS	10/18/02	599.58		28.32		0.8822	571.26		BOTTOM 33.93
MW-4URS	10/18/02	594.59		23.78		0.8	570.81		BOTTOM 31.07
MW-4URS	11/27/02	594.59		24.15		0.8	570.44		
MW-4URS	12/27/02	594.59		23.73		0.8	570.86		
MW-5URS	10/18/02	595.36		14.59		0.8	580.77		BOTTOM 29.16
P-15	10/04/02	597.04	26.09	26.61	0.52	0.88	570.89	0.1	
P-15	10/10/02	597.04	26.04	26.6	0.56	0.88	570.93	0.1	
P-15	10/16/02	597.04	26.17	26.6	0.43	0.88	570.82	0.1	
P-15	10/18/02	597.04	26.13	26.59	0.46	0.88	570.85		
P-15	11/05/02	597.04	26.39	27.25	0.86	0.88	570.55	0.125	
P-15	11/13/02	597.04	26.32	26.63	0.31	0.88	570.68	0.1	
P-15	11/26/02	597.04	26.25	26.62	0.37	0.88	570.75	0.1	
P-15	12/04/02	597.04	26.2	26.6	0.4	0.88	570.79	0.1	
P-15	12/17/02	597.04	26.2	26.65	0.45	0.88	570.79	0.125	
P-15	12/31/02	597.04	25.67	25.71	0.04	0.88	571.37		
RW-8R	10/18/02	593.4		22.24		0.8	571.16		
SB-74	10/18/02	599.1		28.11		0.8	570.99		BOTTOM 37.45
SB-75	10/18/02	599.86		28.73		0.8	571.13		BOTTOM 35.98
SB-76	10/18/02	600.96		26.64		0.8	574.32		BOTTOM 36.5
SB-78	10/18/02	598.97		22.68		0.8	576.29		BOTTOM 34.2
SB-78	11/27/02	598.97		22.3		0.8	576.67		
SB-78	12/27/02	598.97		22.18		0.8	576.79		
SB-79	10/18/02	599.26		26.91		0.8	572.35		BOTTOM 39.4
SB-80	10/18/02	599.11		26.43		0.8	572.68		BOTTOM 40.3
SB-81	10/18/02	597.81		23.63		0.8	574.18		BOTTOM 38.42
SB-82	10/18/02	596.83		25.22		0.8	571.61		BOTTOM 35.66

Table 1. Summary of Water-Level, Product Thickness and Product Bailing Data Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Well Designation	Date	Measuring Point Elevation (ft msl)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Specific Gravity	Corrected Elevation (ft msl)	Product Bailed (gal)	Comments
SB-83	10/18/02	596.61		24.29		0.8	572.32		BOTTOM 29.95
SB-84	10/18/02	594.55		22.23		0.8	572.32		BOTTOM 31.35
SB-85	10/18/02	593.65		19.26		0.8	574.39		BOTTOM 31.12
SB-86	10/18/02	582.53		8.51		0.8	574.02		BOTTOM 16.95
W-1	10/18/02	595.98		17.94		0.8	578.04		BOTTOM 29.15
FORMER REFINERY AREA (FRA)									
B-1MW	10/17/02	590.31		4.79		0.8	585.52		BOTTOM 12.6
MH-13	10/10/02			2.67		0.8			
MH-13	10/16/02			2.58		0.8			
MH-13	10/18/02			2.58		0.8			
MH-13	11/13/02			2.38		0.8			
MH-13	11/26/02			2.42		0.8			
MH-13	12/04/02			1.92		0.8			
MH-13	12/31/02			1.53		0.8			
MH-4	10/10/02			1.4		0.8			
MH-4	10/16/02			1.37		0.8			
MH-4	10/18/02			1.37		0.8			
MH-4	11/13/02			4.26		0.8			
MH-4	11/26/02		4.25	4.26	0.01	0.8			
MH-4	12/04/02		4.3	4.31	0.01	0.8			
MH-4	12/31/02		3.4	3.41	0.01	0.8			
MH-78	10/10/02			3.65		0.8			
MH-78	10/16/02			3.6		0.8			
MH-78	10/18/02			3.6		0.8			
MH-78	11/13/02			3.41		0.8			
MH-78	11/26/02			3.49		0.8			
MH-78	12/04/02			2.88		0.8			
MW-29	10/04/02	586.36	9.29	9.37	0.08	0.8	577.05	0.125	
MW-29	10/10/02	586.36		10.16		0.8	576.20	0.125	ADSORBENT SOCK PRESENT
MW-29	10/16/02	586.36		10.75		0.8	575.61	0.125	ADSORBENT SOCK PRESENT
MW-29	10/17/02	586.36		10.75		0.8	575.61		
MW-29	11/05/02	586.36	9.23	9.24	0.01	0.8	577.13		NEW ADSORBENT SOCK INSTALLED
MW-29	11/13/02	586.36		9.74		0.8	576.62		ADSORBENT SOCK PRESENT
MW-29	11/26/02	586.36		7.83		0.8	578.53	0.125	ADSORBENT SOCK PRESENT
MW-29	12/04/02	586.36		8.48		0.8	577.88		ADSORBENT SOCK PRESENT
MW-29	12/17/02	586.36	8.03	8.03	0	0.8	578.33		ADSORBENT SOCK PRESENT
MW-29	12/31/02	586.36	7.71	7.72	0.01	0.8	578.65		ADSORBENT SOCK REPLACED
MW-30	10/10/02	587.4		15.42		0.8	571.98		ADSORBENT SOCK PRESENT
MW-30	10/16/02	587.4		14.93		0.8	572.47		ADSORBENT SOCK PRESENT
MW-30	10/17/02	587.4		14.93		0.8	572.47		
MW-30	11/05/02	587.4		14.28		0.8	573.12		ADSORBENT SOCK PRESENT
MW-30	11/13/02	587.4		14.06		0.8	573.34		ADSORBENT SOCK PRESENT
MW-30	11/26/02	587.4		12.06		0.8	575.34		ADSORBENT SOCK PRESENT
MW-30	12/04/02	587.4		12.32		0.8	575.08		ADSORBENT SOCK PRESENT
MW-30	12/17/02	587.4	11.04	11.04	0	0.8	576.36		ADSORBENT SOCK PRESENT
MW-30	12/31/02	587.4	9.02	9.02	0	0.8	578.38		ADSORBENT SOCK PRESENT
MW-31	10/17/02	588.67		4.72		0.8	583.95		BOTTOM 25.38
MW-34	10/17/02	591.64		5.85		0.8	585.79		BOTTOM 13.05
MW-5	10/17/02	585.77	10.25	10.42	0.17	0.8922	575.50		
MW-6	10/10/02	585.99		18.28		0.8	567.71		ADSORBENT SOCK PRESENT

Table 1. Summary of Water-Level, Product Thickness and Product Bailing Data Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Well Designation	Date	Measuring Point Elevation (ft msl)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Specific Gravity	Corrected Elevation (ft msl)	Product Bailed (gal)	Comments
MW-6	10/16/02	585.99		18.23		0.8	567.76		ADSORBENT SOCK PRESENT
MW-6	10/17/02	585.99		18.23		0.8	567.76		
MW-6	11/05/02	585.99	19.08	19.09	0.01	0.8	566.91		NEW ADSORBENT SOCK INSTALLED
MW-6	11/13/02	585.99		18.96		0.8	567.03		ADSORBENT SOCK PRESENT
MW-6	11/26/02	585.99		16.89		0.8	569.10		ADSORBENT SOCK PRESENT
MW-6	12/04/02	585.99		17.45		0.8	568.54		ADSORBENT SOCK PRESENT
MW-6	12/17/02	585.99	16.88	16.88	0	0.8	569.11		
MW-6	12/31/02	585.99	14.91	14.91	0	0.8	571.08		ADSORBENT SOCK PRESENT
MW-7	10/17/02	586.36				0.9593			NOT GAUGED-PRODUCT TOO THICK
RW-4	10/17/02	581.91	14.74	17.7	2.96	0.8433	566.71		SYSTEM OFF
RW-5	10/17/02	581.98	14.73	14.85	0.12	0.8529	567.23		
SB-12	10/17/02	582.74		13.02		0.8	569.72		BOTTOM 17.5
NORTHEAST PROCESS AND STORAGE AREA (NPSA)									
B-2MW	10/18/02	588.45		6.4		0.8	582.05		BOTTOM 16.34
BTC-4	10/18/02	590.46				0.8			DESTROYED BY SNOW PLOWING
BTC-5	10/18/02	590.6				0.8			DESTROYED BY SNOW PLOWING
MW-38	10/18/02	589.12	6.39	6.55	0.16	0.8	582.70		
MW-38	11/05/02	589.12	6.36	6.54	0.18	0.8	582.72		ADSORBENT SOCK INSTALLED
NORTHERN TANK YARD AREA (NTYA)									
MH-39	10/10/02		3.98	4	0.02	0.8			
MH-39	10/16/02		3.94	3.96	0.02	0.8			
MH-39	10/18/02		3.94	3.96	0.02	0.8			
MH-39	11/13/02		4	4.03	0.03	0.8			
MH-39	11/26/02		3.99	4.01	0.02	0.8			
MH-39	12/04/02		3.98	4.01	0.03	0.8			
MH-39	12/31/02		3.84	3.94	0.1	0.8			
MW-35	10/18/02	590.65		5.9		0.8	584.75		BOTTOM 12.55
SOUTHERN TANK YARD AREA (STYA)									
ESI-1	10/04/02	586.69	17.11	21.09	3.98	0.8236	568.88	3.5	
ESI-1	10/10/02	586.69	17.3	21.11	3.81	0.8236	568.72	3.5	
ESI-1	10/16/02	586.69	17.18	21.14	3.96	0.8236	568.81	4.5	
ESI-1	10/17/02	586.69	17.18	21.14	3.96	0.8236	568.81		
ESI-1	11/05/02	586.69	17.35	20.92	3.57	0.8236	568.71	3.5	
ESI-1	11/13/02	586.69				0.8236			NOT GAUGED- ACCESS BLOCKED (#38 TANK CLEANING)
ESI-1	11/26/02	586.69	16.32	20.87	4.55	0.8236	569.57	5.5	
ESI-1	12/04/02	586.69	16.18	20.84	4.66	0.8236	569.69	4.5	
ESI-1	12/17/02	586.69	15.84	20.65	4.81	0.8236	570.00	5	
ESI-1	12/31/02	586.69				0.8236			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 12/20/02; DTP 1.88, MOVED FROM ESI-2 DTP 2.12 WHEN MOVED
ESI-2	10/04/02	586.5				0.8338			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 9/20/02; DTP 1.45
ESI-2	10/10/02	586.5				0.8338			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 9/20/02; DTP 1.24
ESI-2	10/16/02	586.5				0.8338			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 9/20/02; DTP 1.05
ESI-2	10/17/02	586.5	16.91	16.93	0.02	0.8338	569.59		SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 9/20/02; DTP 0.95

Table 1. Summary of Water-Level, Product Thickness and Product Bailing Data Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Well Designation	Date	Measuring Point Elevation (ft msl)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Specific Gravity	Corrected Elevation (ft msl)	Product Bailed (gal)	Comments
ESI-2	11/05/02	586.5				0.8338			SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 9/20/02;DTP 2.71; CHANGED DRUM ON 11/1/02 INITIAL DEPTH AT CHANGE 2.80
ESI-2	11/13/02	586.5	16.75	16.77	0.02	0.8338	569.75		SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 9/20/02;DTP 2.41
ESI-2	11/26/02	586.5	16.34	16.36	0.02	0.8338	570.16		SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 9/20/02;DTP 2.23
ESI-2	12/04/02	586.5	16.22	16.24	0.02	0.8338	570.28		SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 9/20/02;DTP 2.23
ESI-2	12/17/02	586.5	16.05	16.07	0.02	0.8338	570.45		SOLAR-POWERED PRODUCT PUMP IN WELL SINCE 9/20/02;DTP 2.23
ESI-2	12/31/02	586.5	15.6	15.66	0.06	0.8338	570.89		ADSORBENT SOCK INSTALLED
ESI-3	10/17/02	588.32	19.14	19.19	0.05	0.8	569.17		
ESI-3	11/27/02	588.32	18.31	18.32	0.01	0.8	570.01		
ESI-3	12/27/02	588.32	17.66	17.69	0.03	0.8	570.65		
ESI-4	10/17/02	583.49		16.32		0.8329	567.17		BOTTOM 20.13
ESI-4	11/27/02	583.49		17.27		0.8329	566.22		
ESI-4	12/27/02	583.49		15.27		0.8329	568.22		
MH-14	10/10/02		6.26	6.27	0.01	0.8			
MH-14	10/16/02		6.27	6.28	0.01	0.8			
MH-14	10/18/02		6.27	6.28	0.01	0.8			
MH-14	11/13/02		6	6.02	0.02	0.8			
MH-14	11/26/02			6.02		0.8			
MH-14	12/04/02			5.46		0.8			
MH-14	12/31/02			4.14		0.8			SHEEN PRESENT
MH-77 (OIL PITS)	10/10/02			2.62		0.8			
MH-77 (OIL PITS)	10/16/02			2.54		0.8			
MH-77 (OIL PITS)	10/18/02			2.54		0.8			
MH-77 (OIL PITS)	11/13/02			2.42		0.8			
MH-77 (OIL PITS)	11/26/02			2.45		0.8			
MH-77 (OIL PITS)	12/04/02			1.81		0.8			
MH-77 (OIL PITS)	12/31/02			0.59		0.8			
MW-10	10/04/02	584.78		13.17		0.7976	571.61		
MW-10	10/10/02	584.78	13.37	13.38	0.01	0.7976	571.41		
MW-10	10/16/02	584.78	12.94	12.95	0.01	0.7976	571.84		
MW-10	10/18/02	584.78	12.94	12.95	0.01	0.7976	571.84		
MW-10	11/05/02	584.78	13.1	13.13	0.03	0.7976	571.67		NEW ADSORBENT SOCK INSTALLED
MW-10	11/13/02	584.78		13.37		0.7976	571.41		ADSORBENT SOCK REPLACED
MW-10	11/26/02	584.78		12.17		0.7976	572.61		ADSORBENT SOCK PRESENT
MW-10	12/04/02	584.78		12.62		0.7976	572.16		ADSORBENT SOCK PRESENT
MW-10	12/17/02	584.78		12.13		0.7976	572.65		ADSORBENT SOCK PRESENT
MW-10	12/31/02	584.78	11.66	11.66	0	0.7976	573.12		ADSORBENT SOCK PRESENT
MW-12	10/18/02	586.68	16.46	17.2	0.74	0.8811	570.13		
MW-12	11/05/02	586.68	16.8	17.45	0.65	0.8811	569.80	0.5	
MW-12	11/13/02	586.68	16.33	16.64	0.31	0.8811	570.31	0.1	
MW-12	11/26/02	586.68	15.42	15.73	0.31	0.8811	571.22	0.25	

Table 1. Summary of Water-Level, Product Thickness and Product Bailing Data Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Well Designation	Date	Measuring Point Elevation (ft msl)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Specific Gravity	Corrected Elevation (ft msl)	Product Bailed (gal)	Comments
MW-12	12/04/02	586.68	15.28	15.37	0.09	0.8811	571.39	0.1	
MW-14	10/04/02	586.91	17.03	18.76	1.73	0.8128	569.56	1.25	PRODUCT PUMP IN WELL SINCE 9/2000
MW-14	10/18/02	586.91				0.8128			PRODUCT PUMP IN WELL SINCE 9/2000
MW-18	10/04/02	582.88	13.64	14.14	0.5	0.8212	569.15	0.25	
MW-18	10/10/02	582.88	13.7	14.15	0.45	0.8212	569.10	0.5	
MW-18	10/16/02	582.88	13.67	14.12	0.45	0.8212	569.13	0.25	
MW-18	10/18/02	582.88	13.67	14.12	0.45	0.8212	569.13		
MW-18	11/05/02	582.88	13.69	14.35	0.66	0.8212	569.07	0.5	
MW-18	11/13/02	582.88	13.49	14.02	0.53	0.8212	569.30	0.5	
MW-18	11/26/02	582.88	12.65	13.09	0.44	0.8212	570.15	0.25	
MW-18	12/04/02	582.88	12.52	12.88	0.36	0.8212	570.30	0.125	
MW-18	12/17/02	582.88	12.12	12.55	0.43	0.8212	570.68		
MW-18	12/31/02	582.88	11.61	12.15	0.54	0.8212	571.17	0.75	
MW-20	10/04/02	585.97		16.59		0.8702	569.38		
MW-20	10/10/02	585.97		16.81		0.8702	569.16		ADSORBENT SOCK PRESENT
MW-20	10/16/02	585.97		16.76		0.8702	569.21	0.1	ADSORBENT SOCK PRESENT
MW-20	10/18/02	585.97		16.75		0.8702	569.22		
MW-20	11/05/02	585.97		17.11		0.8702	568.86		NEW ADSORBENT SOCK INSTALLED
MW-20	11/13/02	585.97		17.06		0.8702	568.91		ADSORBENT SOCK PRESENT
MW-20	11/26/02	585.97		16.39		0.8702	569.58		
MW-20	12/04/02	585.97		16.29		0.8702	569.68		ADSORBENT SOCK PRESENT
MW-20	12/17/02	585.97	16.43	16.43	0	0.8702	569.54		ADSORBENT SOCK PRESENT
MW-20	12/31/02	585.97	16.02	16.02	0	0.8702	569.95		ADSORBENT SOCK PRESENT
MW-21	10/18/02	582.69		17.22		0.8	565.47		BOTTOM 26.4
MW-21	11/27/02	582.69		16.22		0.8	566.47		
MW-21	12/27/02	582.69		15.83		0.8	566.86		
MW-32	10/18/02	585.59		13.76		0.8	571.83		BOTTOM 25.25
MW-33	10/18/02	584.62		8.75		0.8	575.87		BOTTOM 29.1
MW-40	10/18/02	585.56	15.88	17.25	1.37	0.8102	569.42		
MW-40	11/05/02	585.56	15.34	16.82	1.48	0.8102	569.94	2	
MW-40	11/13/02	585.56	16.56	17.25	0.69	0.8102	568.87	1	
MW-40	11/26/02	585.56	9.1	9.12	0.02	0.8102	576.46		
MW-40	12/04/02	585.56		10.98		0.8102	574.58		
MW-41	10/18/02	585.31	17.3	17.34	0.04	0.8102	568.00		
MW-42	10/18/02	585.62	7.18	7.19	0.01	0.8329	578.44		
MW-43	10/18/02	585.49	16.69	17.15	0.46	0.8329	568.72		
MW-44	10/18/02	586.15		18.49		0.8	567.66		BOTTOM 29.45
MW-45	10/18/02	583.01		15.09		0.8	567.92		BOTTOM 30.6
RW-1	10/18/02	581.8	14.63	14.85	0.22	0.8	567.13		
RW-2	10/04/02	581.61		12.87		0.8	568.74		
RW-2	10/10/02	581.61	13.16	13.17	0.01	0.8	568.45		
RW-2	10/16/02	581.61		12.54		0.8	569.07		
RW-2	10/18/02	581.61		12.54		0.8	569.07		
RW-2	11/05/02	581.61				0.8			NOT GAUGED- ACCESS BLOCKED
RW-2	11/13/02	581.61				0.8			NOT GAUGED- ACCESS BLOCKED
RW-2	11/26/02	581.61		13.23		0.8	568.38		
RW-2	12/04/02	581.61		7.23		0.8	574.38		SYSTEM DOWN
RW-2	12/17/02	581.61		13.1		0.8	568.51		
RW-2	12/31/02	581.61	0.67	0.67	0	0.8	580.94		MELTOFF WATER RUNNING INTO WELL
RW-3	10/18/02	583.21	18.7	19	0.3	0.8	564.45		
RW-7	10/18/02	582.81	14.03	14.8	0.77	0.8102	568.63		
RW-7	11/05/02	582.81	14.2	14.9	0.7	0.8102	568.48	2	
RW-7	11/13/02	582.81	14.27	14.85	0.58	0.8102	568.43	0.5	
RW-7	11/26/02	582.81	13.11	13.12	0.01	0.8102	569.70		
RW-7	12/04/02	582.81		13.77		0.8102	569.04		

Table 1. Summary of Water-Level, Product Thickness and Product Bailing Data Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Well Designation	Date	Measuring Point Elevation (ft msl)	Depth to Product (ft)	Depth to Water (ft)	Product Thickness (ft)	Specific Gravity	Corrected Elevation (ft msl)	Product Bailed (gal)	Comments
RW-9	10/18/02	582.56		13.72		0.8329	568.84		BOTTOM 23.0

Table 2. Summary of Volatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)	Sample Designation: Sample Date: Area:	B-1MW 10/24/02 FRA	B-2MW 10/22/02 NPSA	B-3MW 10/22/02 BSPA	B-4MW 10/22/02 BSPA	B-5MW(RR) 10/22/02 AOOA	B-6MW 10/23/02 ETYA
Benzene		1 U	1 U	1 U	1 U	91.1	1 U
Toluene		1 U	1 U	1 U	1 U	2.3	1 U
Ethylbenzene		1 U	1 U	1 U	1 U	5.4	1 U
Xylenes (total)		1 U	1 U	1 U	1 U	44.6	1 U
Total BTEX		0	0	0	0	143.4	0
1,2,4-Trimethylbenzene		1 U	1 U	1 U	1 U	6	1 U
1,3,5-Trimethylbenzene		1 U	1 U	1 U	1 U	5.1	1 U
4-Isopropyltoluene		1 U	1 U	1 U	1 U	1 U	1 U
Isopropylbenzene		1 U	1 U	1 U	1 U	3.4	1 U
MTBE		1 U	1 U	5 U	5 U	1 U	1 U
n-Butylbenzene		1 U	1 U	1 U	1 U	1 U	1 U
n-Propylbenzene		1 U	1 U	1 U	1 U	2.7	1 U
Naphthalene		2.5 U	2.5 U	2.5 U	2.5 U	5 U	2.5 U
sec-Butylbenzene		1 U	1 U	1 U	1 U	1 U	1 U
tert-Butylbenzene		1 U	1 U	1 U	1 U	1 U	1 U
Total VOCs:		0	0	0	0	160.6	0

Notes:

µg/L - Micrograms per liter

U - The analyte was analyzed for, but not detected above the reported quantitation limit.

J - Indicates estimated value

Table 2. Summary of Volatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)	Sample Designation: / Sample Date: / Area:	ESI-4 10/23/02 STYA	LF-2S 10/23/02 ETYA	MW-1URS 10/23/02 ETYA	MW-2 10/22/02 BSPA	MW-4URS 10/23/02 ETYA	MW-5URS 10/24/02 ETYA
Benzene		3020	31.1	1 U	1 U	1 U	1 U
Toluene		35	1 U	1 U	1 U	1 U	1 U
Ethylbenzene		10 U	1 U	1 U	1 U	1 U	1 U
Xylenes (total)		11	1 U	1 U	1 U	1 U	1 U
Total BTEX		3066	31.1	0	0	0	0
1,2,4-Trimethylbenzene		10 U	1 U	1 U	1 U	1 U	1 U
1,3,5-Trimethylbenzene		10 U	1 U	1 U	1 U	1 U	1 U
4-Isopropyltoluene		10 U	1 U	1 U	1 U	1 U	1 U
Isopropylbenzene		36	1 U	1 U	1 U	1 U	1 U
MTBE		10 U	1 U	1 U	1 U	1 U	1 U
n-Butylbenzene		10 U	1 U	1 U	1 U	1 U	1 U
n-Propylbenzene		10 U	1 U	1 U	1 U	1 U	1 U
Naphthalene		25 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
sec-Butylbenzene		10 U	1 U	1 U	1 U	1 U	1 U
tert-Butylbenzene		10 U	1 U	1 U	1 U	1 U	1 U
Total VOCs:		3102	31.1	0	0	0	0

Notes:

µg/L - Micrograms per liter

U - The analyte was analyzed for, but not detected above the reported quantitation limit.

J - Indicates estimated value

Table 2. Summary of Volatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)	**Sample Designation:** / **Sample Date:** / **Area:**	MW-9 10/22/02 CRPA	MW-13 10/23/02 CRPA	MW-16 10/22/02 CRPA	MW-17 10/22/02 CRPA	MW-21 10/23/02 STYA	MW-24 10/24/02 BSPA
Benzene		1250	309	1060	101	1 U	1 U
Toluene		21	16.6	36	2.5	1 U	1 U
Ethylbenzene		10 U	4.6	486	6.5	1 U	1 U
Xylenes (total)		26	47	1570	51.3	1 U	1 U
Total BTEX		1297	377.2	3152	161.3	0	0
1,2,4-Trimethylbenzene		22	1 U	978	7.2	1 U	1 U
1,3,5-Trimethylbenzene		24	1 U	147	5.7	1 U	1 U
4-Isopropyltoluene		10 U	1 U	10 U	1 U	1 U	1 U
Isopropylbenzene		62	18.9	143	3.5	1 U	1 U
MTBE		10 U	1 U	10 U	1 U	1 U	1.2
n-Butylbenzene		26	1 U	10 U	1 U	1 U	1 U
n-Propylbenzene		116	17	85	2.9	1 U	1 U
Naphthalene		50 U	2.5 U	25 U	5 U	2.5 U	2.5 U
sec-Butylbenzene		24	1 U	10 U	1 U	1 U	1 U
tert-Butylbenzene		10 U	1 U	10 U	1 U	1 U	1 U
Total VOCs:		1571	413.1	4505	180.6	0	1.2

Notes:

µg/L - Micrograms per liter

U - The analyte was analyzed for, but not detected above the reported quantitation limit.

J - Indicates estimated value

Table 2. Summary of Volatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)	Sample Designation: / Sample Date: / Area:	MW-26 10/22/02 BSPA	MW-31 10/24/02 FRA	MW-32 10/22/02 STYA	MW-33 10/22/02 STYA	MW-34 10/24/02 FRA	MW-35 10/24/02 NTYA
Benzene		1 U	7	430	19.4	18.4	1 U
Toluene		1 U	3.2	69	0.9 J	12.5	1 U
Ethylbenzene		1 U	7.8	619	2	0.7 J	1 U
Xylenes (total)		1 U	9.8	3750	6.4	18.7	1 U
Total BTEX		0	27.8	4868	28.7	50.3	0
1,2,4-Trimethylbenzene		1 U	4.2	1980	11.6	1 U	1 U
1,3,5-Trimethylbenzene		1 U	2.9	834	6.5	1 U	1 U
4-Isopropyltoluene		1 U	1 U	30	1.7	1 U	1 U
Isopropylbenzene		1 U	3	57	6	1 U	1 U
MTBE		5 U	1 U	10 U	1 U	1 U	1.2
n-Butylbenzene		1 U	1 U	10 U	6.2	1 U	1 U
n-Propylbenzene		1 U	2.3	116	11.1	1 U	1 U
Naphthalene		2.5 U	10.1	284	7.4	6.9	2.5 U
sec-Butylbenzene		1 U	1 U	10 U	4	1 U	1 U
tert-Butylbenzene		1 U	1 U	10 U	1 U	1 U	1 U
Total VOCs:		0	50.3	8169	83.2	57.2	1.2

Notes:

µg/L - Micrograms per liter

U - The analyte was analyzed for, but not detected above the reported quantitation limit.

J - Indicates estimated value

Table 2. Summary of Volatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)	Sample Designation: / Sample Date: / Area:	MW-36R 10/24/02 CRPA	MW-37 10/22/02 CRPA	SB-11/LB-1 10/22/02 BSPA	SB-12 10/22/02 FRA	SB-31 10/22/02 BSPA	SB-75 10/23/02 ETYA
Benzene		1 U	4.8	27.5	1 U	1 U	116
Toluene		1 U	1 U	7.6	1 U	1 U	1 U
Ethylbenzene		1 U	1 U	2.7	1 U	1 U	1 U
Xylenes (total)		1 U	1 U	7	1 U	1 U	3.4
Total BTEX		0	4.8	44.8	0	0	119.4
1,2,4-Trimethylbenzene		0.6 J	2.3	3	1 U	1 U	1 U
1,3,5-Trimethylbenzene		1 U	3.1	1 U	1 U	1 U	1 U
4-Isopropyltoluene		1 U	1 U	1 U	1 U	1 U	1 U
Isopropylbenzene		0.5 J	3.1	1 U	1 U	1 U	1 U
MTBE		1.1	1.2	5 U	1 U	5 U	1 U
n-Butylbenzene		1 U	1 U	6.2	1 U	1 U	1 U
n-Propylbenzene		0.6 J	3.1	43	1 U	1 U	1 U
Naphthalene		2.5 U	2.5 U	3.1	2.5 U	2.5 U	2.5 U
sec-Butylbenzene		1 U	1 U	3.4	1 U	1 U	1 U
tert-Butylbenzene		1 U	1 U	1 U	1 U	1 U	1 U
Total VOCs:		2.8	17.6	103.5	0	0	119.4

Notes:

µg/L - Micrograms per liter

U - The analyte was analyzed for, but not detected above the reported quantitation limit.

J - Indicates estimated value

Table 2. Summary of Volatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)			
	Sample Designation:	SB-78	SB-83
	Sample Date:	10/23/02	10/23/02
	Area:	ETYA	ETYA
Benzene		1 U	1 U
Toluene		1 U	1 U
Ethylbenzene		1 U	1 U
Xylenes (total)		1 U	1 U
Total BTEX		0	0
1,2,4-Trimethylbenzene		1 U	1 U
1,3,5-Trimethylbenzene		1 U	1 U
4-Isopropyltoluene		1 U	1 U
Isopropylbenzene		1 U	1 U
MTBE		1 U	1 U
n-Butylbenzene		1 U	1 U
n-Propylbenzene		1 U	1 U
Naphthalene		2.5 U	2.5 U
sec-Butylbenzene		1 U	1 U
tert-Butylbenzene		1 U	1 U
Total VOCs:		0	0

Notes:

µg/L - Micrograms per liter

U - The analyte was analyzed for, but not detected above the reported quantitation limit.

J - Indicates estimated value

Table 3. Summary of Semivolatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)	**Sample Designation:**	B-1MW	B-2MW	B-3MW	B-4MW	B-5MW(RR)	B-6MW	ESI-4
	Sample Date:	10/24/02	10/22/02	10/22/02	10/22/02	10/22/02	10/23/02	10/23/02
	Area:	FRA	NPSA	BSPA	BSPA	AOOA	ETYA	STYA
Acenaphthene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Acenaphthylene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Anthracene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Benzo[a]anthracene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Benzo[a]pyrene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Benzo[b]fluoranthene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Benzo[g,h,i]perylene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Benzo[k]fluoranthene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Chrysene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Dibenzo[a,h]anthracene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Fluoranthene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Fluorene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Indeno[1,2,3-cd]pyrene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Naphthalene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Phenanthrene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Pyrene		10 U	13.3 U	20 U	10 U	10 U	10 U	16.7 U
Total SVOCs		0	0	0	0	0	0	0

Notes:
µg/L - Micrograms per liter
U - The analyte was analyzed for, but not detected above the reported quantitation limit.
J - Indicates estimated value

Table 3. Summary of Semivolatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)	**Sample Designation:**	LF-2S	MW-1URS	MW-2	MW-4URS	MW-5URS	MW-9	MW-13
	Sample Date:	10/23/02	10/23/02	10/22/02	10/23/02	10/24/02	10/22/02	10/23/02
	Area:	ETYA	ETYA	BSPA	ETYA	ETYA	CRPA	CRPA
Acenaphthene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Acenaphthylene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Anthracene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Benzo[a]anthracene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Benzo[a]pyrene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Benzo[b]fluoranthene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Benzo[g,h,i]perylene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Benzo[k]fluoranthene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Chrysene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Dibenzo[a,h]anthracene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Fluoranthene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Fluorene		10 U	10 U	12.5 U	10 U	10 U	2.9 J	10 U
Indeno[1,2,3-cd]pyrene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Naphthalene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Phenanthrene		10 U	10 U	12.5 U	10 U	10 U	3.9 J	10 U
Pyrene		10 U	10 U	12.5 U	10 U	10 U	10 U	10 U
Total SVOCs		0	0	0	0	0	6.8	0

Notes:
µg/L - Micrograms per liter
U - The analyte was analyzed for, but not detected above the reported quantitatio
J - Indicates estimated value

Table 3. Summary of Semivolatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)	**Sample Designation:** / **Sample Date:** / **Area:**	MW-16 10/22/02 CRPA	MW-17 10/22/02 CRPA	MW-21 10/23/02 STYA	MW-24 10/24/02 BSPA	MW-26 10/22/02 BSPA	MW-31 10/24/02 FRA	MW-32 10/22/02 STYA
Acenaphthene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Acenaphthylene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Anthracene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Benzo[a]anthracene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Benzo[a]pyrene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Benzo[b]fluoranthene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Benzo[g,h,i]perylene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Benzo[k]fluoranthene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Chrysene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Dibenzo[a,h]anthracene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Fluoranthene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Fluorene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Indeno[1,2,3-cd]pyrene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Naphthalene		85	16.7 U	10 U	10 U	10 U	10 U	160
Phenanthrene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Pyrene		10 U	16.7 U	10 U	10 U	10 U	10 U	100 U
Total SVOCs		85	0	0	0	0	0	160

Notes:
µg/L - Micrograms per liter
U - The analyte was analyzed for, but not detected above the reported quantitatio
J - Indicates estimated value

Table 3. Summary of Semivolatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)	**Sample Designation:** / **Sample Date:** / **Area:**	MW-33 10/22/02 STYA	MW-34 10/24/02 FRA	MW-35 10/24/02 NTYA	MW-36R 10/24/02 CRPA	MW-37 10/22/02 CRPA	SB-11/LB-1 10/22/02 BSPA	SB-12 10/22/02 FRA
Acenaphthene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Acenaphthylene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Anthracene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Benzo[a]anthracene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Benzo[a]pyrene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Benzo[b]fluoranthene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Benzo[g,h,i]perylene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Benzo[k]fluoranthene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Chrysene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Dibenzo[a,h]anthracene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Fluoranthene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Fluorene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Indeno[1,2,3-cd]pyrene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Naphthalene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Phenanthrene		2.3 J	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Pyrene		10 U	33.3 U	100 U	10 U	10 U	12.5 U	10 U
Total SVOCs		2.3	0	0	0	0	0	0

Notes:
µg/L - Micrograms per liter
U - The analyte was analyzed for, but not detected above the reported quantitatio
J - Indicates estimated value

Table 3. Summary of Semivolatile Organic Compounds Detected in Groundwater Samples, Exxon Mobil Corporation, Buffalo Terminal, Buffalo, New York.

Parameter (Concentrations in µg/L)	**Sample Designation:**	SB-31	SB-75	SB-78	SB-83
	Sample Date:	10/22/02	10/23/02	10/23/02	10/23/02
	Area:	BSPA	ETYA	ETYA	ETYA
Acenaphthene		20 U	10 U	11.1 U	10 U
Acenaphthylene		20 U	10 U	11.1 U	10 U
Anthracene		20 U	10 U	11.1 U	10 U
Benzo[a]anthracene		20 U	10 U	11.1 U	10 U
Benzo[a]pyrene		20 U	10 U	11.1 U	10 U
Benzo[b]fluoranthene		20 U	10 U	11.1 U	10 U
Benzo[g,h,i]perylene		20 U	10 U	11.1 U	10 U
Benzo[k]fluoranthene		20 U	10 U	11.1 U	10 U
Chrysene		20 U	10 U	11.1 U	10 U
Dibenzo[a,h]anthracene		20 U	10 U	11.1 U	10 U
Fluoranthene		20 U	10 U	11.1 U	10 U
Fluorene		20 U	10 U	11.1 U	10 U
Indeno[1,2,3-cd]pyrene		20 U	10 U	11.1 U	10 U
Naphthalene		20 U	10 U	11.1 U	10 U
Phenanthrene		20 U	10 U	11.1 U	10 U
Pyrene		20 U	10 U	11.1 U	10 U
Total SVOCs		0	0	0	0

Notes:
µg/L - Micrograms per liter
U - The analyte was analyzed for, but not detected above the reported quantitatio
J - Indicates estimated value

Table 4. Summary of Well Construction Data, ExxonMobil Oil Corporation, Buffalo Terminal, Buffalo, New York.

Designation	Geographical Area	Northing	Easting	Measuring Point Elevation (ft amsl)	Land Surface Elevation (ft amsl)	Depth of Boring (ft bls)	Depth of Well (ft bls)	Screen Interval (ft bls)			Sump Length (ft)	Diameter (in)	Installer	Date Installed	Screen Material	Screen Slot Size (in)	Gravel Pack
MW-40	STYA	1042934.96	1080957.24	585.56	582.89	33	32	5	-	30	NA	4	SJB	05/20/02	PVC	0.02	# 1 Morie Sand
MW-41	STYA	1042972.35	1080940.47	585.31	582.45	31	32	5	-	30	NA	4	SJB	05/20/02	PVC	0.02	# 1 Morie Sand
MW-42	STYA	1042785.46	1081562.41	585.62	582.85	23	23	5	-	20	NA	4	SJB	05/17/02	PVC	0.02	# 1 Morie Sand
MW-43	STYA	1042777.42	1081590.20	585.49	582.98	23	23	5	-	20	NA	4	SJB	05/21/02	PVC	0.02	# 1 Morie Sand
MW-44	STYA	1042759.82	1081160.82	586.15	583.15	29	32	5	-	30	NA	4	SJB	05/21/02	PVC	0.02	# 1 Morie Sand
MW-45	STYA	1042898.93	1080945.56	583.01	583.48	29	32	5	-	30	NA	4	SJB	05/21/02	PVC	0.02	# 1 Morie Sand
RW-7	STYA	1042963.12	1080969.08	582.81	582.87	41	40	9	-	39	1	10	SJB	06/06/02	SS	0.02	# 1 Morie Sand
RW-8	ETYA	1042624.84	1082309.96	NA	NA	NA	NA	NA	-	NA	NA	NA	NA	NA	NA	NA	NA
RW-8R	ETYA	1042649.43	1082293.36	593.40	593.81	39	39	8	-	38	1	10	SJB	08/01/02	SS	0.02	# 1 Morie Sand
RW-9	STYA	1042761.40	1081555.21	582.56	582.78	21	25	4	-	24	1	10	SJB	06/10/02	SS	0.02	# 1 Morie Sand

Notes:

STYA - Southern Tank Yard Area
ETYA - Eastern Tank Yard Area
ft amsl - Feet above mean sea level
ft bls - Feet below land surface
in - Inches
PVC - Polyvinyl Chloride
SS - Stainless Steel

Table 5. Summary of Analytical Results from Samples Collected During Aquifer Pump Tests, ExxonMobil Oil Corporation, Buffalo Terminal, Buffalo, New York

Parameter	Sample Designation: / Sample Date: / Geographic Area:	RW-7 06/25/02 STYA	RW-8 06/28/02 ETYA	RW-8R 08/08/02 ETYA	RW-9 06/27/02 STYA
VOCs (Concentrations in µg/L)					
Benzene		3440	8.5	151	1420
Toluene		26	1.4 J	1.9	42
Ethylbenzene		296	2 U	1 U	118
Xylenes (total)		520	2 U	2.7	434
Total BTEX:		4282	9.9	155.6	2014
1,2,4-Trimethylbenzene		254	3.2	1.2	200
1,3,5-Trimethylbenzene		60	2 U	1 U	70
4-Isopropyltoluene		20 U	2 U	1 U	20 U
Isopropylbenzene		42	2 U	2.8	52
MTBE		282	2 U	3.9	28
n-Butylbenzene		34	2 U	3.1	40
n-Propylbenzene		62	2 U	1	66
Naphthalene		100 U	5 U	5 U	100 U
sec-Butylbenzene		20 U	2 U	4	20 U
tert-Butylbenzene		20 U	2 U	1 U	20 U
Total VOCs:		5016	13.1	171.6	2470
SVOCs (Concentrations in µg/L)					
Acenaphthene		10 U	5 U	5 U	NA
Acenaphthylene		10 U	NA	NA	NA
Anthracene		10 U	5 U	5 U	NA
Benzo[a]anthracene		10 U	5 U	5 U	NA
Benzo[a]pyrene		10 U	5 U	5 U	NA
Benzo[b]fluoranthene		10 U	5 U	5 U	NA
Benzo[g,h,i]perylene		10 U	5 U	5 U	NA
Benzo[k]fluoranthene		10 U	5 U	5 U	NA
Chrysene		10 U	5 U	5 U	NA
Dibenzo[a,h]anthracene		10 U	5 U	5 U	NA
Fluoranthene		10 U	5 U	5 U	NA
Fluorene		10 U	5 U	5 U	NA
Indeno[1,2,3-cd]pyrene		10 U	5 U	5 U	NA
Naphthalene		NA	5 U	5 U	NA
Phenanthrene		10 U	5 U	5 U	NA
Pyrene		10 U	5 U	5 U	NA
Total SVOCs:		0	0	0	NA
Metals (Concentrations in mg/L)					
Calcium		149	134	144	106
Iron		19	22.2	25.7	23.6
Magnesium		32.1	33	33.1	16.1
Manganese		1.95	1.11	1.04	0.69
Miscellaneous (Concentrations in mg/L)					
Alkalinity, Total		557	618	588	NA
Total Dissolved Solids		716	724	672	464
Total Suspended Solids		39	66	62	22

Notes:

U - Not Detected
µg/L - Micrograms per liter
mg/L - Milligrams per liter
VOCs - Volatile Organic Compounds
SVOCs - Semivolatile Organic Compounds
NA - Not Analyzed

Table 6. Summary of Separate-Phase Product and Groundwater Sampling for Geotechnical Fluid Properties, ExxonMobil Oil Corporation, Buffalo Terminal, Buffalo, New York.

Sample	Density (gm/ml)	Viscosity (centipoise)	Surface Tension Air/Water (dynes/cm)	Interfacial Tension NAPL/Water (dynes/cm)	Surface Tension Air/NAPL (dynes/cm)	Geographical Area
Main Plume						
Western Portion of Main Plume						
MW-25	0.8533	3.96	58.28	13.31	25.53	BSPA
MW-43	0.8523	4.04	53.17	5.58	24.07	STYA
MW-46	0.8570	4.24	61.15	11.61	26.17	BSPA
RW-5	0.8571	4.90	54.84	10.59	25.80	FRA
Average	0.8549	4.29	56.86	10.27	25.39	
Eastern Portion of Main Plume						
MW-15	0.8110	1.89	60.76	13.75	23.39	CRPA
MW-18	0.8304	2.03	52.68	3.55	23.50	STYA
MW-18*			51.02	3.72	23.77	STYA
MW-41	0.8182	1.92	67.34	10.85	22.67	STYA
RW-7	0.8102	1.51	58.30	10.50	23.00	STYA
RW-9	0.8329	2.82	68.00	6.60	24.70	STYA
Average	0.8205	2.03	59.68	8.16	23.51	
Average for Main Plume	0.8358	3.03	58.55	9.01	24.26	
ETYA Plume						
LF-1S	0.8835	4.26	58.97	15.17	26.11	ETYA
LF-6	0.8830	4.33	69.00	17.70	26.70	ETYA
Average for ETYA Plume	0.8833	4.30	63.99	16.44	26.41	

Notes:
STYA - Southern Tank Yard Area
ETYA - Eastern Tank Yard Area
CRPA - Central Rail and Process Area
FRA - Former Refinery Area
BSPA - Babcock Street Properties Area
* - Repeat Analysis
gm/ml - Grams per milliliter
cm - Centimeter

**Table 7. Summary of Pump Test Results,
ExxonMobil Oil Corporation, Buffalo Terminal, Buffalo, New York.**

RW-7

Designation	Distance to Pumping Well (ft)	Diameter (in)	Saturated Thickness (ft)	Transmissivity (ft^2/day)	Hydraulic Conductivity (ft/day)
RW-7	0	10	20	1262.9	**63.15**
MW-40	30.6	4	20	3357.7	**167.89**
MW-41	30	4	20	3198.1	**159.91**
MW-45	68.4	4	20	2558.6	**127.93**
MW-32	121.1	4	20	NA	NA
MW-18	225.1	4	20	NA	NA
			Average	2594.33	**129.72**

RW-8R

Designation	Distance to Pumping Well (ft)	Diameter (in)	Saturated Thickness (ft)	Transmissivity (ft^2/day)	Hydraulic Conductivity (ft/day)
RW-8R	0	10	14	107.4	**7.67**
LF-1S	30.9	2	14	NA	NA
LF-3	45.7	4	14	NA	NA
LF-5	91.3	4	14	NA	NA
LF-6	43.4	4	14	NA	NA
MW-3URS	51.2	2	14	NA	NA
P-15	53.4	2	14	NA	NA
			Average	107.40	**7.67**

RW-9

Designation	Distance to Pumping Well (ft)	Diameter (in)	Saturated Thickness (ft)	Transmissivity (ft^2/day)	Hydraulic Conductivity (ft/day)
RW-9	0	10	15	NA	NA
MW-42	25.16	4	15	2032.8	**135.52**
MW-43	38.42	4	15	642.8	**42.85**
MW-20	156.3	4	15	NA	NA
MW-21	212.2	4	15	NA	NA
MW-14	122.2	4	15	NA	NA
ESI-4	32.3	4	15	711.8	**47.45**
			Average	1129.13	**75.28**

NA - Not Analyzable
ft - feet
in - inches
ft/day - feet per day

Table 8. Summary of Groundwater Model Calibration Targets, ExxonMobil Oil Corporation, Buffalo Terminal, Buffalo, New York.

Designation	Model Layer	Observed Head (ft)	Computed Head (ft)	Residual (ft)
B-3MW	1	583.13	583.35	-0.22
B-1MW	2	585.19	585.20	-0.01
SB-37	2	572.18	572.09	0.09
LF-1S	3	572.53	572.67	-0.14
LF-2S	3	573.63	573.04	0.59
LF-3	3	572.56	574.03	-1.47
LF-6	3	572.64	572.61	0.03
MW-13	3	583.75	580.84	2.91
MW-17	3	583.12	583.96	-0.84
MW-24	3	572.28	572.19	0.08
MW-25	3	573.06	572.24	0.82
MW-28	3	573.00	572.50	0.50
MW-29	3	578.18	576.37	1.81
MW-30/MW-8	3	575.27	576.55	-1.29
MW-32	3	575.02	573.94	1.08
MW-34	3	585.74	584.68	1.06
MW-35	3	584.92	585.04	-0.12
MW-39	3	576.62	576.39	0.23
MW-3URS	3	572.52	572.60	-0.08
MW-4URS	3	572.21	573.72	-1.51
P-15	3	572.51	572.73	-0.22
RW-3	3	575.25	575.60	-0.34
RW-4	3	574.37	574.45	-0.08
SB-17	3	572.26	572.20	0.06
SB-20	3	575.32	573.95	1.37
SB-76	3	575.31	576.45	-1.14
SB-78	3	577.31	577.58	-0.27
SB-80	3	574.16	575.46	-1.30
SB-82	3	573.46	573.70	-0.24
SB-84	3	574.41	574.30	0.11
W-1	3	578.77	579.15	-0.38
B-2MW	4	582.36	583.39	-1.03
B-4MW	4	578.63	579.03	-0.40
B-5MWRR	4	582.63	583.86	-1.23
B-6MW	4	572.45	572.69	-0.24
LF-4	4	573.63	572.75	0.88
MW-1	4	572.15	572.31	-0.16
MW-16	4	584.93	581.82	3.11
MW-1URS	4	581.60	581.29	0.31
MW-2	4	572.35	572.18	0.17
MW-26	4	584.11	583.55	0.56
MW-31	4	583.62	583.13	0.49
MW-36R	4	583.84	582.68	1.16
MW-37	4	583.43	581.64	1.79
MW-38	4	582.98	582.91	0.07
MW-5URS	4	581.40	579.96	1.44
SB-16	4	573.00	572.43	0.57
SB-31	4	572.66	572.49	0.17
SB-74	4	572.28	572.61	-0.33
SB-86	4	575.71	576.33	-0.62

Summary Statistics	
Residual Mean	0.16
Res. Std. Dev.	0.98
Sum of Squares	49.03
Abs. Res. Mean	0.70
Min. Residual	-1.51
Max. Residual	3.11
Range	13.59
Std/Range	0.07

Notes:
Abs. Res. Mean - Absolute Residual of Mean
Res. Std. Dev. - Standard Deviation of Mean
ft - feet
Std/Range - Stand Deviation of Range
min - minimum
max - maximum

Table 9. Summary of Soil Properties Used in the Multi-Phase Model, ExxonMobil Oil Corporation, Buffalo Terminal, Buffalo, New York.

Name of Zone	Hydraulic Conductivity (ft/d)	Porosity	Irreducible Water Saturation	S_{or}	Alpha (α) [1/ft]	Parameter N	S_{og}
Loamy Sand	95	41%	0.139	14%	3.7795	2.28	5%
Sand	110	43%	0.105	10%	4.4196	2.68	5%
Sandy Loam	25	41%	0.159	16%	2.286	1.89	5%
Silt Loam	4	45%	0.149	15%	0.6096	1.41	5%
Clay	0.01	38%	0.179	18%	0.2438	1.09	5%
Gravel	150	30%	0.139	14%	3.7795	2.28	5%

Notes:
ft/d - feet per day
ft - feet
S_{or} - Residual Saturation in Saturated Zone
S_{og} - Residual Saturation in Vadose Zone

Table 10. Summary of Specific Gravity Analyses, ExxonMobil Oil Corporation, Buffalo Terminal, Buffalo, New York.

Designation	Specific Gravity	Geographic Area
Main Plume		
Western Portion of Main Plume		
Catch Basin	0.8488	BSPA
MW-25*	0.8533	BSPA
MW-4	0.8504	FRA
MW-46*	0.8570	BSPA
MW-5	0.8922	FRA
MW-7	0.9593	FRA
MW-8	0.8017	FRA
RW-4 Tank	0.8433	FRA
RW-5 Tank	0.8529	FRA
RW-5*	0.8571	FRA
Sewer Drain	0.9047	BSPA
Storm Sewer	0.9047	BSPA
Average	0.8688	
Eastern Portion of Main Plume		
ESI-1	0.8236	STYA
ESI-2	0.8338	STYA
ESI-5	0.8560	STYA
MW-10	0.7976	STYA
MW-11	0.8280	STYA
MW-12	0.8811	STYA
MW-14	0.8128	STYA
MW-15	0.8265	CRPA
MW-15*	0.8110	CRPA
MW-18	0.8212	STYA
MW-18*	0.8304	STYA
MW-19	0.8294	STYA
MW-20	0.8702	STYA
MW-41*	0.8182	STYA
MW-43*	0.8523	STYA
RW-1 Tank	0.8165	STYA
RW-2 Tank	0.8413	STYA
RW-3 Tank	0.8591	STYA
RW-7*	0.8102	STYA
RW-9*	0.8329	STYA
Average	0.8326	
Average for Main Plume	0.8462	
P-15	0.8800	ETYA
MW-28	0.8827	ETYA
MW-3URS	0.8822	ETYA
LF-6*	0.8830	ETYA
LF-1S*	0.8835	ETYA
LF-1S	0.8838	ETYA
Average for ETYA Plume	0.8825	

Notes:
STYA - Southern Tank Yard Area
ETYA - Eastern Tank Yard Area
CRPA - Central Rail and Process Area
FRA - Former Refinery Area
BSPA - Babcock Street Properties Area
* - Obtained from Separate-Phase Propduct Sampling During this Investigation

Table 11. Summary of Water-Level and Separate-Phase Product Thickness for June 2002, ExxonMobil Oil Corporation, Buffalo Terminal, Buffalo, New York.

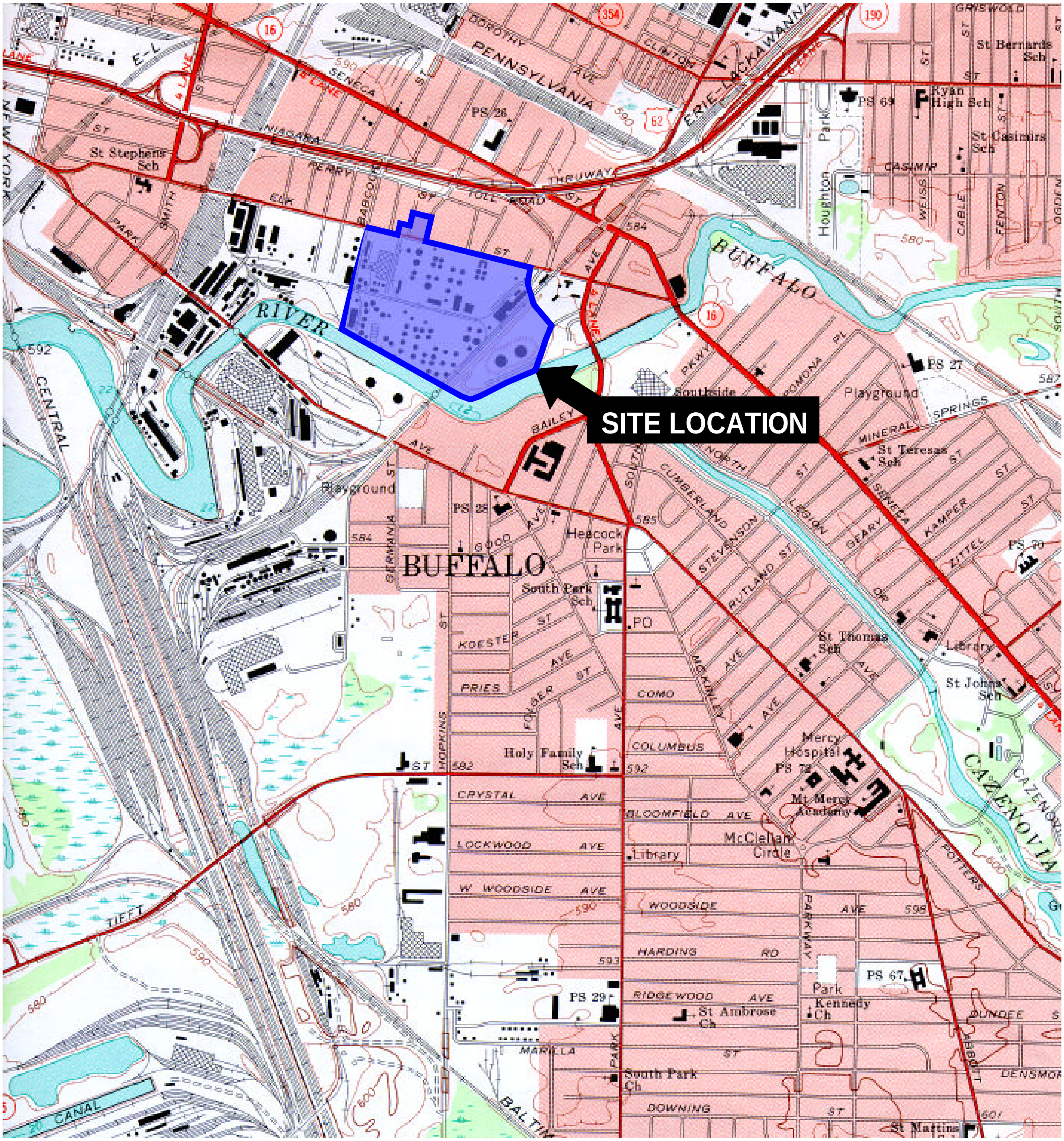
Designation	Date Measured	Measuring Point Elevation (ft amsl)	Depth to Product (ft)	Depth to Water (ft)	Groundwater Elevation (ft amsl)	Product Elevation (ft amsl)	Product Thickness (ft)
B-1MW	6/17/2002	590.31	--	5.12	585.19	--	--
B-2MW	6/17/2002	588.45	--	6.09	582.36	--	--
B-3MW	6/17/2002	586.82	--	3.69	583.13	--	--
B-4MW	6/17/2002	587.05	--	8.42	578.63	--	--
B-5MWRR	6/17/2002	587.54	--	4.91	582.63	--	--
B-6MW	6/17/2002	596.35	--	23.90	572.45	--	--
ESI-1	6/17/2002	586.69	15.13	21.05	570.62	571.56	5.92
ESI-2	6/17/2002	586.5	14.91	15.33	571.52	571.59	0.42
ESI-3	6/17/2002	588.32	17.65	17.70	570.66	570.67	0.05
ESI-4	6/17/2002	583.49	--	13.25	570.24	--	--
ESI-5*	1/17/02	586.97	--	11.77	575.20	--	
LF-1S	6/17/2002	596.27	22.81	23.75	573.31	573.46	0.94
LF-2S	6/17/2002	581.83	--	8.14	573.69	--	--
LF-3	6/17/2002	596.17	23.30	23.63	572.82	572.87	0.33
LF-4	6/17/2002	594.87	21.23	21.24	573.64	573.64	0.01
LF-5		597.62	23.12	23.12	574.50	574.50	0.00
LF-6	6/17/2002	598.14	24.90	25.52	573.14	573.24	0.62
LF-7	6/17/2002	598.28	--	25.81	572.47	--	--
LF-8		596.99	--			--	--
MW-1	6/17/2002	582.13	--	9.98	572.15	--	--
MW-10*	6/21/02	584.78	11.09	11.45	573.63	573.69	0.36
MW-12	6/17/2002	586.68	14.65	15.27	571.93	572.03	0.62
MW-13	6/17/2002	584.37	--	0.62	583.75	--	--
MW-14	6/17/2002	586.91	15.45	16.75	571.25	571.46	1.30
MW-15	6/17/2002	586.65	15.1	15.66	571.46	571.55	0.56
MW-16	6/17/2002	589.15	--	4.73	584.42	--	--
MW-17	6/17/2002	588.39	--	5.27	583.12	--	--
MW-18	6/17/2002	582.88	11.75	12.12	571.07	571.13	0.37
MW-1URS	6/17/2002	594.82	--	13.22	581.60	--	--
MW-2	6/17/2002	583.09	--	10.74	572.35	--	--
MW-20	6/17/2002	585.97	14.21	14.43	571.73	571.76	0.22
MW-21	6/17/2002	582.69	--	12.84	569.85	--	--
MW-22*	7/22/2002	582.36	10.72	10.73	571.64	571.64	0.01
MW-23	6/17/2002	586.14	--	14.41	571.73	--	--
MW-24	6/17/2002	583.67	11.39	11.42	572.28	572.28	0.03
MW-25	6/17/2002	583.28	8.55	10.22	574.47	574.73	1.67
MW-26	6/17/2002	584.87	--	0.76	584.11	--	--
MW-27	6/17/2002	582.69	12.84	12.85	569.85	569.85	0.01
MW-28	6/17/2002	599.91	26.35	26.96	573.46	573.56	0.61
MW-29	6/17/2002	586.36	8.18	8.20	578.18	578.18	0.02
MW-2URS	6/17/2002	581.83	--	11.07	570.76	--	--
MW-3	6/17/2002	581.72	--	9.79	571.93	--	--
MW-30/MW-8	6/17/2002	587.4	12.13	12.16	575.27	575.27	0.03
MW-31	6/17/2002	588.67	--	5.05	583.62	--	--
MW-33	6/17/2002	584.62	--	8.17	576.45	--	--
MW-34	6/17/2002	591.64	--	5.90	585.74	--	--
MW-35	6/17/2002	590.65	--	5.73	584.92	--	--
MW-36R	6/17/2002	589.65	--	5.81	583.84	--	--
MW-37	6/17/2002	589.8	--	6.37	583.43	--	--
MW-38	6/17/2002	589.12	--	6.14	582.98	--	--
MW-39	6/17/2002	596.21	19.57	19.59	576.64	576.64	0.02
MW-3URS	6/17/2002	599.58	--	27.06	572.52	--	--
MW-40	6/17/2002	585.56	--	14.31	571.25	--	--
MW-41*	6/15/2002	585.31	15.67	15.69	569.64	569.64	0.02
MW-42	6/17/2002	585.62	5.28	5.29	580.34	580.34	0.01
MW-43	6/17/2002	585.49	14.02	14.05	571.47	571.47	0.03
MW-44	6/17/2002	586.15	15.07	15.08	571.08	571.08	0.01
MW-45	6/17/2002	583.01	--	12.97	570.04	--	--

Table 11. Summary of Water-Level and Separate-Phase Product Thickness for June 2002, ExxonMobil Oil Corporation, Buffalo Terminal, Buffalo, New York.

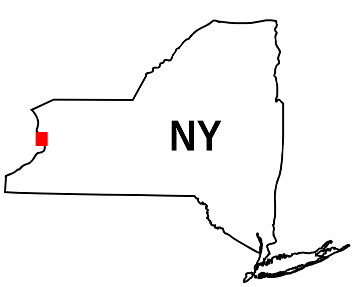
Designation	Date Measured	Measuring Point Elevation (ft amsl)	Depth to Product (ft)	Depth to Water (ft)	Groundwater Elevation (ft amsl)	Product Elevation (ft amsl)	Product Thickness (ft)
MW-46*	7/11/2002	582.87	10.24	12.10	572.34	572.63	1.86
MW-4URS	6/17/2002	594.59	--	22.38	572.21	--	--
MW-5URS	6/17/2002	595.36	--	13.96	581.40	--	--
MW-6	6/17/2002	585.99	14.5	14.51	571.49	571.49	0.01
MW-9	6/17/2002	588.5	--	5.58	582.92	--	--
Buffalo River	6/17/2002	586.18	--	14.22	571.96	--	--
RW-1	6/17/2002	581.8	11.19	12.36	570.43	570.61	1.17
RW-2	6/17/2002	581.61	--	8.40	573.21	--	--
RW-3	6/17/2002	583.21	7.94	8.05	575.25	575.27	0.11
RW-4*	7/2/2002	581.91	7.52	7.54	574.39	574.39	0.02
RW-5	6/17/2002	581.98	9.52	12.97	571.91	572.46	3.45
RW-6*	10/16/01	581.99	--	3.20	578.79	--	
RW-7*	6/15/2002	582.81	12.6	12.64	570.20	570.21	0.04
RW-8	6/17/2002	593.4	--	--		--	--
RW-9	7/11/2002	582.56	12.84	14.27	569.49	569.72	1.43
SB-11/LB-1	6/17/2002	582.08	--	10.15	571.93	--	--
SB-12	6/17/2002	582.74	--	10.47	572.27	--	--
SB-14	6/17/2002	584.79	--	10.81	573.98	--	--
SB-16*	7/22/2002	583.81	10.73	10.81	573.07	573.08	0.08
SB-17	6/17/2002	583.53	11.23	11.47	572.26	572.30	0.24
SB-20	6/17/2002	583.46	8.14	8.16	575.32	575.32	0.02
SB-31	6/17/2002	581.92	--	9.26	572.66	--	--
SB-37	6/17/2002	583.1	--	10.92	572.18	--	--
SB-74	6/17/2002	599.1	--	26.82	572.28	--	--
SB-76	6/17/2002	600.96	--	25.65	575.31	--	--
SB-78	6/17/2002	598.97	--	21.66	577.31	--	--
SB-80	6/17/2002	599.11	--	24.95	574.16	--	--
SB-82	6/17/2002	596.83	--	23.37	573.46	--	--
SB-84	6/17/2002	594.55	--	20.14	574.41	--	--
SB-86	6/17/2002	582.53	--	6.82	575.71	--	--
W-1	6/17/2002	595.98	--	17.21	578.77	--	--

Notes:

ft amsl - Feet above mean sea level
* - Measurement inferred from historical data
-- - Not applicable
ft - Feet



QUADRANGLE LOCATION



SOURCE:
USGS; 1965, Buffalo SE, New York
7.5 Minute Topographic Quadrangle

Title:

SITE LOCATION MAP

BUFFALO TERMINAL

Prepared for:

EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: N.C.	Date: 26FEB03	FIGURE
Prepared by: G.M.	Scale: AS SHOWN	1
Project Mgr.: N.C.	Office: NY	
File No.: MC5219716.CDR	Project No.: 17252Y05	

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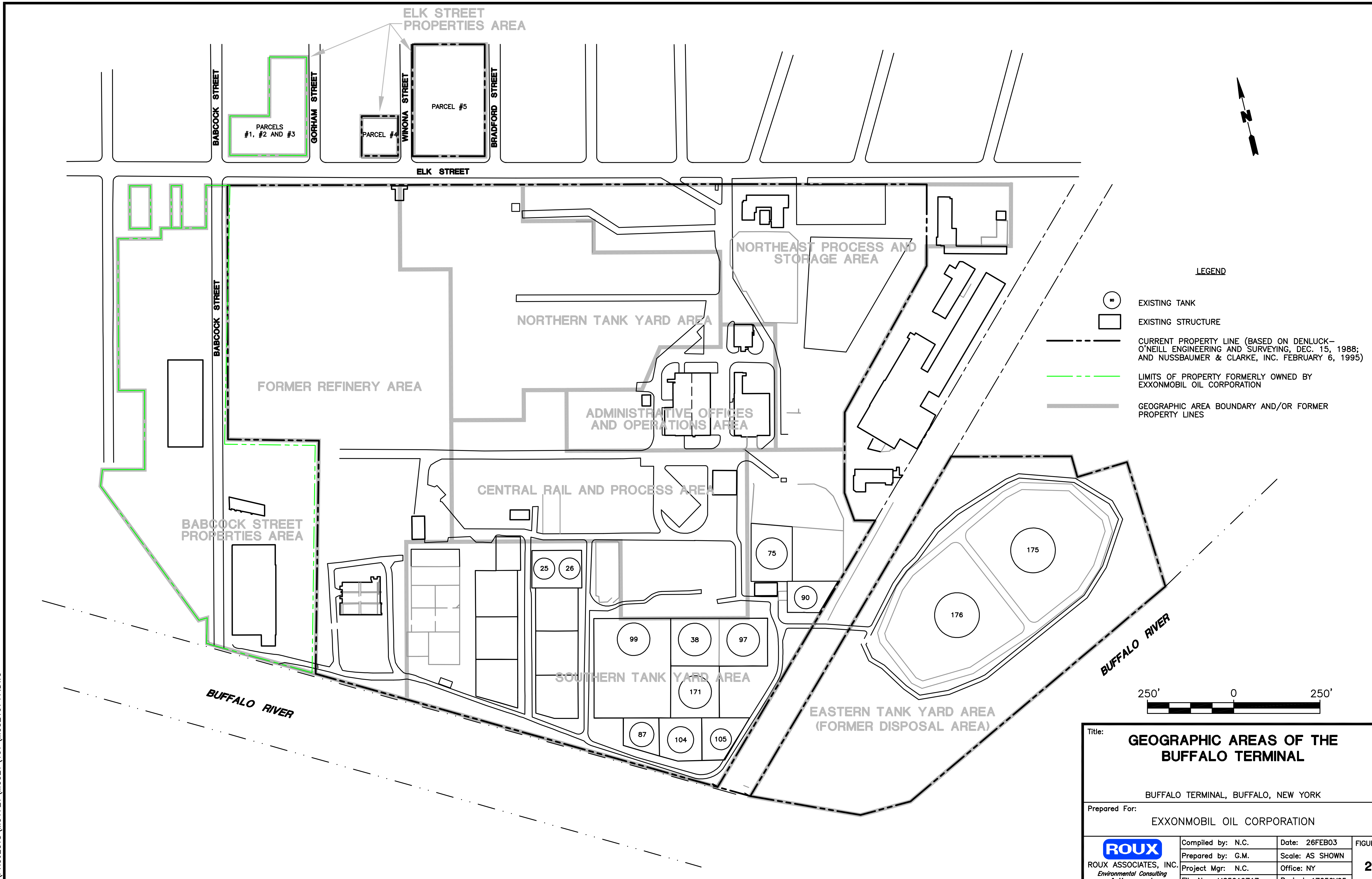

Title: **GEOGRAPHIC AREAS OF THE BUFFALO TERMINAL**

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For: EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: N.C.	Date: 26FEB03	FIGURE
Prepared by: G.M.	Scale: AS SHOWN	2
Project Mgr: N.C.	Office: NY	
File No: MC5219717	Project: 17252Y05	

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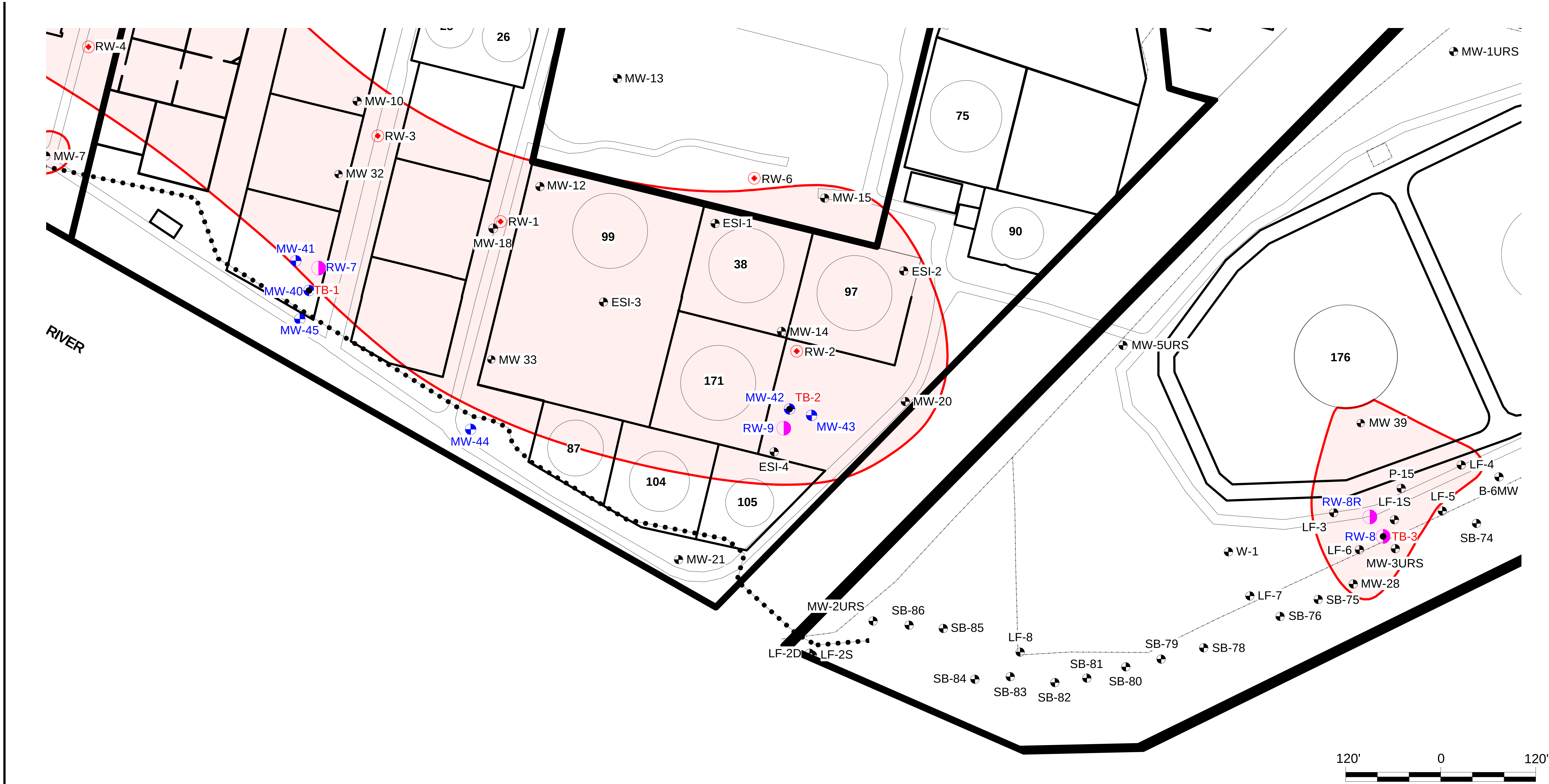


EXPLANATION

RW-1 LOCATION AND DESIGNATION OF EXISTING RECOVERY WELL

MW-18 LOCATION AND DESIGNATION OF EXISTING MONITORING WELL

TB-1 LOCATION AND DESIGNATION OF TEST BOREHOLE

RW-7 LOCATION AND DESIGNATION OF NEWLY-INSTALLED 10-INCH DIAMETER RECOVERY WELL

MW-40 LOCATION AND DESIGNATION OF NEWLY-INSTALLED 4-INCH DIAMETER MONITORING WELL

HORIZONTAL EXTENT OF HISTORICAL AND CURRENT FREE-PRODCT PLUME AS OF JANUARY 2001

N

Title:

LOCATIONS OF NEWLY-INSTALLED MONITORING WELLS AND RECOVERY WELLS

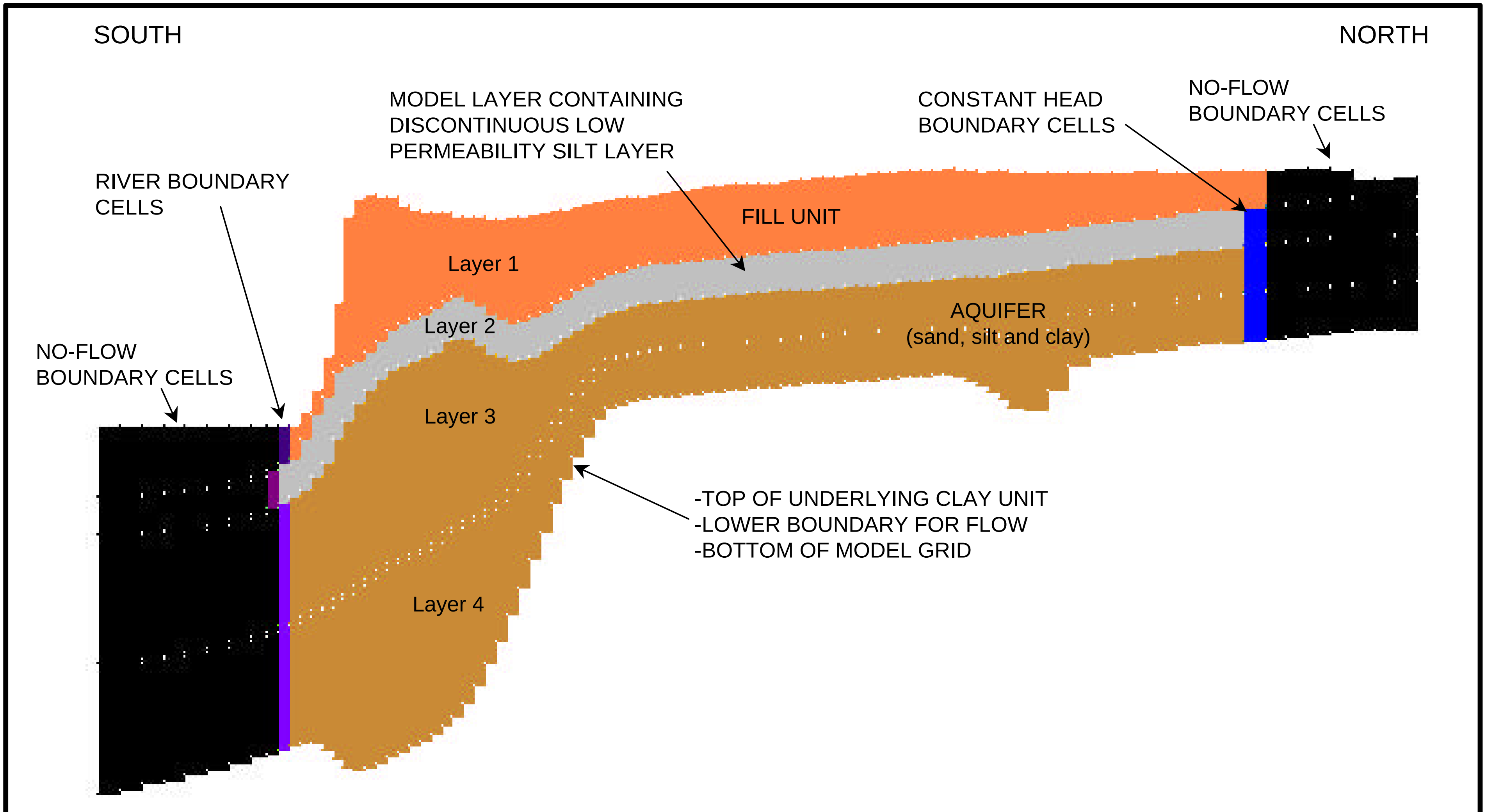
BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX ASSOCIATES INC
Environmental Consulting & Management

Compiled by: S.S.	Date: 2/26/03	FIGURE
Prepared by: S.S.	Scale: AS SHOWN	3
Project Mgr: N.C.	Office: NY	
File No: MC5219701.WOR	Project: 17252Y05	



Title:

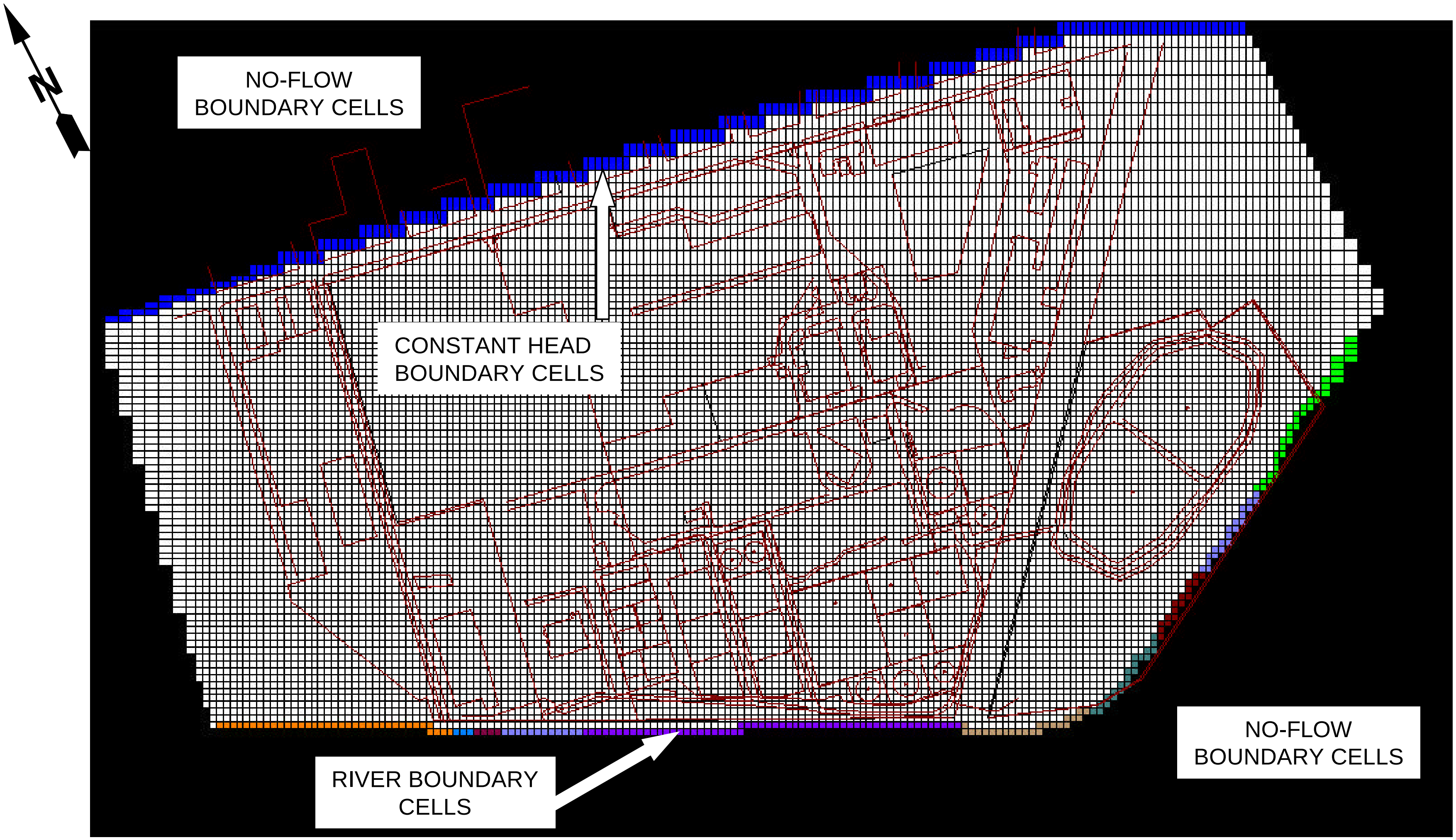
CONCEPTUAL MODEL CROSS SECTION

BUFFALO TERMINAL, BUFFALO, NEW YORK

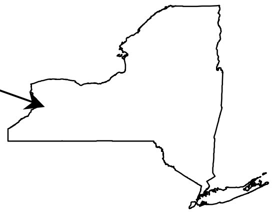
Prepared For: EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES INC
Environmental Consulting & Management

Compiled by: NE	Date: 2/25/03	FIGURE 4
Prepared by: NE	Scale: NTS	
Project Mgr: NC	Office: NY	
File No: MC5219702.PPT	Project: 17252Y05	



ROW SPACING – 20 TO 40 FEET
COLUMN SPACING – 20 TO 40 FEET



Title:

MODFLOW GRID EXTENT

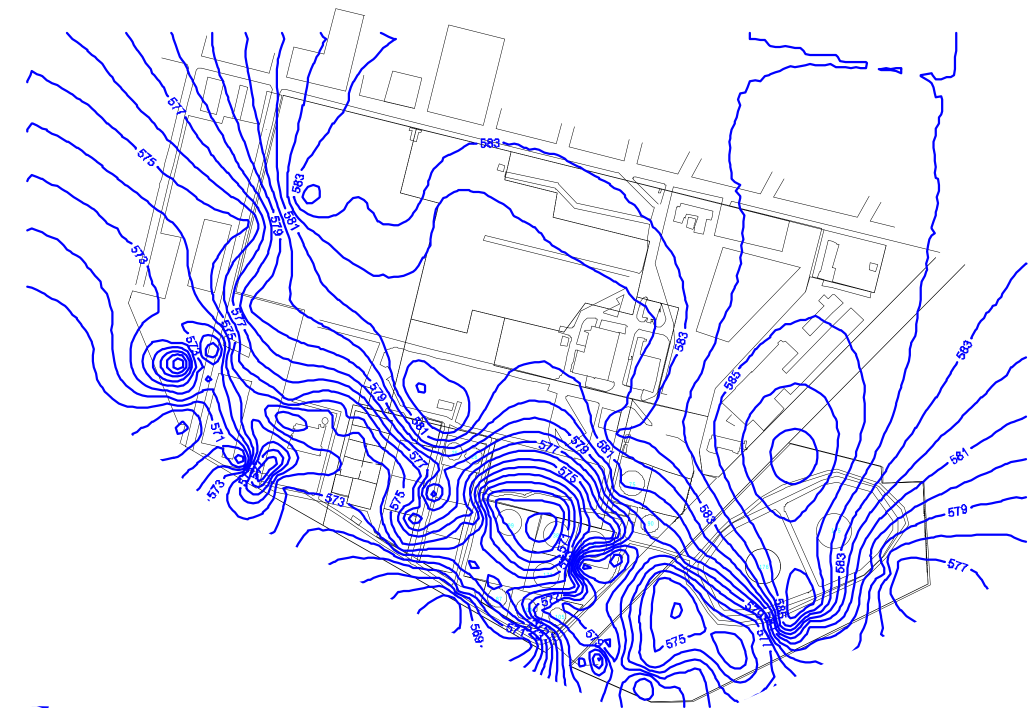
BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For: EXXONMOBIL OIL CORPORATION

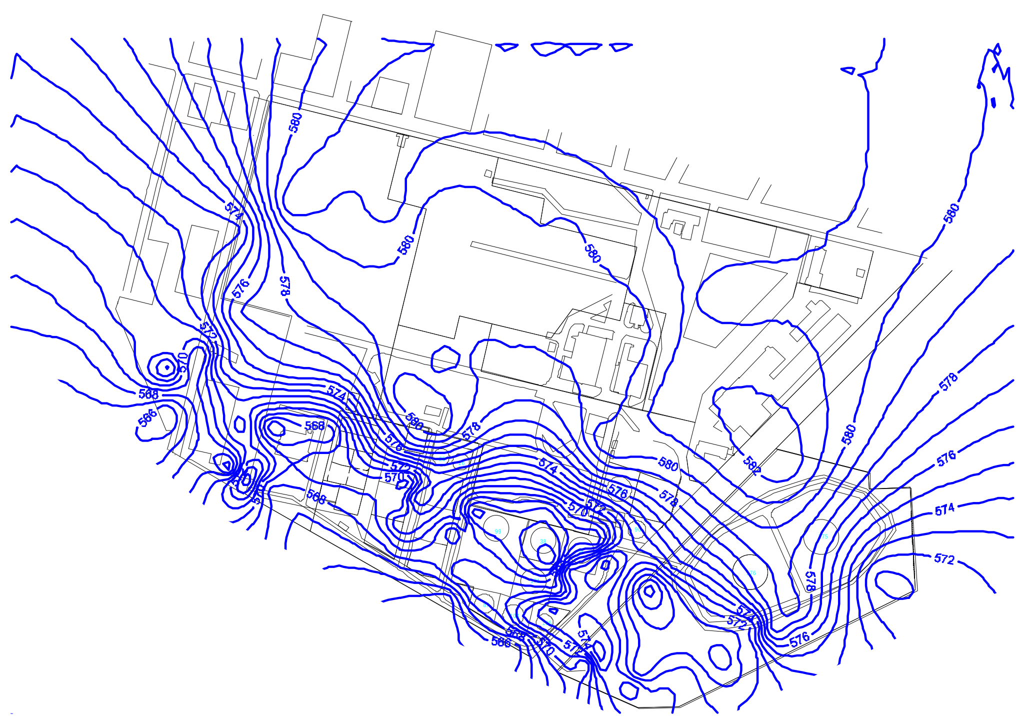
ROUX ASSOCIATES INC
Environmental Consulting & Management

Compiled by: NE	Date: 2/25/03	FIGURE
Prepared by: NE	Scale: 1" = 440'	5
Project Mgr: NC	Office: NY	
File No: MC5219703.PPT	Project: 17252Y05	

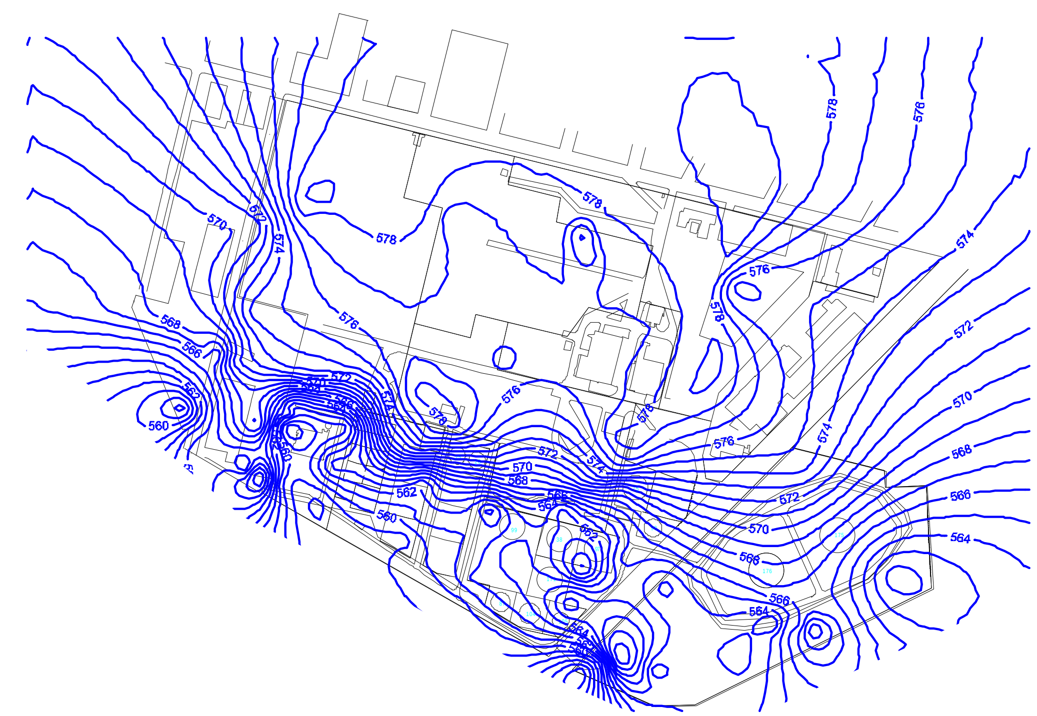
LAYER 1



LAYER 2



LAYER 3



LAYER 4

Title:

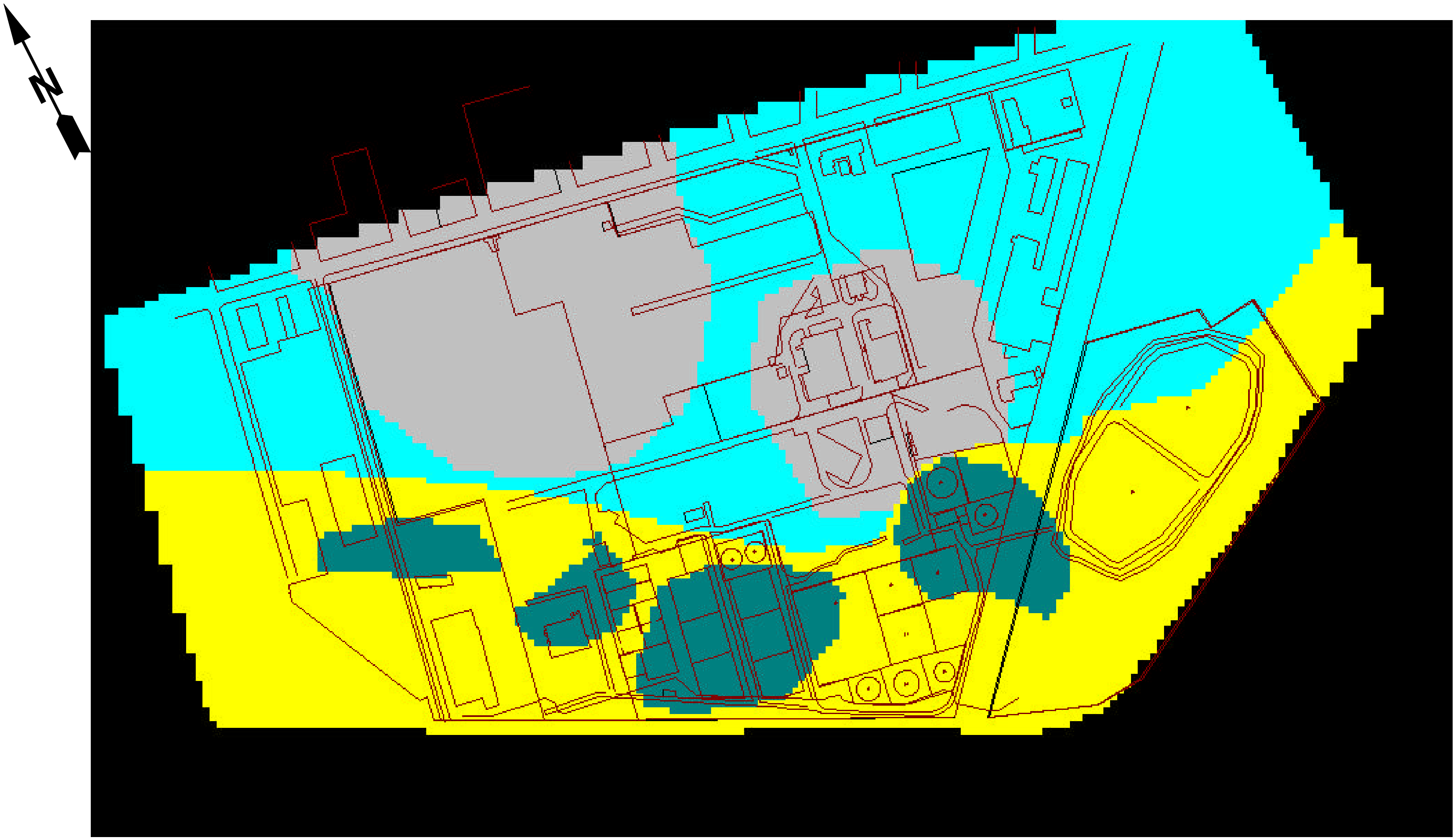
MODFLOW GRID
BOTTOM ELEVATIONS

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX ASSOCIATES INC Environmental Consulting & Management	Compiled by: NE	Date: 2/20/03	FIGURE
	Prepared by: NE	Scale: 1"=650'	6
	Project Mgr: NC	Office: NY	
	File No: MC5219704.PPT	Project: 17252Y05	



0 FEET PER DAY

0.002 FEET PER DAY

0.0037 FEET PER DAY

0.006 FEET PER DAY

Title:

MODFLOW MODEL RECHARGE ZONES

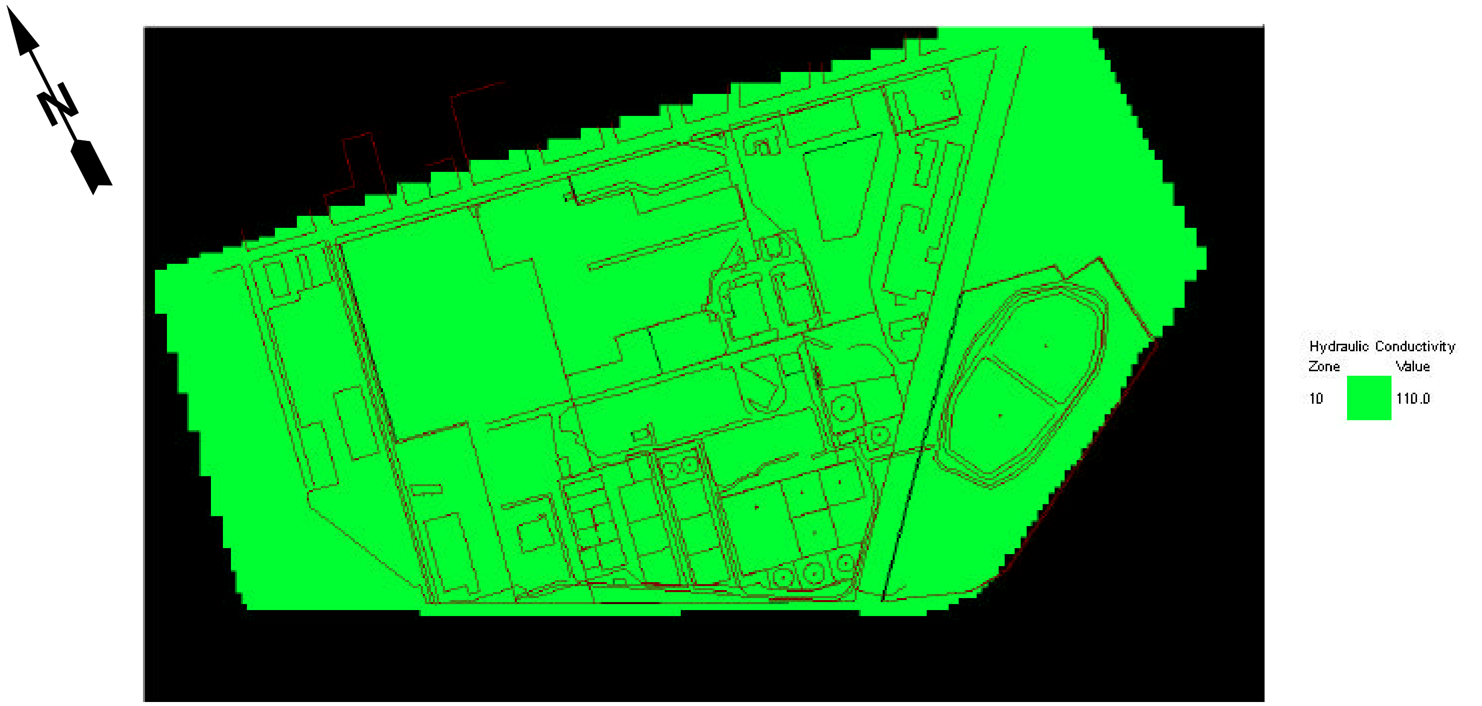
BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For: EXXONMOBIL OIL CORPORATION

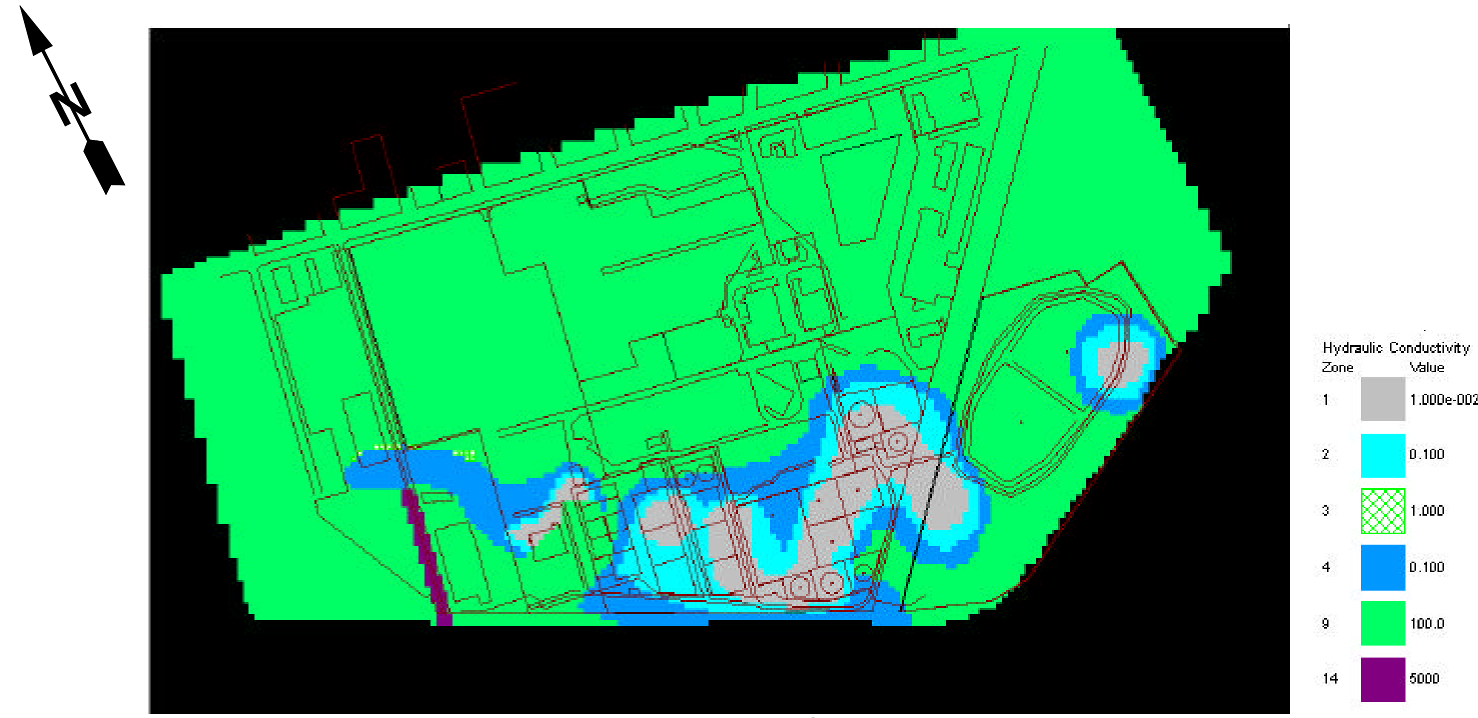
ROUX

ROUX ASSOCIATES INC
Environmental Consulting & Management

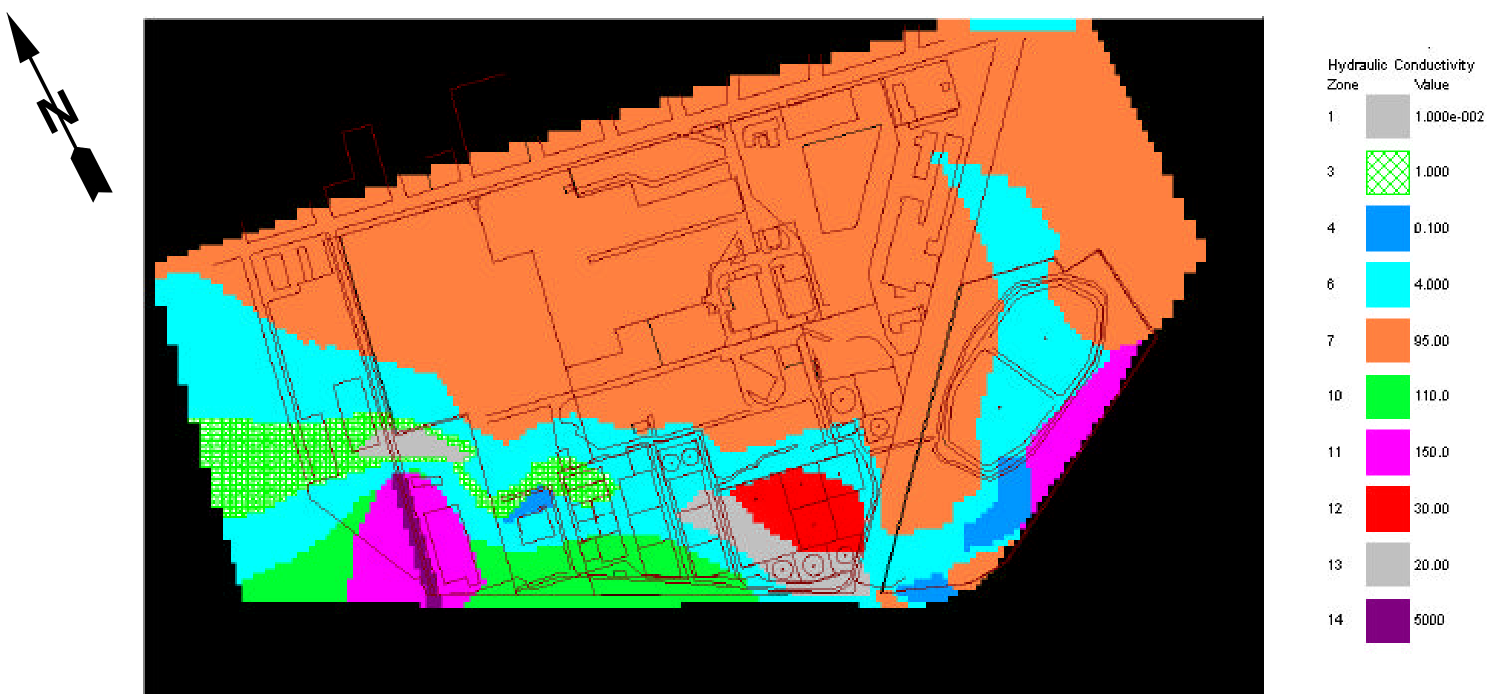
Compiled by: NE	Date: 2/20/03	FIGURE
Prepared by: NE	Scale: 1" = 440'	7
Project Mgr: NC	Office: NY	
File No: MC5219705.PPT	Project: 17252Y05	



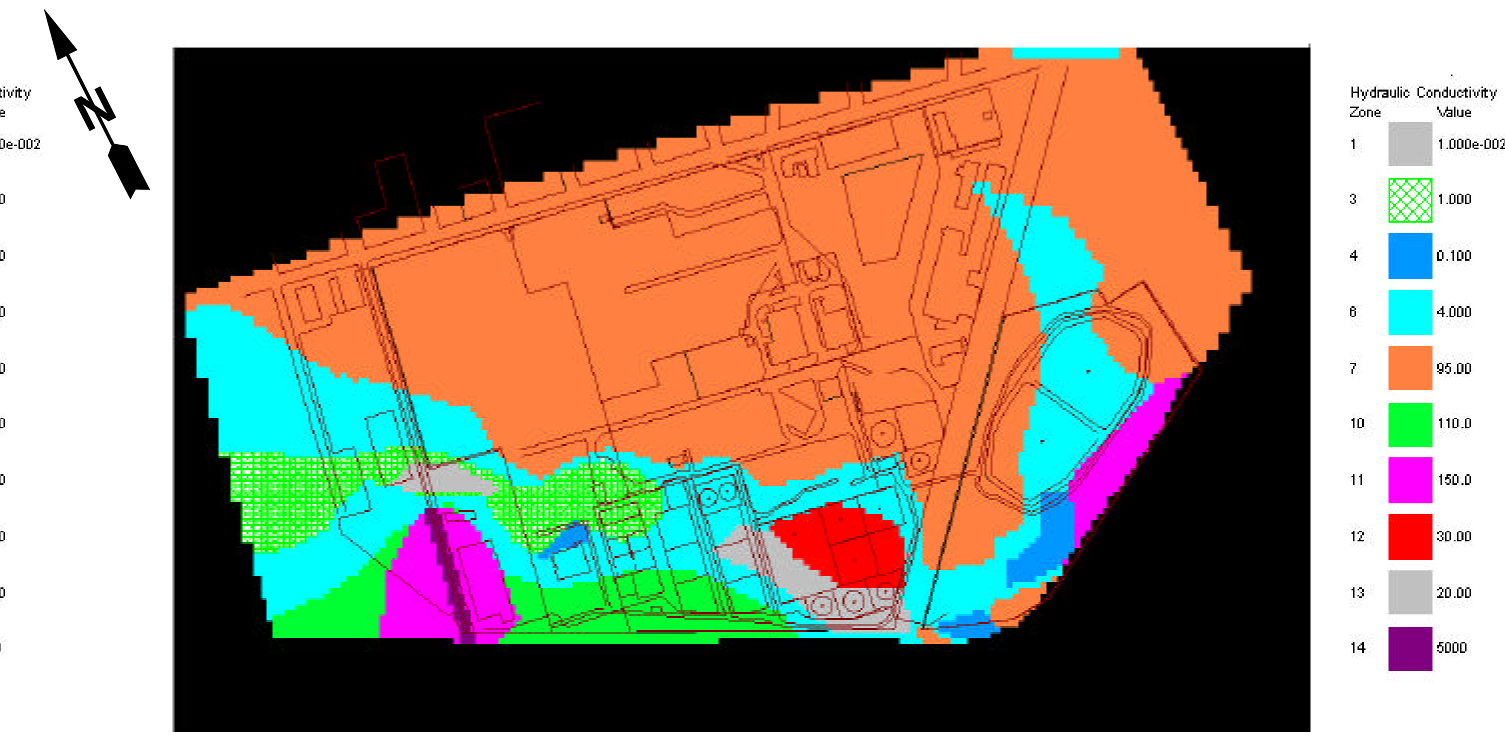
LAYER 1



LAYER 2



LAYER 3



LAYER 4

Title:

MODFLOW GRID
HYDRAULIC CONDUCTIVITY ZONES

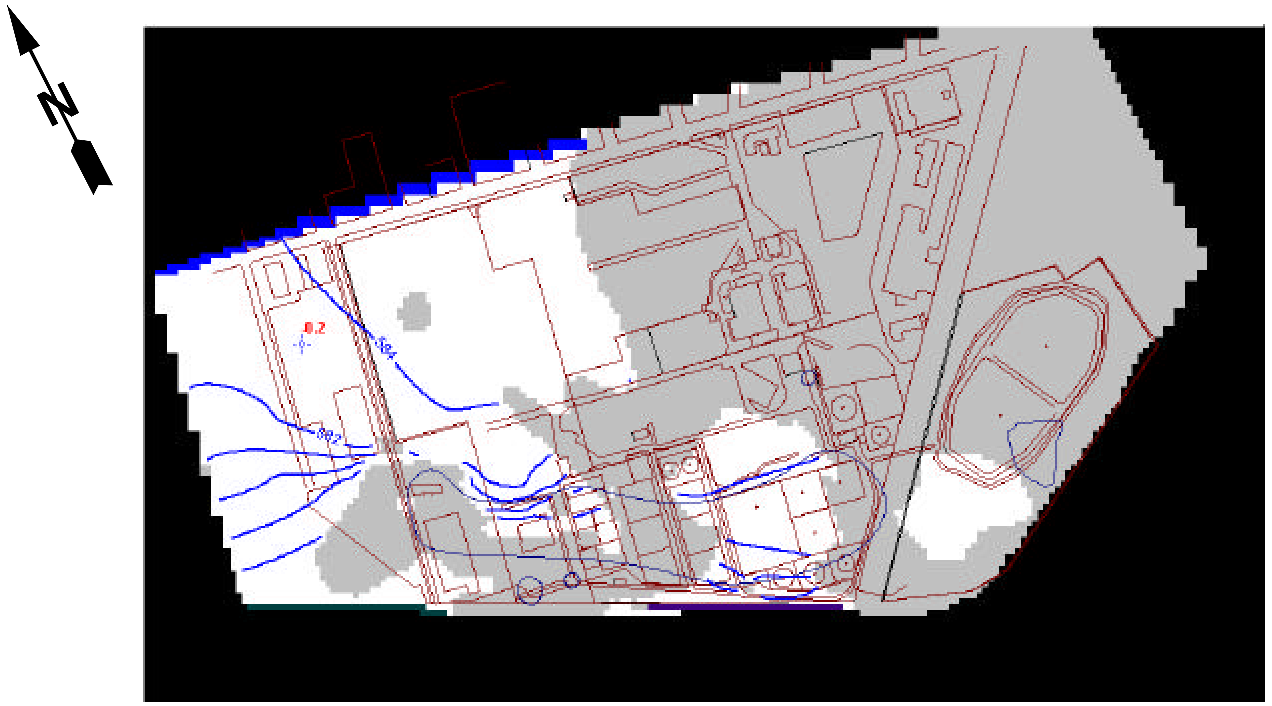
BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

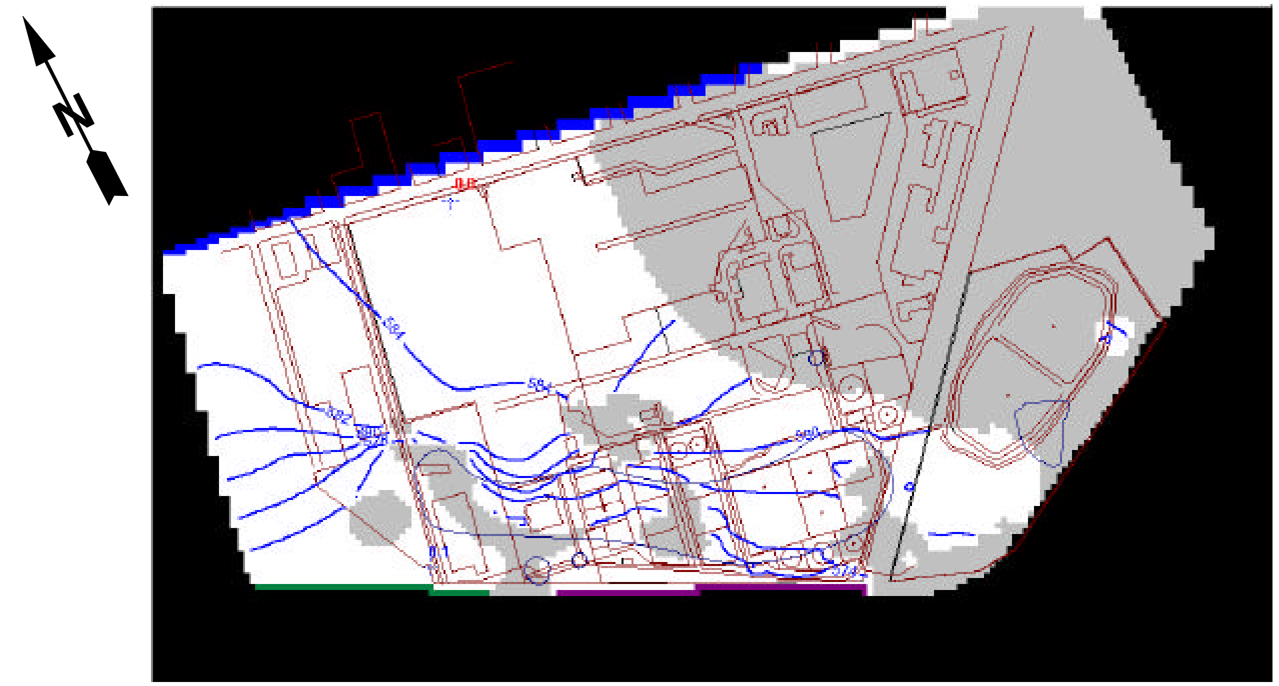
EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES INC
Environmental Consulting & Management

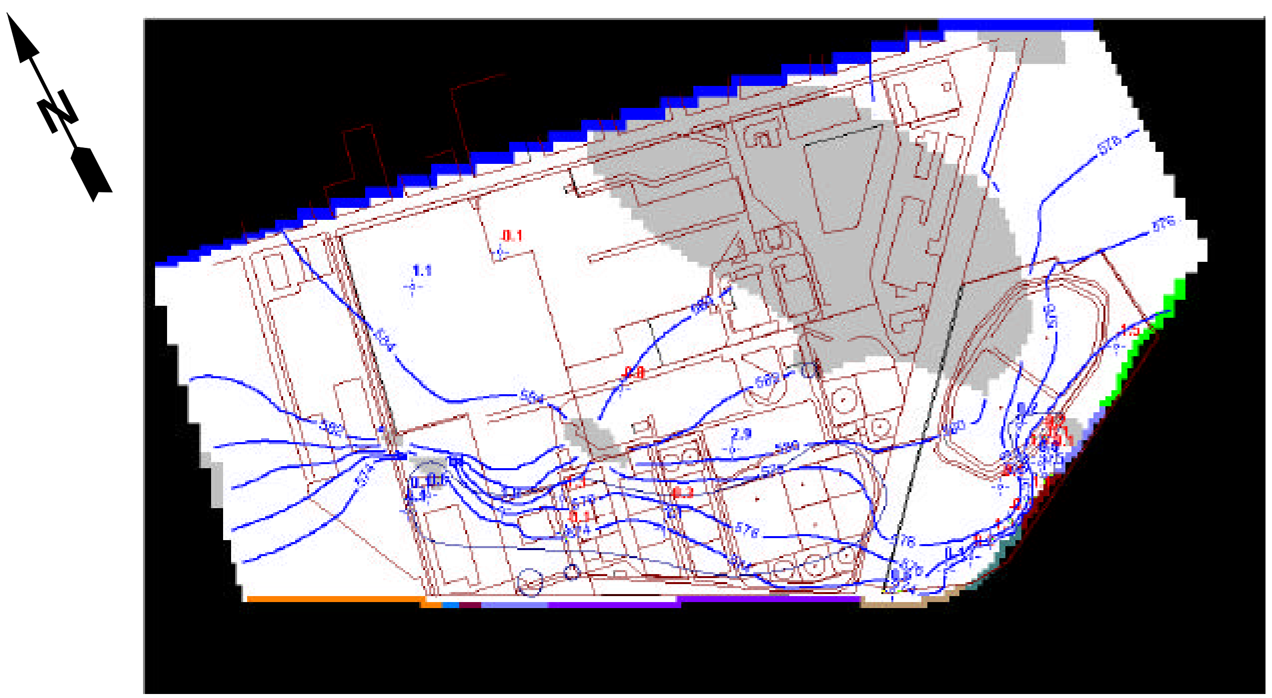
Compiled by: NE	Date: 3/20/03	FIGURE	
Prepared by: NE	Scale: 1"=650'	8	
Project Mgr: NC	Office: NY		
File No: MC5219706.PPT	Project: 17252Y05		



LAYER 1



LAYER 2



LAYER 3

LAYER 4

PORTION OF MODEL GRID WHERE CELLS ARE DRY

0.1 CALIBRATION RESIDUALS (FEET)
BLUE – MODELED HEADS BELOW TARGET HEADS
-0.1 RED – MODELED HEADS ABOVE TARGET HEADS

584 CONTOURS OF EQUAL MODELED HEAD (FT RMSL)

FT RMSL – FEET RELATIVE TO MEAN SEA LEVEL

Title:
MODFLOW MODEL CALIBRATED HYDRAULIC HEADS
BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:
EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES INC
Environmental Consulting & Management

Compiled by: NE	Date: 3/20/03	FIGURE
Prepared by: NE	Scale: 1"=650'	9
Project Mgr: NC	Office: NY	
File No: MC5219707.PPT	Project: 17252Y05	

Figure 10. MODFLOW Model Sensitivity Analysis of Hydraulic Conductivtity Zones

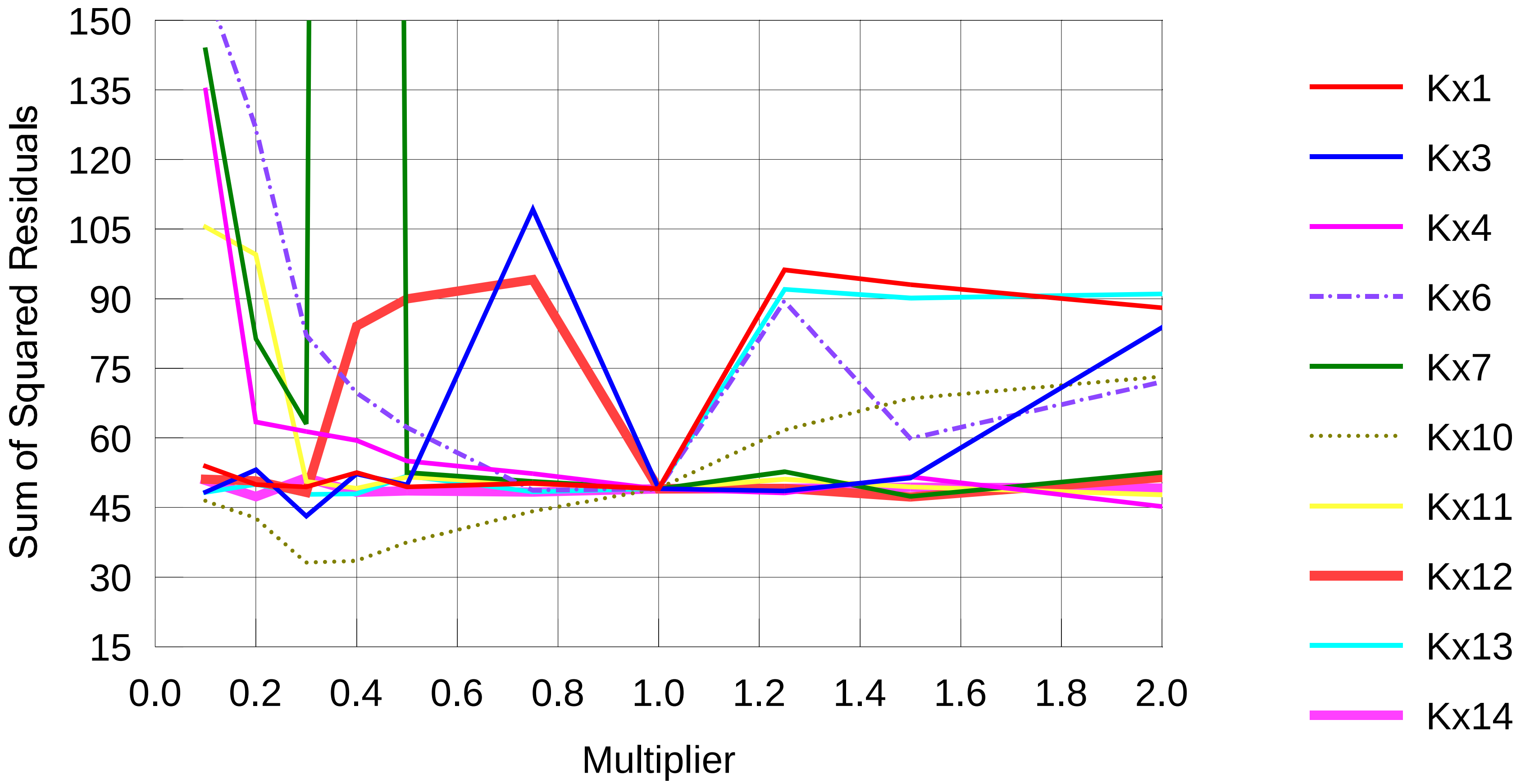


Figure 11. MODFLOW Model Sensitivity Analysis of River Conductance Zones

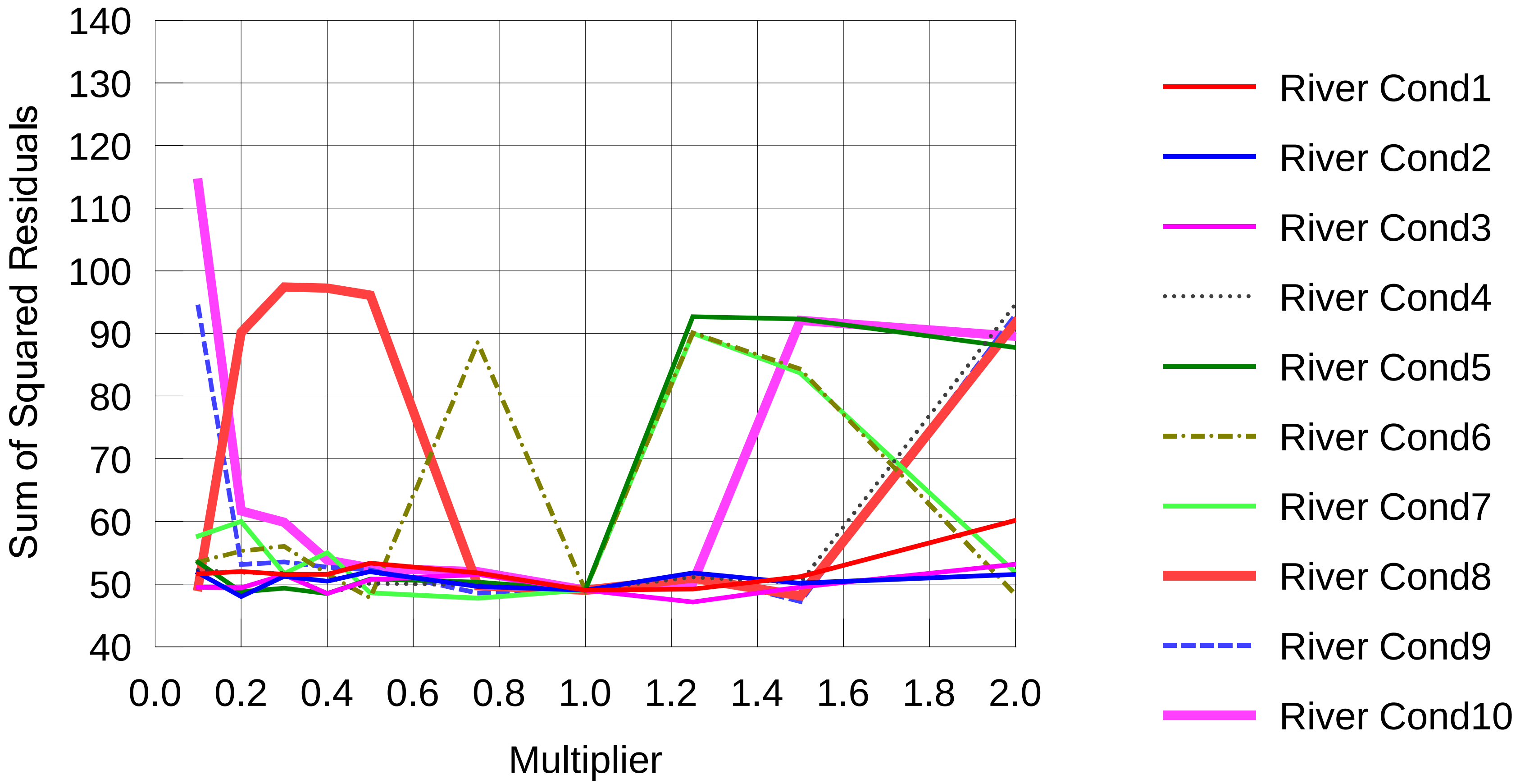
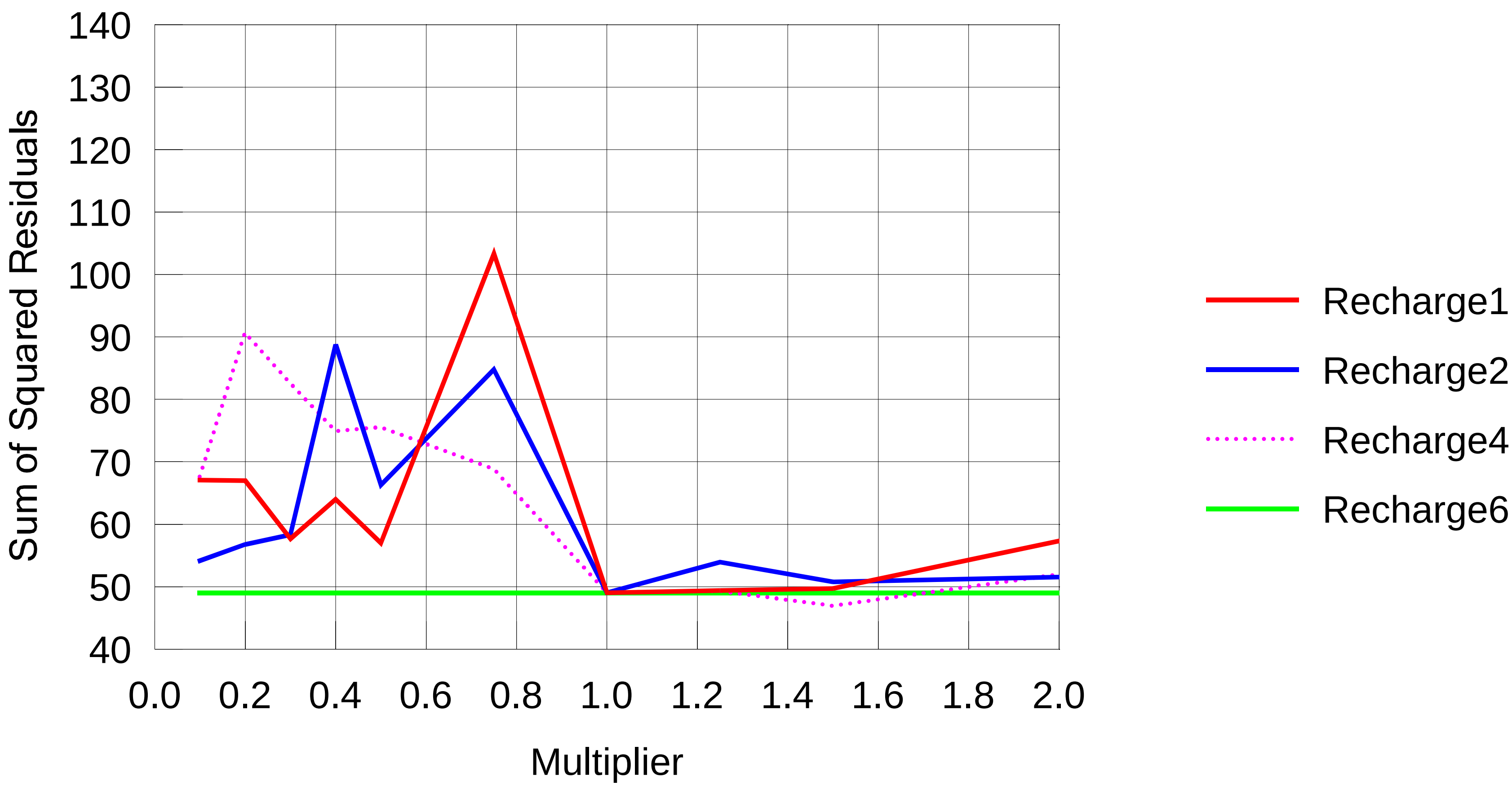
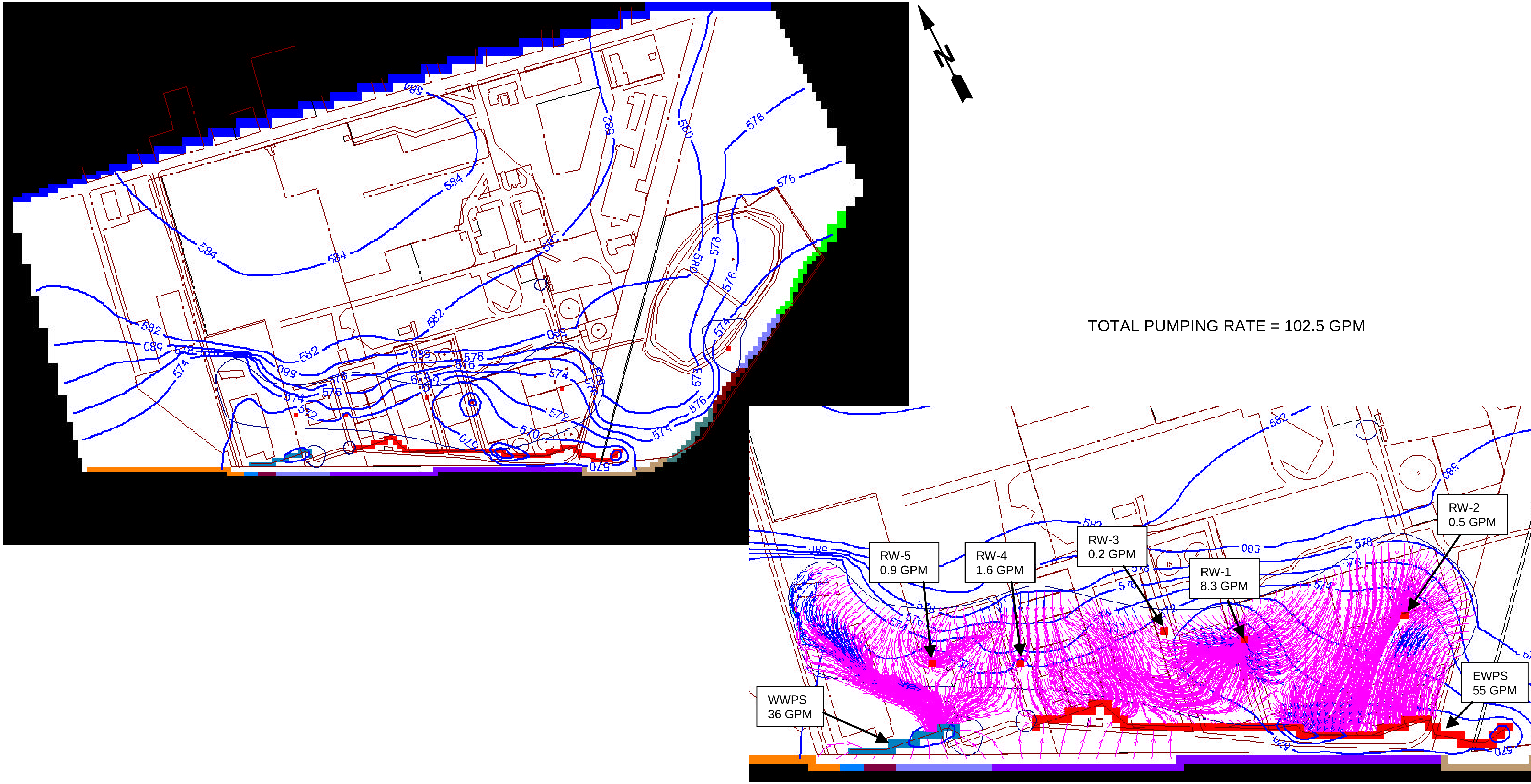


Figure 12. MODLFOW Model Sensitivity Analysis of Recharge Zones





PUMPING (RECOVERY) WELL CELL

PUMPING WELL CELLS FOR EWPS

PUMPING WELL CELLS FOR WWPS

MODPATH-GENERATED FLOWPATHS
ARROWS INDICATE DIRECTION OF FLOW

584 CONTOURS OF EQUAL MODELED HEAD (FT RMSL)

FT RMSL – FEET RELATIVE TO MEAN SEA LEVEL

Title:

SIMULATION 1:
CURRENT PUMPING CONDITIONS

BUFFALO TERMINAL, BUFFALO, NEW YORK

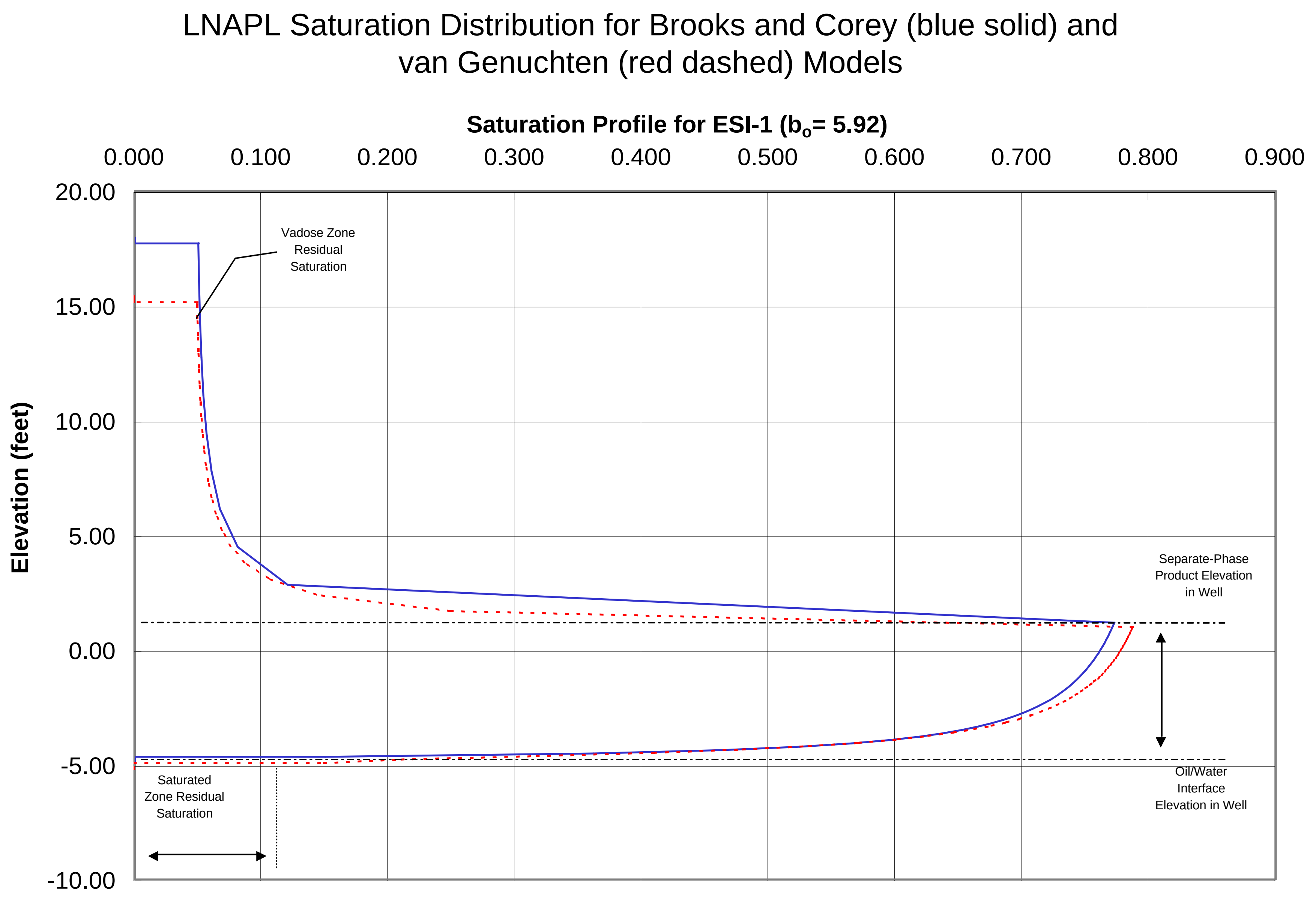
Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX ASSOCIATES INC
Environmental Consulting & Management

Compiled by: NE	Date: 3/20/03	FIGURE	
Prepared by: NE	Scale: 1"=650'	13	
Project Mgr: NC	Office: NY		
File No: MC5219708.PPT	Project: 17252Y05		

Figure 14. Typical Separate-Phase Product Saturation Distribution in the Subsurface, ExxonMobil, Buffalo Terminal, Buffalo, New York.



ROUX ASSOCIATES, INC.

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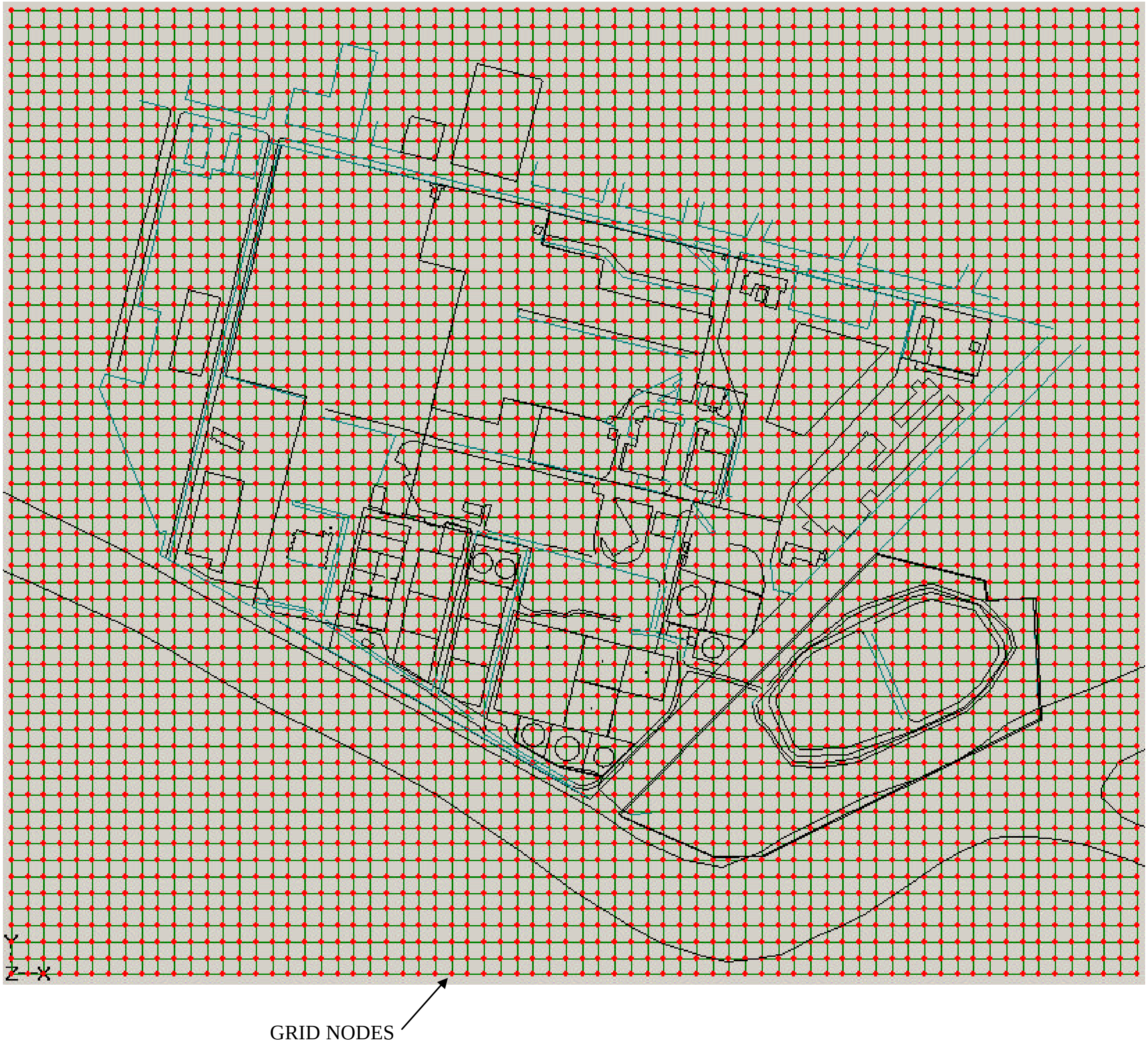


Title:

BIOSLURP MODEL GRID FOR THE MAIN PLUME MODEL

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

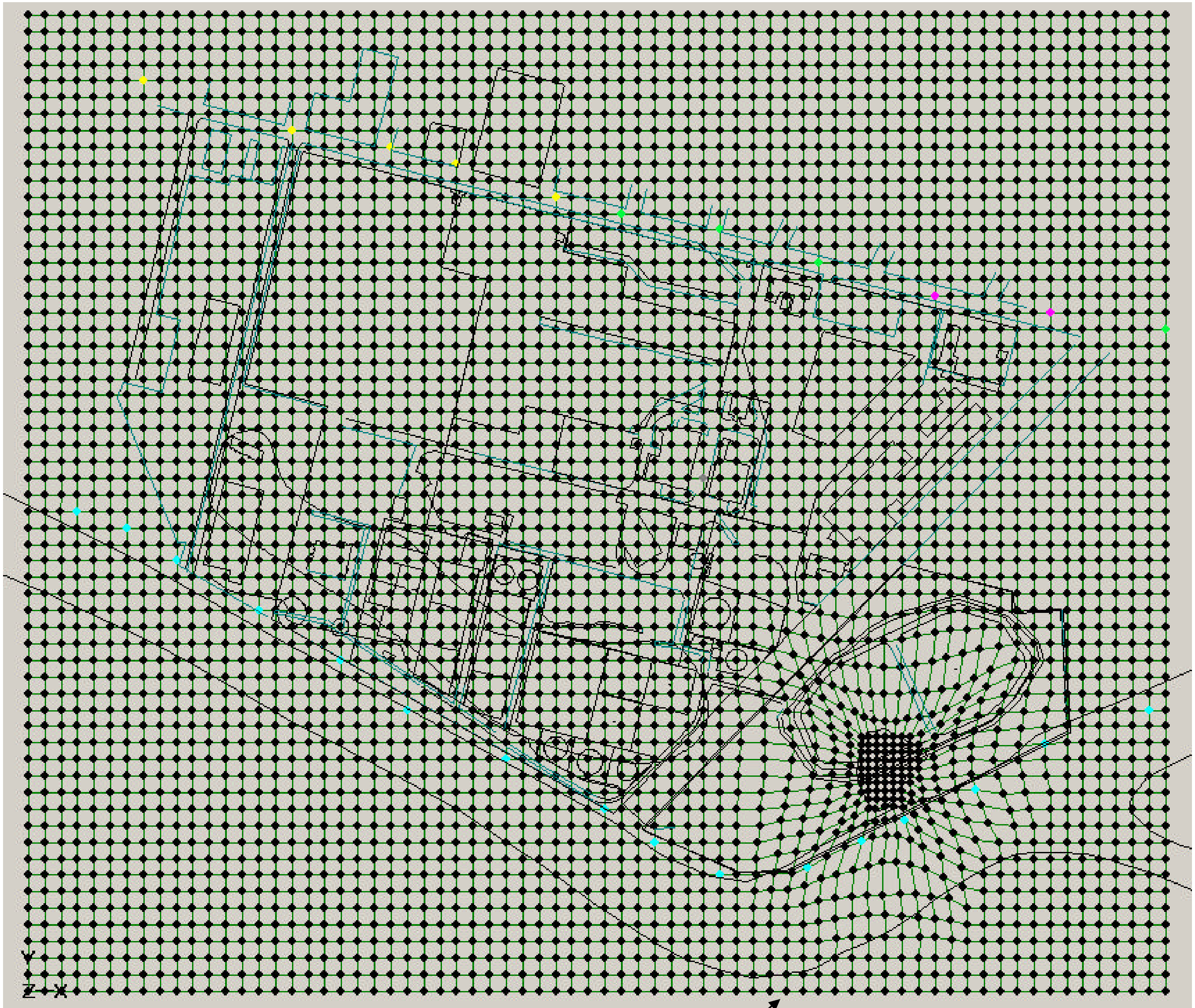
EXXONMOBIL OIL CORPORATION

N

ROUX

ROUX ASSOCIATES INC
Environmental Consulting & Management

Compiled by: S.S.	Date: 2/27/03	FIGURE
Prepared by: S.S.	Scale: NTS	15
Project Mgr: N.C.	Office: NY	
File No: MC5219722.PPT	Project: 17252Y05	



GRID NODES

TYPE I BOUNDARY CONDITIONS

Default	
River	
CH 584	
CH 585	
CH 586	
CH 583	

N

Title:

BIOSLURP MODEL GRID FOR THE ETYA PLUME

BUFFALO TERMINAL, BUFFALO, NEW YORK

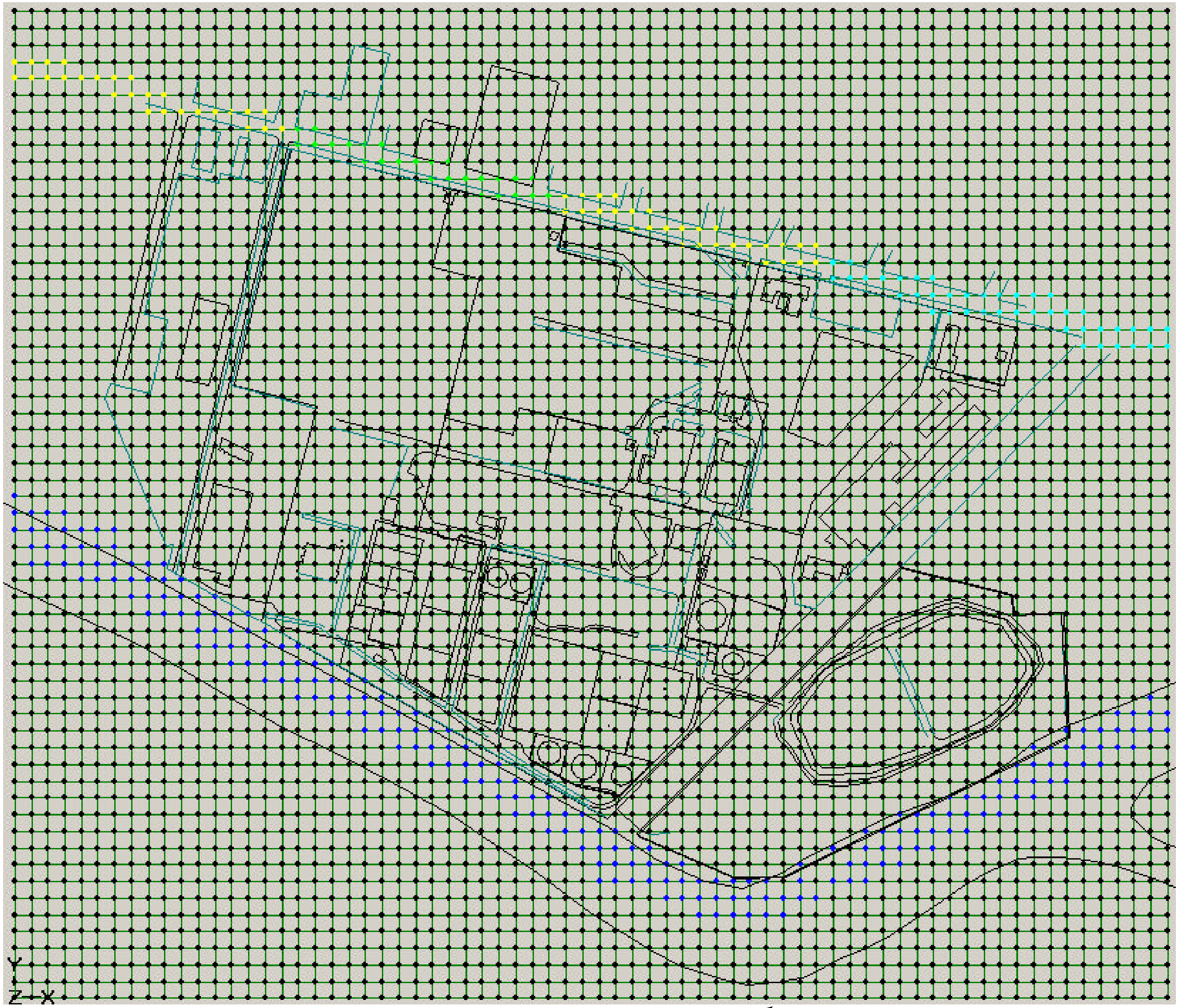
Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX

ROUX ASSOCIATES INC
Environmental Consulting & Management

Compiled by: S.S.	Date: 2/27/03	FIGURE
Prepared by: S.S.	Scale: NTS	16
Project Mgr: N.C.	Office: NY	
File No: MC5219721.PPT	Project: 17252Y05	



GRID NODES

TYPE I BOUNDARY CONDITIONS

Default	(black)
River	(blue)
CH 584	(yellow)
CH 585	(green)
CH 586	(red)
CH 583	(cyan)

N

Title: BIOSLURP DISTRIBUTION OF TYPE I BOUNDARY CONDITION FOR THE MAIN PLUME MODEL

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX			FIGURE
ROUX ASSOCIATES INC *Environmental Consulting & Management*	Compiled by: S.S.	Date: 2/27/03	17
	Prepared by: S.S.	Scale: NTS	
	Project Mgr: N.C.	Office: NY	
	File No: MC5219723.PPT	Project: 17252Y05	

HYDRAULIC CONDUCTIVITY ZONES

Loamy Sand	
Sand	
Sandy Loam	
Silt Loam	
Clay	
Gravel	

N

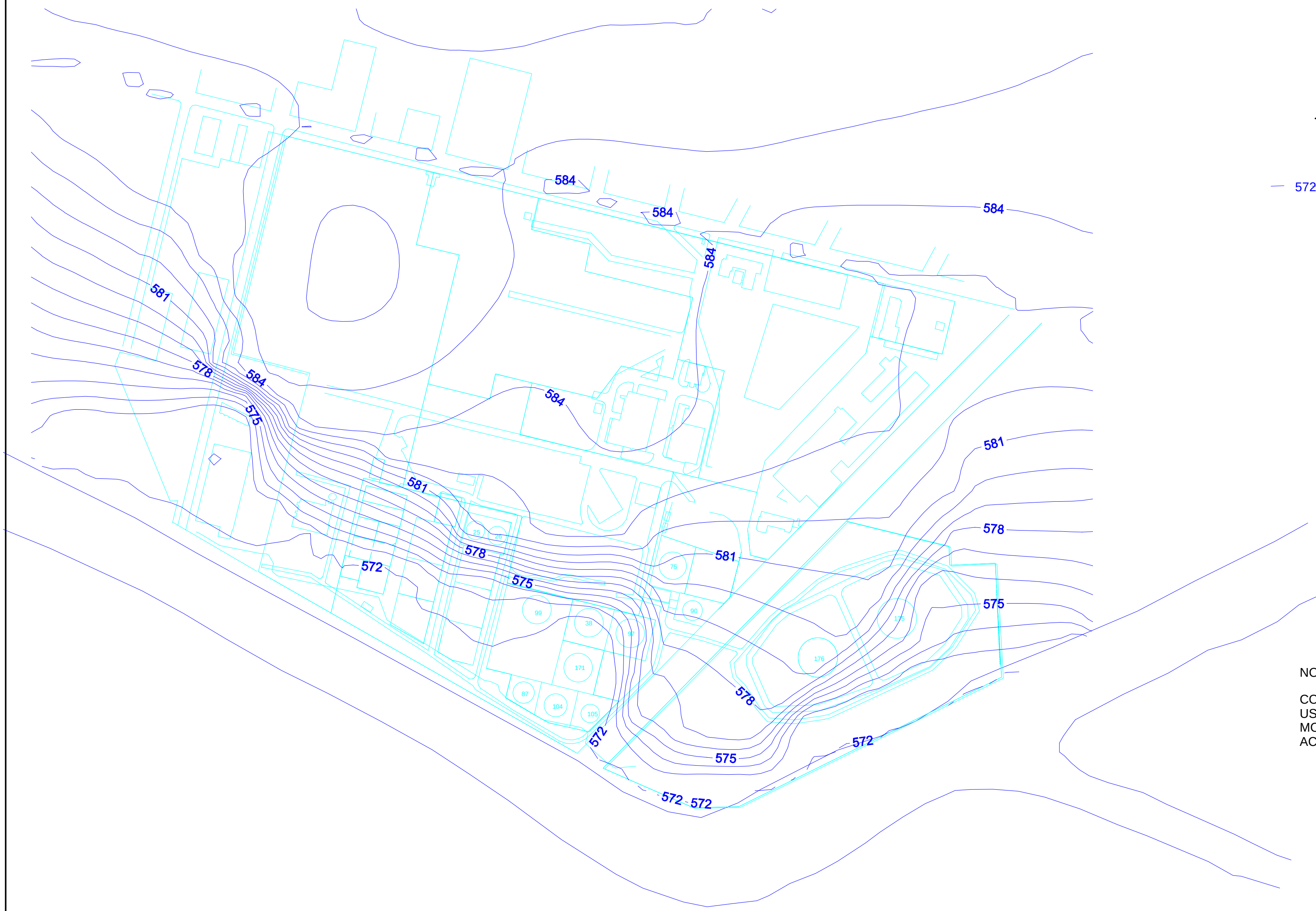
Title: DISTRIBUTION OF BIOSLURP HYDRAULIC CONDUCTIVITY ZONES

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX ASSOCIATES INC *Environmental Consulting & Management*	Compiled by: S.S.	Date: 2/27/03	FIGURE 18
	Prepared by: S.S.	Scale: NTS	
	Project Mgr: N.C.	Office: NY	
	File No: MC5219724.PPT	Project: 17252Y05	



EXPLANATION

572 LINE OF EQUAL GROUNDWATER ELEVATION IN FEET ABOVE SEA LEVEL

NOTE:

CONTOUR LINES GENERATED BY SURFER; USED ONLY FOR COMPARISON BETWEEN MODEL-GENERATED DATA AND ACTUAL MEASURED DATA.

SCALE IN FEET

0 500 1000

N

Title :

MODEL-SIMULATED GROUNDWATER ELEVATIONS

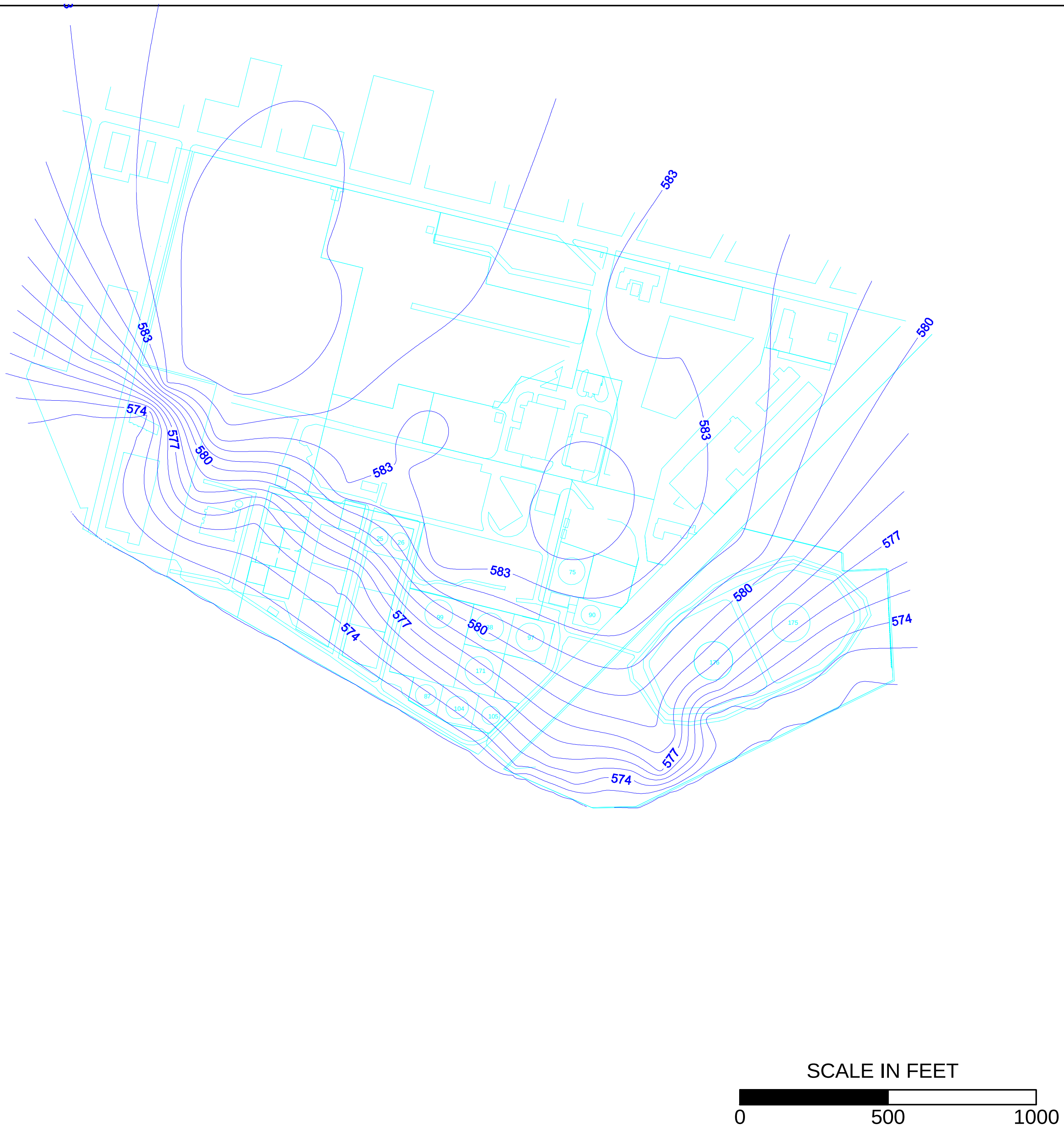
BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For :

EXXONMOBIL OIL CORPORATION

ROUX ASSOCIATES INC
Environmental Consulting & Management

Compiled By : S.S.	Date : 2/27/03	FIGURE
Prepared By : S.S.	Scale : AS SHOWN	19
Project Manager : N.C.	Office: NY	
File Name : MC5219728.SRF	Project : 17252Y05	



EXPLANATION

572 LINE OF EQUAL GROUNDWATER ELEVATION IN FEET ABOVE SEA LEVEL

NOTE:

CONTOUR LINES GENERATED BY SURFER; USED ONLY FOR COMPARISON BETWEEN MODEL-GENERATED DATA AND ACTUAL MEASURED DATA.

Title :

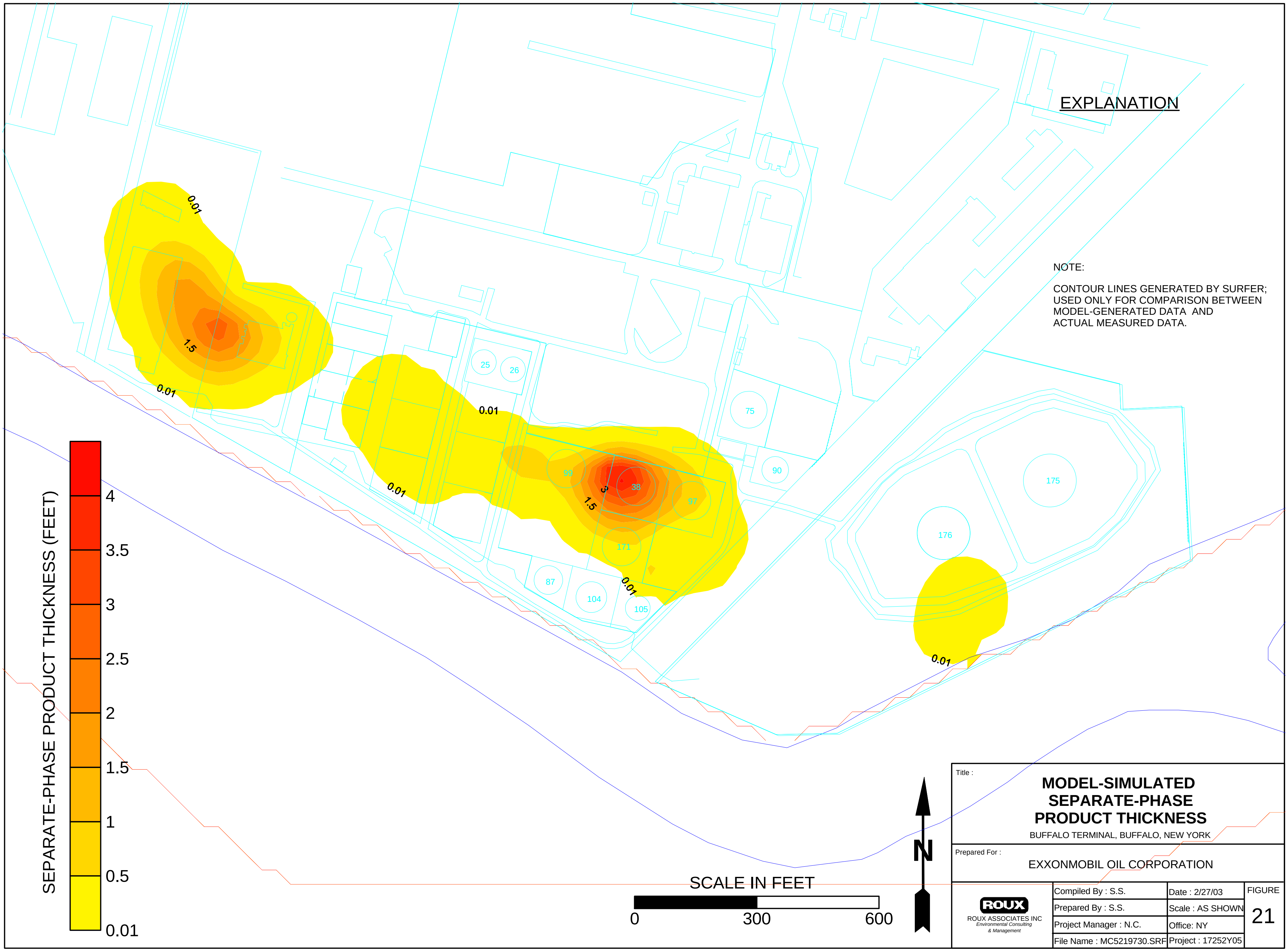
OBSERVED GROUNDWATER ELEVATIONS

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For :

EXXONMOBIL OIL CORPORATION

ROUX ASSOCIATES INC *Environmental Consulting & Management*	Compiled By : S.S.	Date : 2/27/03	FIGURE
	Prepared By : S.S.	Scale : AS SHOWN	20
	Project Manager : N.C.	Office: NY	
	File Name : MC5219729.SRF	Project : 17252Y05	



Title :

MODEL-SIMULATED SEPARATE-PHASE PRODUCT THICKNESS

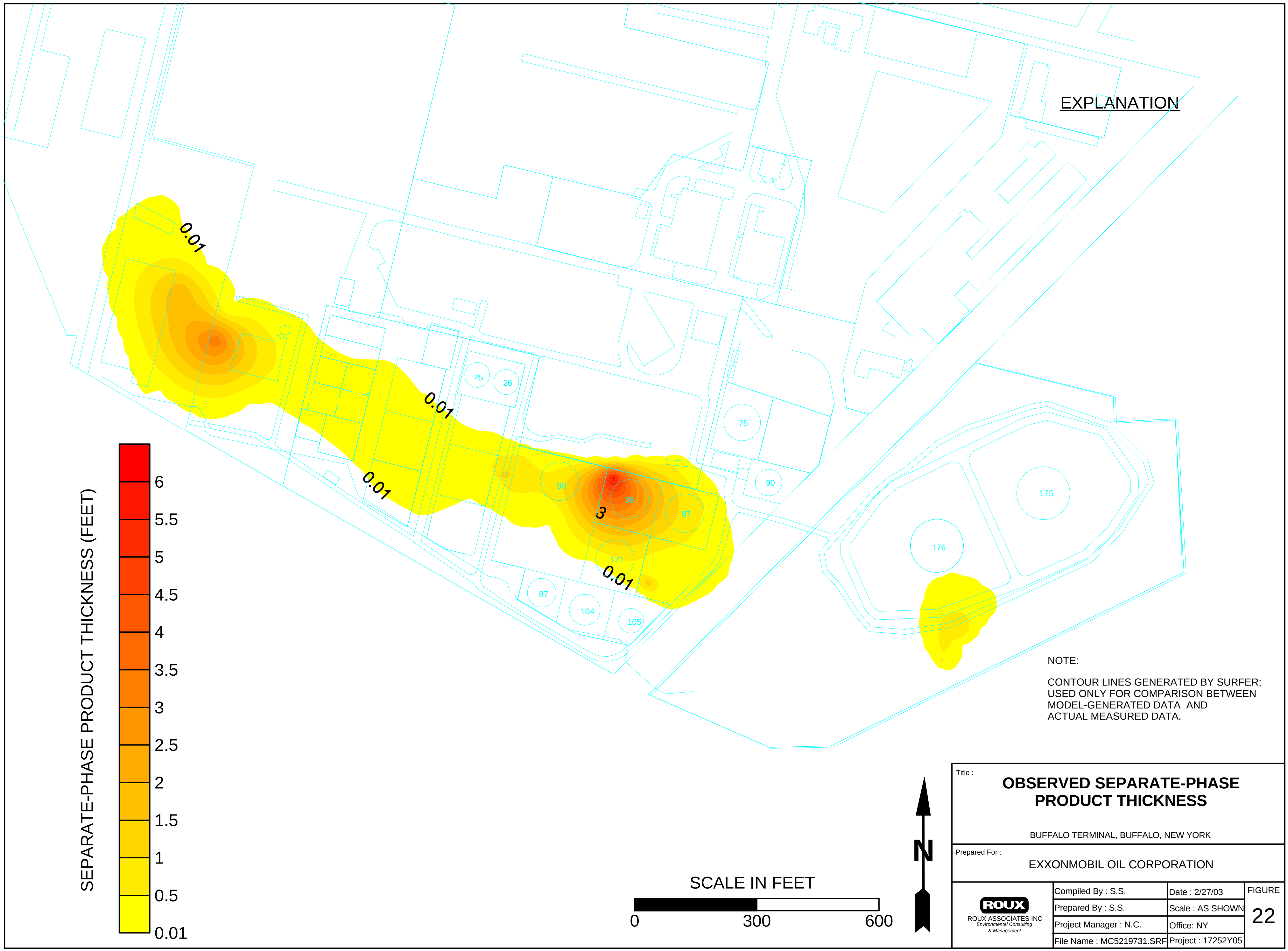
BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For :

EXXONMOBIL OIL CORPORATION

ROUX ASSOCIATES INC
Environmental Consulting & Management

Compiled By : S.S.	Date : 2/27/03	FIGURE
Prepared By : S.S.	Scale : AS SHOWN	21
Project Manager : N.C.	Office: NY	
File Name : MC5219730.SRF	Project : 17252Y05	



NOTE:

CONTOUR LINES GENERATED BY SURFER; USED ONLY FOR COMPARISON BETWEEN MODEL-GENERATED DATA AND ACTUAL MEASURED DATA.

Title :

OBSERVED SEPARATE-PHASE PRODUCT THICKNESS

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For :

EXXONMOBIL OIL CORPORATION

ROUX ROUX ASSOCIATES INC Environmental Consulting & Management	Compiled By : S.S.	Date : 2/27/03	FIGURE
	Prepared By : S.S.	Scale : AS SHOWN	22
	Project Manager : N.C.	Office: NY	
	File Name : MC5219731.SRF	Project : 17252Y05	

APPENDIX A

Geologic logs

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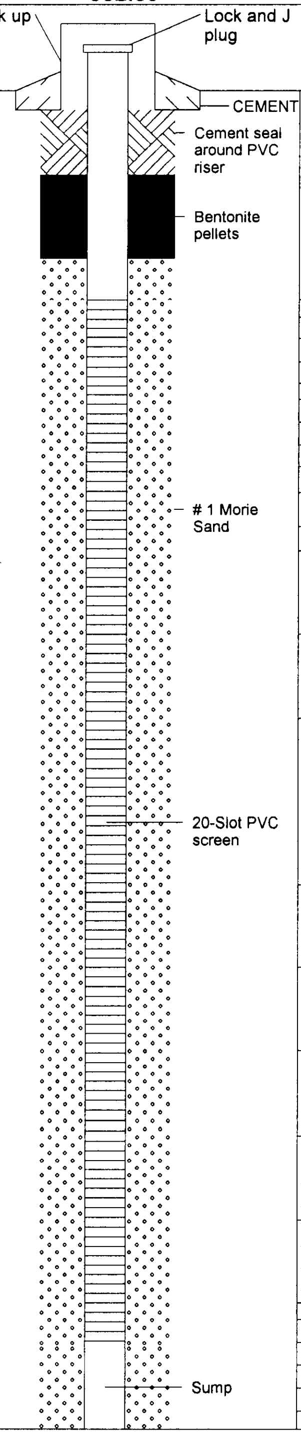
Environmental Consulting & Management
1377 Motor Parkway
Islandia, NY 11749
Telephone: 631-232-2600
Fax: 631-232-9898

WELL CONSTRUCTION LOG

WELL NO. **MW-40**	NORTHING **1042934.96**	EASTING **1080957.24**		
PROJECT NO./NAME **17252Y04 / ExxonMobil Buffalo Terminal**		LOCATION **625 Elk Street Buffalo, New York**		
APPROVED BY **S. Senh**	LOGGED BY **M. Falzone**			
DRILLING CONTRACTOR/DRILLER **SJB / SJB**		GEOGRAPHIC AREA **STYA**		
DRILL BIT DIAMETER/TYPE **6.25-in. / Auger**	BOREHOLE DIAMETER **10.25-inches**	DRILLING EQUIPMENT/METHOD **/ HSA**	SAMPLING METHOD **2" Split Spoon**	START-FINISH DATE **5/20/02-5/20/02**
CASING MAT./DIA. **PVC / 4-inch**	SCREEN: TYPE **Slotted** MAT. **PVC**	TOTAL LENGTH **25.0**	DIA. **4-inch**	SLOT SIZE **20-Slot**
ELEVATION OF: (FT.) GROUND SURFACE **582.89**	TOP OF WELL CASING **585.56**	TOP & BOTTOM SCREEN **577.9 / 552.9**	GW SURFACE **571.25**	GRAVEL PACK **Morie #1**



Depth, feet	Visual Description	Blow Counts per 6"	REMARKS
0–5			Hand cleared
5–7	Red brown CLAY, with little Silt; Wet	3, 2, 2, 3	70% Recovery
7–9	Olive gray to gray SILT and CLAY, some fine Sand; Wet	1, 3, 2, 2	80% Recovery
9–11	Olive gray fine to medium SAND, with some Clay, little fine to medium subrounded Gravel: Wet	4, 5, 8, 7	70% Recovery Presence of separate-phase product noted
11–13	Olive gray fine to coarse SAND, some fine to medium subrounded Gravel; Wet		70% Recovery
13–15			90% Recovery; Shelby tube collected
15–19	Olive gray medium to coarse SAND, with some fine subrounded Gravel, little fine Sand; Wet		90% Recovery 90% Recovery
19–21	Olive gray to gray medium to coarse SAND, with some fine Gravel and trace of fine Sand; Wet		60% Recovery
21–23	Olive gray medium to coarse SAND, some fine to medium Gravel; Wet	7, 10, 12, 14	70% Recovery
23–25	Olive gray medium to coarse SAND, some fine to medium Gravel, trace of coarse Gravel; Wet	6, 7, 10, 10	70% Recovery
25–27	Olive gray medium to coarse SAND, with little fine Gravel, little Silt and Clay, trace of medium Gravel; Wet	5, 6, 10, 15	70% Recovery
27–29	Olive gray to gray medium to coarse SAND, with some fine Gravel, trace of medium to coarse Gravel; Wet	22, 20, 8, 8	70% Recover; clay in shoe
29–32	Red brown soft CLAY; Wet	13, 8, 1, 1, 2, 3	100% Recovery 100% Recovery Bottom of well at 32 ft bls

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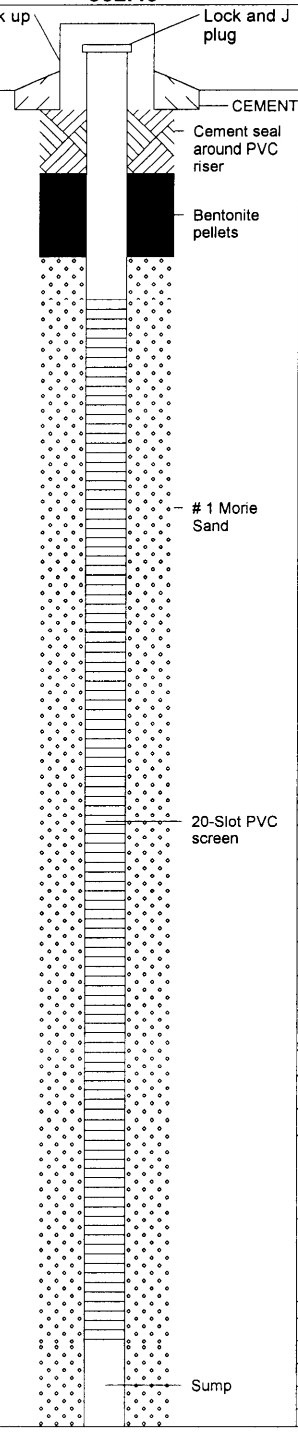
Islandia, NY 11749
Telephone: 631-232-2600
Fax: 631-232-9898

WELL CONSTRUCTION LOG

WELL NO.	MW-41
NORTHING	1042972.35
EASTING	1080940.47
PROJECT NO./NAME	17252Y04 / ExxonMobil Buffalo Terminal
LOCATION	625 Elk Street, Buffalo, New York
APPROVED BY	S. Senh
LOGGED BY	M. Falzone
DRILLING CONTRACTOR/DRILLER	SJB / SJB
GEOGRAPHIC AREA	STYA
DRILL BIT DIAMETER/TYPE	6.25-in. / Auger
BOREHOLE DIAMETER	10.25-inches
DRILLING EQUIPMENT/METHOD	/ HSA
SAMPLING METHOD	2" Split Spoon
START-FINISH DATE	5/20/02-5/20/02
CASING MAT./DIA.	PVC / 4-inch
SCREEN: TYPE	Slotted
MAT.	PVC
TOTAL LENGTH	25.0
DIA.	4-inch
SLOT SIZE	20-Slot
ELEVATION OF: (FT.) GROUND SURFACE	582.45
TOP OF WELL CASING	585.31
TOP & BOTTOM SCREEN	577.5 / 552.5
GW SURFACE	569.64
GRAVEL PACK	Morie #1



Depth, feet	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
0–5				Hand cleared
5	Olive gray CLAY and SILT, with little fine Sand, trace of Gravel; Wet	2, 4, 4, 5		5% Recovery
	Olive gray CLAY and SILT, grading to fine to medium Sand, with little fine subrounded Gravel; Wet	4, 4, 7, 9		60% Recovery
10	Black fine to medium SAND, with some Clay, little Silt and trace of fine subrounded Gravel; Wet	4, 3, 3, 3		70% Recovery Black staining noted
	Black fine to medium SAND, little Clay, little Silt, trace of subrounded Gravel; Wet	3, 5, 6, 6		70% Recovery Black staining noted
	Olive gray fine to medium SAND, little Silt, trace of Clay and fine subrounded Gravel; Wet	3, 3, 6, 7		70% Recovery
15		3, 3, 6, 8		70% Recovery
	Olive gray fine to medium SAND, little Silt, trace of Clay and trace of fine subrounded Gravel; Wet	5, 6, 7, 6		
20	Olive gray fine to coarse SAND, trace of Clay, some fine subrounded Gravel; Wet	4, 6, 5, 7		70% Recovery
		3, 4, 4, 3		
	Olive gray fine to medium SAND, little Clay, little fine subrounded Gravel; Wet	2, 2, 1, 3		70% Recovery
25	Olive gray fine to medium SAND, little fine subrounded Gravel; Wet	2, 3, 2, 6		70% Recovery
	Olive gray fine to coarse SAND, some fine subrounded Gravel, grading to Clay; Wet	4, 5, 6, 4		80% Recovery
30	Red brown CLAY; Wet			Bottom of well at 32 ft bls

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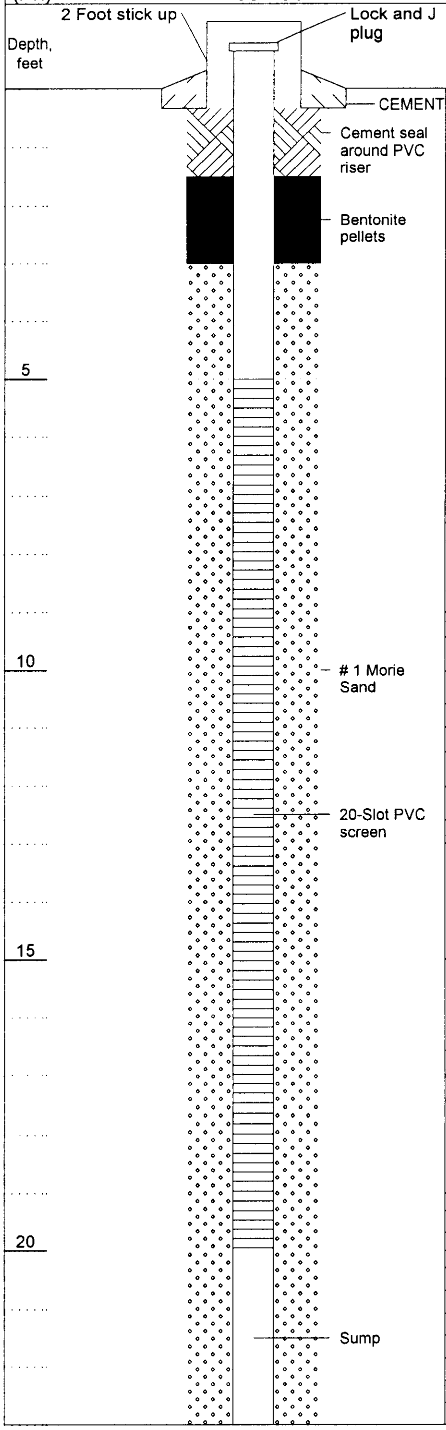
Fax: 631-232-9898

WELL CONSTRUCTION LOG

WELL NO. MW-42	NORTHING 1042785.46	EASTING 1081562.41		
PROJECT NO./NAME 17252Y04 / ExxonMobil Buffalo Terminal		LOCATION 625 Elk Street Buffalo, New York		
APPROVED BY S. Senh	LOGGED BY M. Falzone			
DRILLING CONTRACTOR/DRILLER SJB / SJB		GEOGRAPHIC AREA STYA		
DRILL BIT DIAMETER/TYPE 6.25-in. / Auger	BOREHOLE DIAMETER 10.25-inches	DRILLING EQUIPMENT/METHOD / HSA	SAMPLING METHOD 3" Split Spoon	START-FINISH DATE 5/17/02-5/17/02
CASING MAT./DIA. PVC / 4-inch	SCREEN: TYPE Slotted MAT. PVC	TOTAL LENGTH 15.0	DIA. 4-inch	SLOT SIZE 20-Slot
ELEVATION OF: (FT.) GROUND SURFACE 582.85	TOP OF WELL CASING 585.62	TOP & BOTTOM SCREEN 577.9 / 562.9	GW SURFACE 580.34	GRAVEL PACK Morie #1



Depth, feet	Graphic Log	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
					Hand cleared
5		Olive gray fine SAND and SILT, some soft Clay	2 1 2 2		60% Recovery
		Olive gray fine SAND and SILT, some soft Clay; Wet	2 2 2 1		60% Recovery
10		Olive gray SILT and CLAY, with black organic matter, little fine Sand and trace of medium Sand; Wet	1 2 2 1		60% Recovery
		Olive gray SILT and Clay, with some fine Sand; Wet	3 2 3 3		60% Recovery
		Olive gray fine to medium SAND, with little Silt and Clay; Wet			Collected for sieve analysis
15		Shelby tube collected			90% Recovery Shelby tube collected
		Olive gray to gray fine to medium SAND, little coarse Sand, little fine subrounded Gravel, trace of Silt; Wet	6 3 14 15		75% Recovery Presence of separate-phase product noted
20		Olive gray to gray fine to medium SAND, little coarse Sand, little fine subrounded Gravel, trace of Silt; Wet Red brown CLAY, trace of Silt; Wet	5 9 9 5 3 5 4 5		90% Recovery Bottom of well at 23 ft bls

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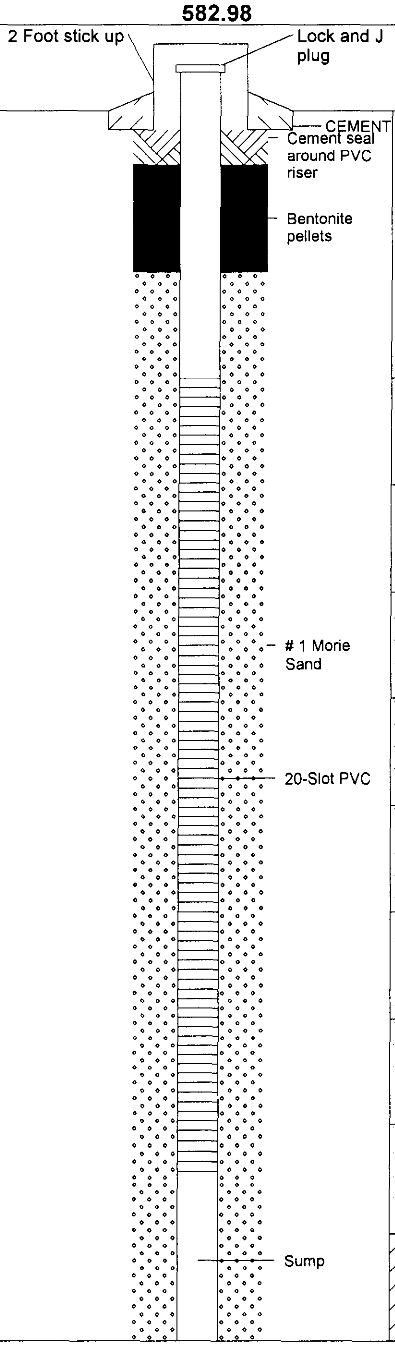
WELL CONSTRUCTION LOG

WELL NO. **MW-43**	NORTHING **1042777.42**	EASTING **1081590.2**		
PROJECT NO./NAME **17252Y04 / ExxonMobil Buffalo Terminal**		LOCATION **625 Elk Street Buffalo, New York**		
APPROVED BY **S. Senh**	LOGGED BY **M. Falzone**			
DRILLING CONTRACTOR/DRILLER **SJB / SJB**		GEOGRAPHIC AREA **STYA**		
DRILL BIT DIAMETER/TYPE **6.25-in. / Auger**	BOREHOLE DIAMETER **10.25-inches**	DRILLING EQUIPMENT/METHOD **/ HSA**	SAMPLING METHOD **2" Split Spoon**	START-FINISH DATE **-**
CASING MAT./DIA. **PVC / 4-inch**	SCREEN: TYPE **Slotted**	MAT. **PVC**	TOTAL LENGTH **15.0** DIA. **4-inch**	SLOT SIZE **20-Slot**
ELEVATION OF: (FT.) GROUND SURFACE **582.98**	TOP OF WELL CASING **585.49**	TOP & BOTTOM SCREEN **578.0 / 563.0**	GW SURFACE **571.47**	GRAVEL PACK **Morie #1**



Depth, feet	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
0–5				Hand cleared
5–7	No Recovery	0, 0, 0, 1		
7–9	No Recovery	0, 0, 0, 1		
9–11	Olive gray fine SAND, some Silt and Clay; Wet	2, 1, 1, 1		25% Recovery
11–13	Olive gray fine SAND, little Silt and Clay, trace medium Sand; Wet	1, 3, 2, 3		50% Recovery
13–15	Olive gray fine SAND, trace Silt and Clay, trace medium Sand (lenses); Wet	1, 2, 1, 2		50% Recovery
15–17	Olive gray fine SAND, trace Silt and Clay, trace medium Sand (lenses); Wet	1, 2, 1, 6		70% Recovery
17–19	Olive gray fine SAND, trace Silt and Clay, trace medium Sand; Wet	10, 12, 8, 13		90% Recovery
19–21	Olive gray fine SAND, trace Silt and Clay, trace medium Sand grading to red brown Clay; Wet	9, 7, 8, 6		90% Recovery
21–23	Red brown CLAY	5, 6, 8, 10		10% Recovery

Bottom of well at 23 ft bls

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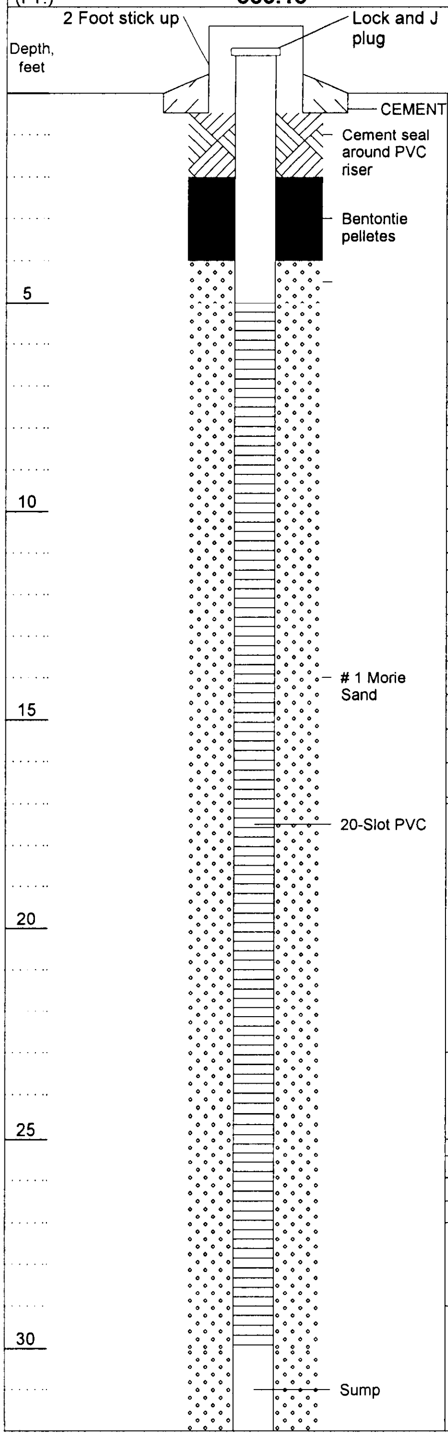
WELL CONSTRUCTION LOG

WELL NO. **MW-44**	NORTHING **1042759.82**	EASTING **1081160.82**		
PROJECT NO./NAME **17252Y04 / ExxonMobil Buffalo Terminal**		LOCATION **625 Elk Street Buffalo, New York**		
APPROVED BY **S. Senh**	LOGGED BY **M. Falzone**			
DRILLING CONTRACTOR/DRILLER **SJB / SJB**		GEOGRAPHIC AREA **STYA**		
DRILL BIT DIAMETER/TYPE **6.25-in. / Auger**	BOREHOLE DIAMETER **10.25-inches**	DRILLING EQUIPMENT/METHOD **/ HSA**	SAMPLING METHOD **2" Split Spoon**	START-FINISH DATE **5/21/02-5/21/02**
CASING MAT./DIA. **PVC / 2-inch**	SCREEN: TYPE **Slotted** MAT. **PVC**	TOTAL LENGTH **25.0**	DIA. **2-inch**	SLOT SIZE **20-Slot**
ELEVATION OF: (FT.) GROUND SURFACE **583.15**	TOP OF WELL CASING **586.15**	TOP & BOTTOM SCREEN **578.2 / 553.2**	GW SURFACE **571.08**	GRAVEL PACK **Morie #1**



Depth, feet	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
0–5				Hand cleared
5–7	Olive gray CLAY and SILT, little fine Sand; Moist	0, 0, 0, 2		25% Recovery
7–9	Olive gray CLAY and SILT, little fine Sand; Moist	0, 0, 0, 0		60% Recovery
9–11	Olive gray CLAY and SILT, ash, little fine Sand; Moist	5, 2, 2, 1		
11–13	Olive gray CLAY and SILT, little fine Sand, trace of Gravel; Wet	1, 1, 1, 1		10% Recovery
13–15	Black SILT and CLAY, with some fine to coarse Gravel and ash; Wet	0, 0, 1, 1		40% Recovery; Presence of separate-phase product noted Black staining noted
15–17		3, 2, 4, 3		40% Recovery; Presence of separate-phase product noted
17–19	Black medium to coarse SAND and fine to medium Gravel; Wet	1, 2, 5, 3		25% Recovery Black staining noted
19–21		8, 4, 4, 12		60% Recovery; Presence of separate-phase product noted
21–23		2, 4, 5, 7		70% Recovery
23–25	Olive gray fine to medium SAND, with some fine subrounded Gravel	6, 10, 15, 12		40% Recovery
25–27	Red brown soft CLAY; Wet	4, 5, 1, 1		5% Recovery; clay only in shoe
27–29	Not sampled			
32				Bottom of well at 32 ft bls

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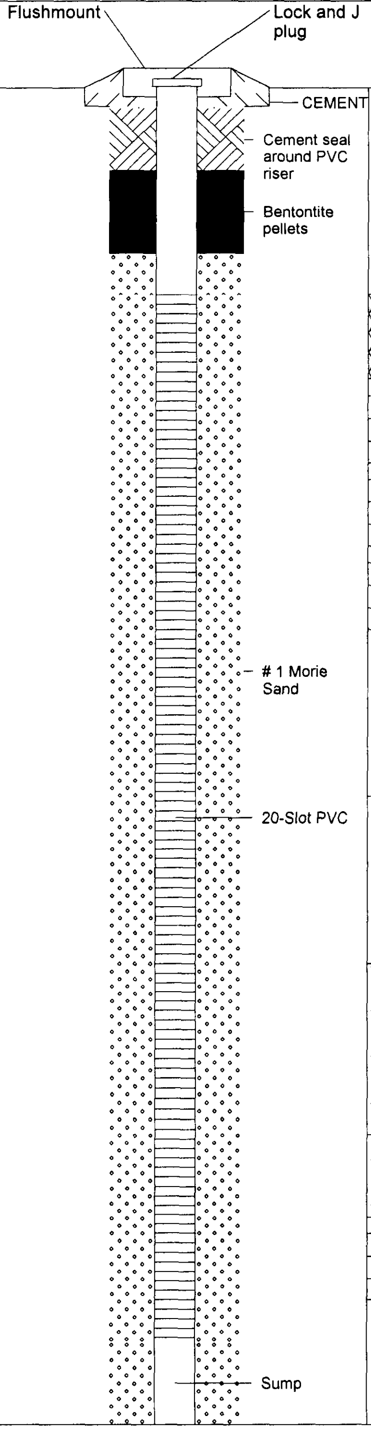
WELL CONSTRUCTION LOG

WELL NO.	NORTHING	EASTING		
MW-45	**1042898.93**	**1080945.56**		
PROJECT NO./NAME		LOCATION		
17252Y04 / ExxonMobil Buffalo Terminal		**625 Elk Street**		
APPROVED BY	LOGGED BY			
S. Senh	**M. Falzone**	**Buffalo, New York**		
DRILLING CONTRACTOR/DRILLER		GEOGRAPHIC AREA		
SJB / SJB		**STYA**		
DRILL BIT DIAMETER/TYPE	BOREHOLE DIAMETER	DRILLING EQUIPMENT/METHOD	SAMPLING METHOD	START-FINISH DATE
6.25-in. / Auger	**10.25-inches**	**/ HSA**	**2" Split Spoon**	**5/21/02-5/21/02**
CASING MAT./DIA.	SCREEN: TYPE **Slotted**	MAT. **PVC**	TOTAL LENGTH **25.0** DIA. **2-inch**	SLOT SIZE **20-Slot**
PVC / 2-inch				

ELEVATION OF: (FT.)	GROUND SURFACE	TOP OF WELL CASING	TOP & BOTTOM SCREEN	GW SURFACE	GRAVEL PACK
	583.48	**583.01**	**578.5 / 553.5**	**570.04**	**Morie #1**



Depth, feet	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
0–5				Hand cleared
5–7	FILL- Fine to coarse SAND, brick, Gravel; Moist	1, 2, 4, 5		50% Recovery; Black staining noted
7–9	Red brown CLAY, with lenses of fine Sand and Silt; Moist	2, 4, 3, 2		70% Recovery
9–11	Medium brown CLAY, medium soft, little Silt; Moist/Wet	0, 0, 0, 2		
11–13	Red brown CLAY, medium soft, trace of Silt, grading to olive gray fine to medium Sand, with little fine subrounded Gravel; Wet	2, 3, 5, 5		90% Recovery
13–17	Olive gray to dark gray, fine to medium SAND, with little fine subrounded Gravel, trace of Silt and Clay; Wet	1, 3, 4, 4, 3, 2, 3, 2		75% Recovery; 70% Recovery
17–21	Olive gray to dark gray fine to medium SAND, some fine subrounded Gravel; Wet	2, 2, 4, 6		70% Recovery Presence of separate-phase product noted
21–25	Olive gray fine to medium coarse SAND, with some fine subrounded Gravel; Wet	6, 8, 7, 10, 4, 6, 7, 11		50% Recovery Presence of separate-phase product noted; 25% Recovery
25–27	Olive gray medium to coarse SAND, little fine Sand, some fine subrounded Gravel; Wet			90% Recovery
27–29	Red brown medium stiff CLAY; Wet			90% Recovery
29–32				Bottom of well at 32 ft bls

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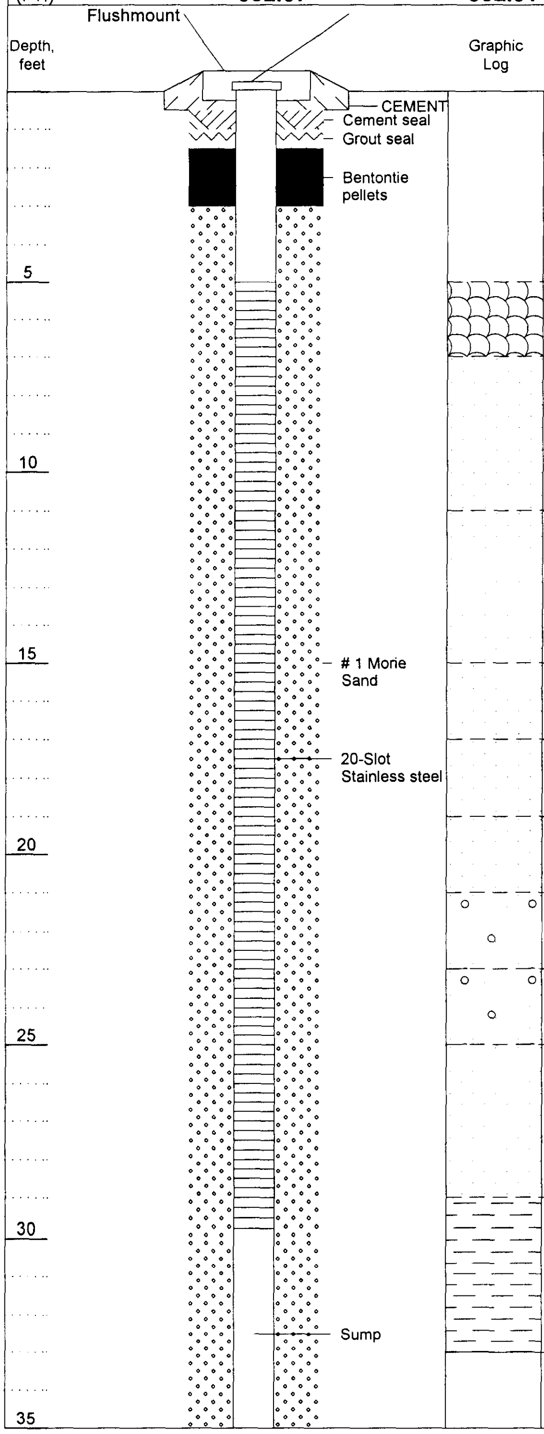
Islandia, NY 11749
Telephone: 631-232-2600
Fax: 631-232-9898

WELL CONSTRUCTION LOG

WELL NO. **RW-7**	NORTHING **1042963.12**	EASTING **1080969.08**		
PROJECT NO./NAME **17252Y04 / ExxonMobil Buffalo Terminal**		LOCATION **625 Elk Street Buffalo, New York**		
APPROVED BY **S. Senh**	LOGGED BY **M. Falzone**			
DRILLING CONTRACTOR/DRILLER **SJB / SJB**		GEOGRAPHIC AREA **STYA**		
DRILL BIT DIAMETER/TYPE **10.25-in. / Auger**	BOREHOLE DIAMETER **18-inches**	DRILLING EQUIPMENT/METHOD **/ HSA**	SAMPLING METHOD **2" Split Spoon**	START-FINISH DATE **-**
CASING MAT./DIA. **Stainless Stl / 10-inch**	SCREEN: TYPE **Slotted**	MAT. **Stainless Steel** TOTAL LENGTH **25.0**	DIA. **10-inch**	SLOT SIZE **20-Slot**
ELEVATION OF: (FT.) GROUND SURFACE **582.87**	TOP OF WELL CASING **582.81**	TOP & BOTTOM SCREEN **577.9 / 552.9**	GW SURFACE **568.83**	GRAVEL PACK **Morie #1**



Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
			Hand cleared
Fill - medium to coarse SAND, grading to red brown CLAY, trace Silt; Dry	1, 2, 1, 1		20% Recovered; black staining
Olive gray fine to medium SAND, little Silt, little subangular Gravel; Wet	4, 5, 7, 8		50% Recovered; petroleum odor
	WOH, 1, 1		20% Recovered
Olive gray to dark gray fine SAND, little red Sand, trace subrounded Gravel; Wet	9, 6, 11, 11		40% Recovered
	3, 4, 4, 5		50% Recovered
Olive gray to gray fine to medium SAND, trace coarse Sand; Wet	WOH, 1, 1		50% Recovered
Olive gray to gray medium to coarse SAND, trace subrounded Gravel; Wet	2, 2, 3, 5		70% Recovered
Olive gray to gray medium to coarse SAND, little fine Sand and subrounded Gravel, trace Silt; Wet	1, 3, 9, 11		40% Recovered; petroleum odor
Olive gray medium to coarse SAND, subrounded Gravel; Wet	6, 8, 9, 11		60% Recovered; petroleum odor
Olive gray medium to coarse SAND, some subrounded Gravel, little fine Sand; Wet	5, 9, 9, 6		70% Recovered; petroleum odor
Olive gray fine to coarse SAND, trace fine subrounded Gravel, trace Silt; Wet	WOH, 2, 3, 5, 7, 8, 9		
Olive gray CLAY medium soft, trace Silt; Wet	WOH, WOH, 2, 2, 3		
			Bottom of well at 35 ft bls

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Telephone: 631-232-2600
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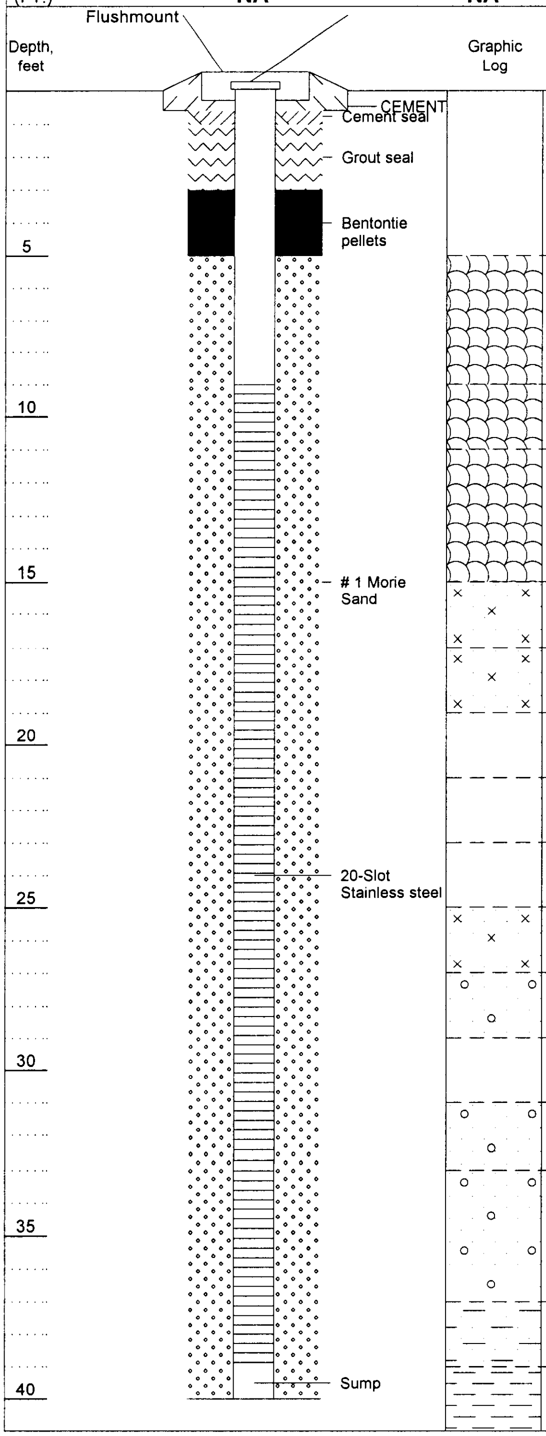
WELL CONSTRUCTION LOG

WELL NO. **RW-8**	NORTHING **1042624.84**	EASTING **1082309.96**		
PROJECT NO./NAME **17252Y04 / ExxonMobil Buffalo Terminal**		LOCATION **625 Elk Street Buffalo, New York**		
APPROVED BY **S. Senh**	LOGGED BY **M. Falzone**			
DRILLING CONTRACTOR/DRILLER **SJB / SJB**		GEOGRAPHIC AREA **ETYA**		
DRILL BIT DIAMETER/TYPE **10.25-in. / Auger**	BOREHOLE DIAMETER **18-inches**	DRILLING EQUIPMENT/METHOD **/ HSA**	SAMPLING METHOD **2" Split Spoon**	START-FINISH DATE **5/16/02-5/16/02**
CASING MAT./DIA. **Stainless Stl / 10-inch**	SCREEN: TYPE **Slotted**	MAT. **Stainless Steel** TOTAL LENGTH **NA**	DIA. **10-inch**	SLOT SIZE **20-Slot**
ELEVATION OF: (FT.) GROUND SURFACE **NA**	TOP OF WELL CASING **NA**	TOP & BOTTOM SCREEN **NA / NA**	GW SURFACE **NA**	GRAVEL PACK **NA**



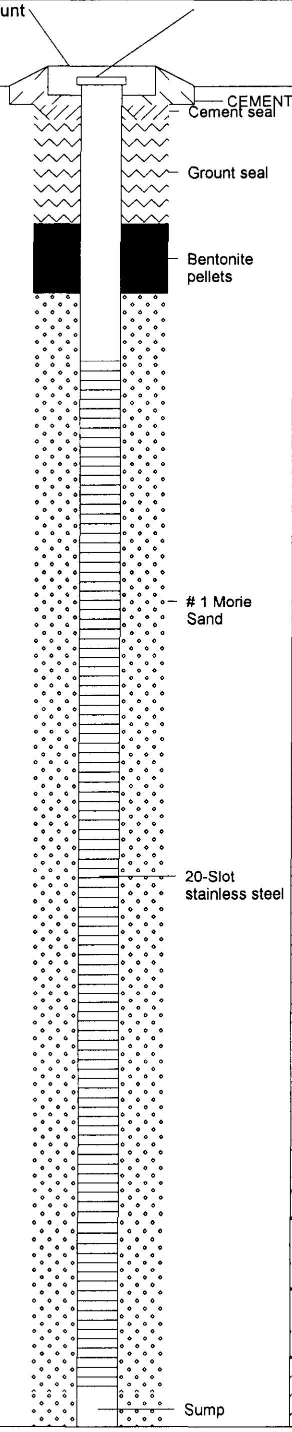
Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
			Hand cleared
FILL- Red brown coarse SAND, slag, ash with little glass; Moist	1 2 1 1 0 0 1 1		25% Recovery; 25% Recovery
FILL- White to gray ASH, black cinders, slag, some coarse Sand, little glass; Moist	4 6 5 3		50% Recovery
FILL- White to gray ASH, yellow orange slag, some medium Sand, little glass grading to gray fine to medium Sand with some Silt and Clay, little Gravel; Moist	2 1 1 2		60% Recovery; 60% Recovery
Olive gray fine SAND, with some Silt, little Clay; Moist	3 3 3 5		75% Recovery
Olive gray fine SAND, with some Silt, little Clay, trace of medium Sand; Moist/Wet			
Shelby tube collected, collapsed Fill material			Presence of separate-phase product noted; Shelby tube collected
Shelby tube collected, black fine SAND, trace of Silt			Black staining noted; Shelby tube collected
Shelby tube collected			Shelby tube collected
Olive gray fine to medium SAND, little Silt; Wet	3 2 5 5		Collected for sieve analysis (TB-3 25-27)
Olive gray medium to coarse SAND, little fine Sand, little fine to medium Gravel; Wet	2 1 5 5		75% Recovery
Shelby tube			100% Recovery; Shelby tube collected
Olive gray to dark gray medium to coarse SAND, with some fine to medium Gravel, trace of large Gravel; Wet	13 10 9 10		75% Recovery
Olive gray to dark gray medium to coarse SAND, with some fine to medium Gravel; Wet	3 5 6 5 7 7 8 7		75% Recovery; 90% Recovery
Olive gray to gray coarse SAND, little medium Sand, some fine to medium Gravel graded to Clay	6 6 6 6		75% Recovery
Olive gray CLAY	4 3 2 3		90% Recovery; Bottom of well at 41 ft bls

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

1377 Motor Parkway
Islandia, NY 11749
Telephone: 631-232-2600
Fax: 631-232-9898

WELL CONSTRUCTION LOG

WELL NO.	NORTHING	EASTING		
RW-8-R	1042649.43	1082293.36		
PROJECT NO./NAME: 17252Y04 / ExxonMobil Buffalo Terminal		LOCATION: 625 Elk Street, Buffalo, New York		
APPROVED BY: S. Senh	LOGGED BY: M. Falzone			
DRILLING CONTRACTOR/DRILLER: SJB / SJB		GEOGRAPHIC AREA: ETYA		
DRILL BIT DIAMETER/TYPE: 10.25-in. / Auger	BOREHOLE DIAMETER: 18-inches	DRILLING EQUIPMENT/METHOD: / HSA	SAMPLING METHOD: 2" Split Spoon	START-FINISH DATE: 8/1/02-8/2/02
CASING MAT./DIA.: Stainless Stl / 10-inch	SCREEN: TYPE Slotted	MAT. Stainless Steel; TOTAL LENGTH 30.0	DIA. 10-inch	SLOT SIZE 20-Slot
ELEVATION OF: (FT.)	GROUND SURFACE: 593.81	TOP OF WELL CASING: 593.40	TOP & BOTTOM SCREEN: 585.8 / 555.8; GW SURFACE: 571.16	GRAVEL PACK: Morie #1



Depth, feet	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
				Hand cleared
5	Fill - Coarse Sand and Ash, glass, slag; dry	4 2 2 1		10 % Recovery
	Fill - Medium to caorse SAND, some fine to coarse Gravel; dry	1 1 1 1		10 % Recovery
10	Fill - Medium to caorse SAND, some fine to coarse Gravel; dry	1 5 5 5		10 % Recovery
	Fill - Medium to caorse SAND, some fine to coarse Gravel; dry	4 3 2 3		10 % Recovery
	Red brown CLAY, with embedded Coal, trace fine Sand and Silt; dry			10 % Recovery
15	No Recovery	4 3 5 4		
	Black fine Sand and Silt and Clay, some organic matter, wood, coal; dry	4 4 5 7		20 % Recovery
20	Black fine Sand and Silt and Clay; moist	4 2 3 3		50% Recovery
	Olive gray fine SAND, some Silt and Clay; moist	5 7 12 12		50% Recovery
	Olive gray fine to medium SAND, little Silt and Clay; wet	5 7 4 4		70% Recovery
25	Olive gray fine to medium SAND, little Silt and Clay grading to olive gray medium to fine Sand, trace silt; wet	7 6 6 8		70% Recovery
	Olive gray fine to medium SAND, trace coarse Sand, soft; wet	4 6 3 3		70% Recovery
30	Olive to dark gray fine to medium Sand, some Silt and Clay, little fine to coarse subrounded Gravel; wet			50% Revoery
	Olive gray medium to coarse SAND, little fine to medium subrounded Gravel, inclusion of silty sand at 32.5 - 33 ft bls; wet	7 4 2 3		
35	Gray fine to medium SAND, little fine Gravel; wet	12 10 10 9		
	Olive gray fine to medium SAND, some coarse Sand, trace of fine subrounded gravel; wet	16 15 6 6		
	Olive gray to red brown CLAY, trace silt	0 3 6 7		Bottom of well at 38 ft bls

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1377 Motor Parkway
Islandia, NY 11749
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Fax: 631-232-9898

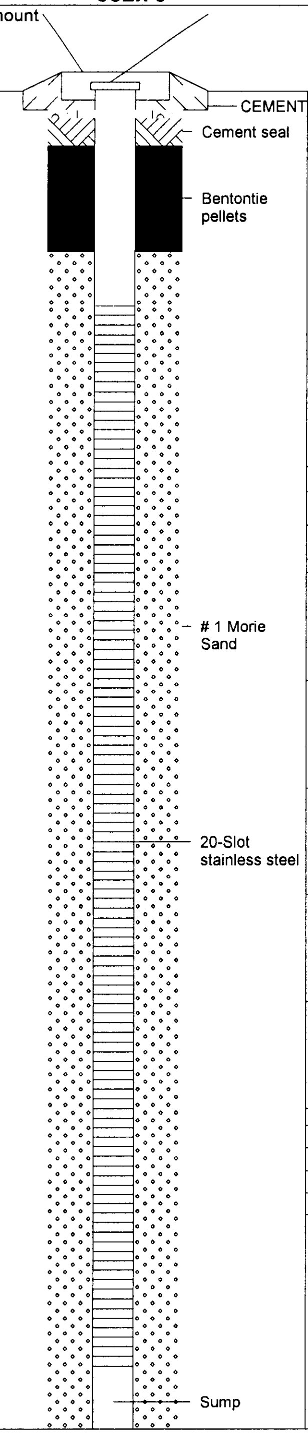
WELL CONSTRUCTION LOG

WELL NO. **RW-9**	NORTHING **1042761.4**	EASTING **1081555.21**
PROJECT NO./NAME **17252Y04 / ExxonMobil Buffalo Terminal**		LOCATION **625 Elk Street Buffalo, New York**
APPROVED BY **S. Senh**	LOGGED BY **M. Falzone**	
DRILLING CONTRACTOR/DRILLER **SJB / SJB**		GEOGRAPHIC AREA **STYA**

DRILL BIT DIAMETER/TYPE **10.25-in. / Auger**	BOREHOLE DIAMETER **18-inches**	DRILLING EQUIPMENT/METHOD **/ HSA**	SAMPLING METHOD **2" Split Spoon**	START-FINISH DATE **-**

CASING MAT./DIA. **Stainless Stl / 10-inch**	SCREEN: TYPE **Slotted**	MAT. **Stainless Steel**	TOTAL LENGTH **20.0**	DIA. **10-inch**	SLOT SIZE **20-Slot**

ELEVATION OF: (FT.)	GROUND SURFACE	TOP OF WELL CASING	TOP & BOTTOM SCREEN	GW SURFACE	GRAVEL PACK
	582.78	**582.56**	**578.8 / 558.8**	**569.49**	**Morie #1**



Depth, feet	Graphic Log	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
0–5					Hand cleared
5–7		No Recovery	WOH, 2		
7–9		SILT and CLAY, trace fine Sand; Moist	WOH, 2, 1, 1		Black staining noted; Petroleum odor
9–11		No Recovery	WOH, 2, 1, 1		
11–13		No Recovery	1, 1, 2, 4		
13–15		Olive gray fine to medium SAND, trace Silt; Wet	1, 2, 2, 3		Petroleum odor
15–17		Olive gray fine to medium SAND, trace Silt; Wet	WOH, 1, 2, 2		Petroleum odor
17–19		Olive gray fine to medium SAND, trace coarse Sand, trace Silt; Wet	3, 3, 3, 4		Petroleum odor
19–21		Red brown CLAY			
21					Bottom of boring at 21 ft bls

APPENDIX B

Results From Sieve Analysis

SJB SERVICES, INC.

Contract Drilling and Testing

BUFFALO OFFICE
5167 South Park Avenue
Hamburg, NY 14075
Phone: (716) 649-3110
Fax: (716) 649-8051

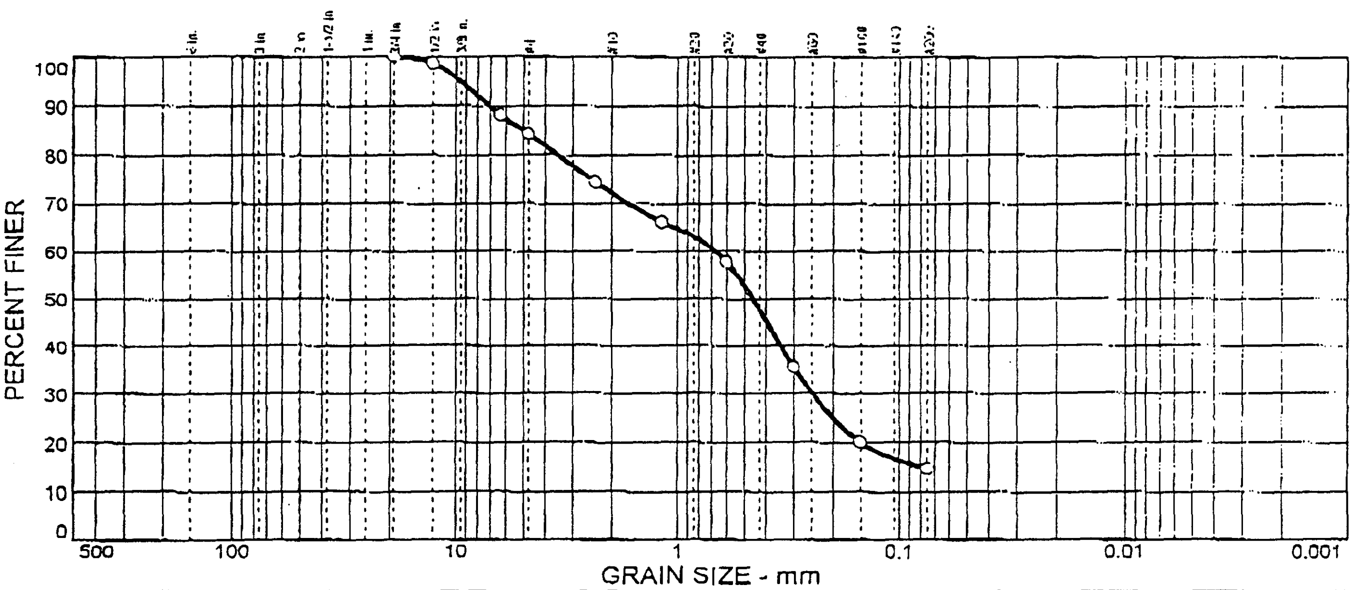
Particle Size Distribution Report

Project: MOBIL TERMINAL **Project No.:** BD02-072

Client: GES

Sample No: 02-380 **Source of Sample:** BORING TB-1 **Date:** 5/24/02

Location: BORING TB-1: 15' - 17' **Elev./Depth:**



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	15.8	12.1	24.7	32.8	14.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	98.6		
.25 in.	88.1		
#4	84.2		
#8	74.3		
#16	66.1		
#30	57.5		
#50	35.7		
#100	20.1		
#200	14.6		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 5.05 D_{60}= 0.680 D_{50}= 0.460
D_{30}= 0.246 D_{15}= 0.0812 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

LTR-1
SAMPLE NUMBER: 02-380
DATE RECEIVED: 5/24/02

Plate

SJB SERVICES, INC.

Contract Drilling and Testing

BUFFALO OFFICE
5167 South Park Avenue
Hamburg, NY 14075
Phone: (716) 649-3110
Fax: (716) 649-8051

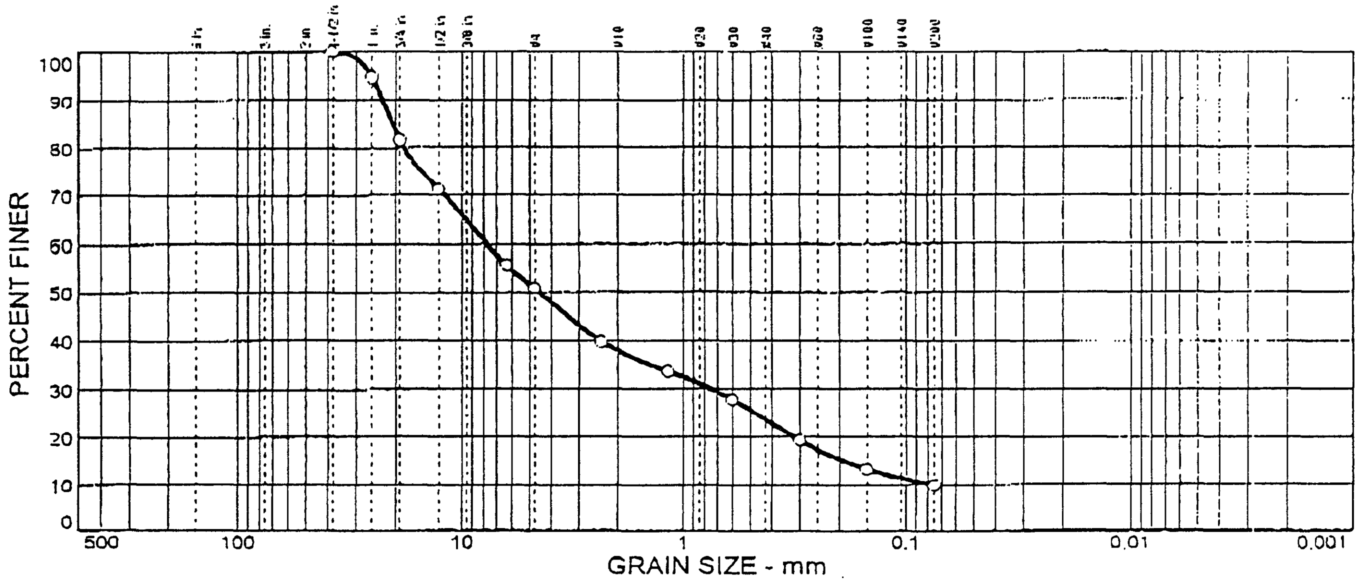
Particle Size Distribution Report

Project: MOBIL TERMINAL **Project No.:** BD02-072

Client: GES

Sample No: 02-381 **Source of Sample:** BORING TB-2 **Date:** 5/24/02

Location: BORING TB-2: 17' - 19' **Elev./Depth:**



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	18.5	30.8	12.8	14.3	13.8	9.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	94.7		
.75 in.	81.5		
.5 in.	71.2		
.25 in.	55.6		
#4	50.7		
#8	39.8		
#16	33.5		
#30	27.8		
#50	19.3		
#100	13.3		
#200	9.8		

* (no specification provided)

Soil Description

GREVAL & SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 20.6 D_{60}= 7.80 D_{50}= 4.55
D_{30}= 0.752 D_{15}= 0.191 D_{10}= 0.0785
C_u= 99.37 C_c= 0.92

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

LTR-2
SAMPLE NUMBER: 02-381
DATE RECEIVED: 5/24/02

Plate

SJB SERVICES, INC.
Contract Drilling and Testing

BUFFALO OFFICE
5167 South Park Avenue
Hamburg, NY 14075
Phone: (716) 649-8110
Fax: (716) 649-8051

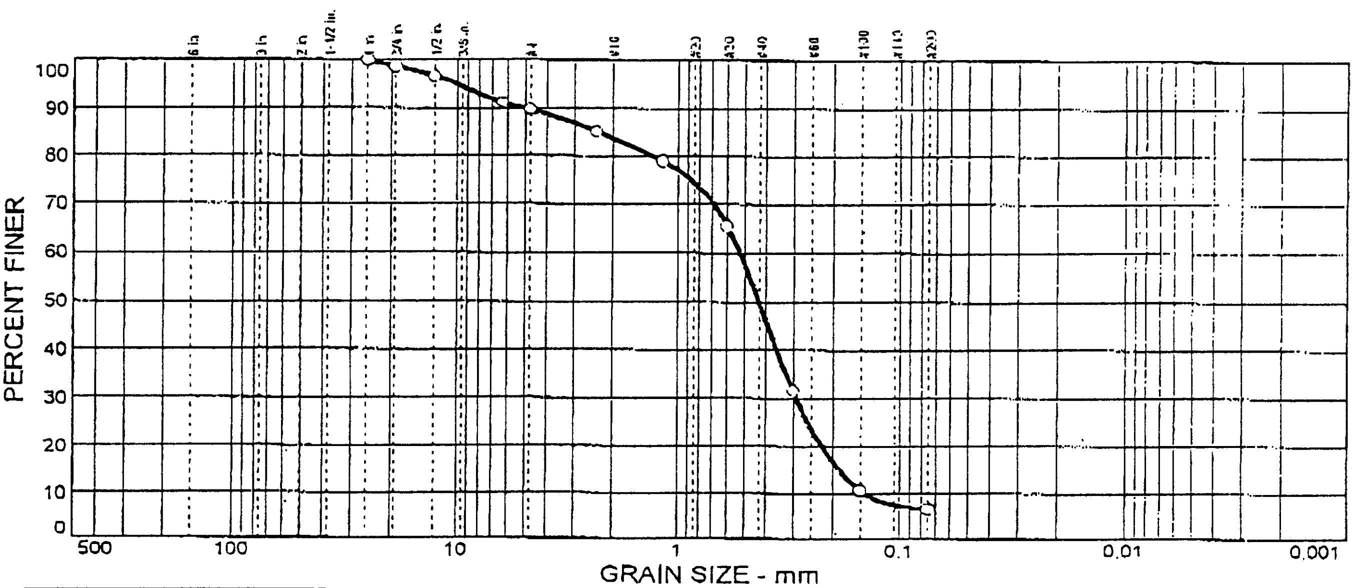
Particle Size Distribution Report

Project: MOBIL TERMINAL **Project No.:** BD02-072

Client: GES

Sample No: 02-382 **Source of Sample:** BORING TB-3 **Date:** 5/24/02

Location: BORING TB-3: 27' - 29' **Elev./Depth:**



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	1.4	8.9	6.0	34.3	42.7	6.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	98.6		
.5 in.	96.7		
.25 in.	91.2		
#4	89.7		
#8	85.0		
#16	78.8		
#30	65.4		
#50	31.6		
#100	10.7		
#200	6.7		

* (no specification provided)

Soil Description

GRAVEL & SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 2.36 D_{60}= 0.527 D_{50}= 0.430
D_{30}= 0.290 D_{15}= 0.187 D_{10}= 0.143
C_u= 3.69 C_c= 1.11

Classification

USCS= SP-SM AASHTO= A-1-b

Remarks

LTR-3
SAMPLE NUMBER: 02-382
DATE RECEIVED: 5/24/02

Plate

GRAIN SIZE DISTRIBUTION TEST DATA

Client: GES
Project: MOBIL TERMINAL
Project Number: BD02-072

Sample Data

Source: BORING TB-1
Sample No.: 02-380
Elev. or Depth: Sample Length (in./cm.):
Location: BORING TB-1: 15' - 17'
Description:
Date: 5/24/02 PL: LL: PI:
USCS Classification: AASHTO Classification:
Testing Remarks: LTR-1
SAMPLE NUMBER: 02-380
DATE RECEIVED: 5/24/02

Mechanical Analysis Data

	Initial
Dry sample and tare=	616.78
Tare =	0.00
Dry sample weight =	616.78

Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
.75 inch	0.00	100.0
.5 inch	8.60	98.6
.25 inch	73.27	88.1
# 4	97.32	84.2
# 8	158.77	74.3
# 16	208.96	66.1
# 30	261.97	57.5
# 50	396.41	35.7
# 100	492.56	20.1
# 200	526.83	14.6

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% COBBLES = % GRAVEL = 15.8 (% coarse = % fine = 15.8)
% SAND = 69.6 (% coarse = 12.1 % medium = 24.7 % fine = 32.8)
% FINES = 14.6

D_{85}= 5.05 D_{60}= 0.68 D_{50}= 0.46
D_{30}= 0.25 D_{15}= 0.08

GRAIN SIZE DISTRIBUTION TEST DATA

Client: GES
Project: MOBIL TERMINAL
Project Number: BD02-072

Sample Data

Source: BORING TB-2
Sample No.: 02-381
Elev. or Depth: Sample Length (in./cm.):
Location: BORING TB-2: 17' - 19'
Description: GREVAL & SAND
Date: 5/24/02 PL: LL: PI:
USCS Classification: AASHTO Classification:
Testing Remarks: LTR-2
SAMPLE NUMBER: 02-381
DATE RECEIVED: 5/24/02

Mechanical Analysis Data

	Initial
Dry sample and tare=	957.61
Tare =	0.00
Dry sample weight =	957.61

Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
1.5 inch	0.00	100.0
1 inch	51.15	94.7
.75 inch	176.75	81.5
.5 inch	275.58	71.2
.25 inch	425.28	55.6
# 4	472.13	50.7
# 8	576.56	39.8
# 16	636.63	33.5
# 30	691.56	27.8
# 50	772.51	19.3
# 100	830.72	13.3
# 200	863.75	9.8

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% COBBLES = % GRAVEL = 49.3 (% coarse = 18.5 % fine = 30.8)
% SAND = 40.9 (% coarse = 12.8 % medium = 14.3 % fine = 13.8)
% FINES = 9.8

D_{85}= 20.57 D_{60}= 7.80 D_{50}= 4.55
D_{30}= 0.75 D_{15}= 0.19 D_{10}= 0.08
C_c= 0.9237 C_u= 99.3726

GRAIN SIZE DISTRIBUTION TEST DATA

Client: GES
Project: MOBIL TERMINAL
Project Number: BD02-072

Sample Data

Source: BORING TB-3
Sample No.: 02-382
Elev. or Depth: Sample Length (in./cm.):
Location: BORING TB-3: 27' - 29'
Description: GRAVEL & SAND
Date: 5/24/02 PL: LL: PI:
USCS Classification: AASHTO Classification:
Testing Remarks: LTR-3
SAMPLE NUMBER: 02-382
DATE RECEIVED: 5/24/02

Mechanical Analysis Data

	Initial
Dry sample and tare=	714.94
Tare =	0.00
Dry sample weight =	714.94

Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
1 inch	0.00	100.0
.75 inch	9.89	98.6
.5 inch	23.64	96.7
.25 inch	62.91	91.2
# 4	73.97	89.7
# 8	106.95	85.0
# 16	151.75	78.8
# 30	247.64	65.4
# 50	489.18	31.6
# 100	638.48	10.7
# 200	666.94	6.7

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% COBBLES = % GRAVEL = 10.3 (% coarse = 1.4 % fine = 8.9)
% SAND = 83.0 (% coarse = 6.0 % medium = 34.3 % fine = 42.7)
% FINES = 6.7

D_{85}= 2.36 D_{60}= 0.53 D_{50}= 0.43
D_{30}= 0.29 D_{15}= 0.19 D_{10}= 0.14
C_c= 1.1149 C_u= 3.6901

APPENDIX C

Well Development Logs

MW-40 Well Development

DTW - 5.13 / DTP -

DTB - 35.50

Surge Block

30-25 15 min

25-20 15 min

20-15 15 min

15-10 15 min

~~Pumped 65 gallons @~~

Bailed approx 10 gallons
heavy sediment

Pumped well @ 8 gpm
Sustained, purged ~45 gallons
via pumping

Removed an additional 15 gallons water less turbid. Adjusted flow to maintain W.L. in well

W.L. between 19.4 – 19.8 fluctuation gpm @ 5 gallons per 3 min 3 sec

W.L. between 19.6 – 19.8 fluctuati gpm @ 5 gallons per 3 min 5 sec

Removed a total of 60 gallons water clear after development

5/23 3:00

~~Spoke to Joe G regarding~~
~~Shelby tube samples:~~
~~TS~~
~~Moisture~~ -
~~Specific Gravity~~ -
~~Gradation~~ -

~~Told Joe to run sieve~~ on
~~local samples~~

2:30 / 10 gallons =

1:00 / 8 gallons = 8 gpm
max pump flow -

No drop in W.T. - W.T @ 3.9 BTOC,
water noted @ surface around well
Removed total of 30 gallons pumped

Removed total of 60 gallons - water
slt. turbid

150 sec / 10 gallons =

MW-43 Well Development
DTW - 15.41
DTB - 25.75

Well Redevelopment
20-15 11:05-11:20
15-10 11:20-11:35
10-5 11:35-11:50

Bailed well to remove solids - removed
10 gallons via bailer - heavy sediment
Removed 10gal via pumping ; pump
continues to turn on and off, ~~dte~~ well dry.

SJB Break for lunch p/u Truck 12-1:15

DTW - 16.35 DTP - 16.34
MW-42/TB-2 DTB - 25.10 (soft) DTB - 25.70 after bail
- Bailed well to remove solids, ~30 gallons rem

Well Redevelopment:

20-15 (~~8:30~~ 8:55 - 9:10)

15-10 (9:10 - 9:35)

10-5 (9:35 - 9:50)

At 8:35 during well development
winch on Rig malfunctioned
Stopped well development for repair
20 minute downtime

- Returned to surge blocking
Surged block 3 intervals
Bailed well, removed ~ 30 gallons
Start pumping using Redi-Flow-2

XOM/MB7 6/5/02

11:50 MF arrives on site
met w/ SSB, review
scope of work - Mike
completed tailgate
Setup @ RW-7
offloaded augers (12 1/4)
@ upwest

Started SS sample @ 12:30
see chart ended boring
4:50

MF + SSB offsite @ 5:15

XOM/MB7 6/6/02

7:40 MF arrives on site met
w/ SSB discussed w/
Art (Terminal Mgr) scope of
work and the need for
"Hot work" permit today
b/c of welding.

Discussed w/ Art + Tony (driller)
the method of welding +

6/6 +

Installation of well -
Agreed to weld @ well
location + monitor LEL
during welding at TOC
(where there is the greatest
risk for flammable vapors)
IF LEL readings are above
10% then a alternate
installation method would
be ~~on~~ selected.
MF to indicate LEL reading
on hot work permit.

MF completed tailgate
mtg discussed importance
of safety during welding

900 Setup @ RW-1 location
Check on the inflow
of material in the augers
approx 1' total - will redrill
the bottom 1'

1000 SSB prep to weld -
did not have correct

6/6 XOM/MBT

welding rods, will borrow
from Mobil and replace with
new rods

10^{15} MIG welder not operating
SSB offsite to get parts

10^{30} Returned to site
Started up welder
welded sump and screen
from 10^{30}-11^{30}, cut standpipe
11^{30}-12^{15}

12^{30}-1^{00} lunch

Set well into place -
welded joints
Completed well install
w/ sand + bentonite
SSB + MF offsite @ 6:00

XOM/MBT MF 6/7/02

MF arrives on site @ 8:00
met w/ SJB - obtained
work permit, completed
tailgate mtg, reviewed
Scope

Completed grout work @ RW
loaded augers - Tom from
Mobil brought over forklift
off loaded sand & screen @
RW-9 + RW-8 location

Setup Rig @ RW-9

Sampled SS to 25 ftbgs
Augered to 25' + set
well @ 25' BG

Screen 5-25 no sump
clay @ 14' BG

Sand to 3' BG

MF + SJB offsite @ 5:30

XOM/MBT MF 6/10/02

MF arrives on site @ 7:30
met w/ SJB obtained work
permit. Complete tailgate
mtg

8:00 Completed grouting @
RW-9, installed
~~xx~~ well cover

8:30 Cleaned sand off augers,
loaded augers, marked
drums

9:15 SJB liftgate malfunctioned
and cannot off load augers.
attempting to make repairs.

9:50 SJB offsite to pick up
new solenoid for liftgate

11:15 SJB completed work on
liftgate operational

11:30 Setup @ RW-8

XOM/MBT MF 6/10/02

Started HSA w/o sampling.

12:00-12:30 Lunch

12:30-1:30 Completed well installation

1:30-3:30 Prepped for welding, started welding sump

3:30-4:00 Set well site plan started welding 10' screen to 20' screen

4:00-8:00 Set well to 40' bgs

39-40' Sump

5'-35' Screen

Sand to 5' bgs

Bentonite to 3' bgs

MF + SJB offsite @ 8 pm

XOM/MBT 6/11/03

MF arrives on site @ 800 met w/ SJB @ 8:15 Obtained work permit. Reviewed tailgate mtg

8:30 Started well completion @ RW-8 - grouted well, secured ~~man~~ well cover.

8:30-10:30 clean area, drummed cuttings, loaded augers. Mail to RW-9

RW-9

ND - DTP

12.02 - DTW

24.90 - DTB

~~11:05~~ Started surge block

11:10 25-20

11:25 20-15

11:40 15-12

11:50

XOM/MBT 6/11/02

Setup hose to MH-76
installed flow manifold
set pump in place

12^{30} - 1^{00} Lunch

DTW 12.10 after removing
20 gallons @ 50 gpm
to test pump

1:24 start pumping

DTW 15.60 after removing
20 gallons @ ~30 gpm
will reduce flow

16.30 after 10 gallons
removed @ 12 gpm

XOM/MBT 6/11/02

Pumped @ 9 gpm
DTW rebound to 15.95
during 45 seconds pump

Time	DTW
1:38	14.68

> 20 gpm

~~1:43~~ 1:44 17.09 DTW

40 sec / 5 gallons
20 gpm

Heavy sediment

1:56 21.01 low > 20 gpm

Reduced flow @ 1:54
DTW - 21.01

55 sec / 5 gallons
≈ 11 gpm

1:58 DTW - 20.73

1:59 DTW - 20.69

2:04 DTW - 20.20

2:07 DTW - 19.60

XOM/MBT 6/11/02

11 gpm	2:09	19.60
	2:11	19.52
	2:18	19.00
	2:23	19.02
	2:26	19.02
	2:29	19.02
	2:36	18.90
	2:44	18.62

2:15
Flow
Check
5 gal ~~5 pine~~ 5 sec =
11 gpm

2:35
52 sec = 11 gpm
5 gallons

STOP PUMPING

water clear

Ended pumping @ 2:45
water clear

Rebound

2:47	16.56
2:54	14.98

ExxonMobil Buffalo 6/11/02

Moved tailgate - started
to surge block @ 3:45

DTP 14.45
DTW 14.80
DTB 34.45

Surge Block

Start	Interval	
~~345~~ NC	35-30	(sump)
350	30-25	
405	25-20	
420	20-15	

MF + SJB offsite @ 450p

ExxonMobil - Terminal 6/12/02

MF arrived on site @ 7:40
met w/ SJB obtained work
permit
Completed tailgate mtg

FROM : GES BUFFALO NEW YORK FAX NO. : 716 873 4175 Feb. 13 2003 10:34AM P11

ExxonMobil Buffalo Terminal 6/12/02

RW-7 Well Development

DTW ~~43.85~~ - Removed 20 gal
@ ~ 9-15 gpm
~~slowed~~ flow to 9 gpm

START
DTW - ~~15~~.18 ~9+ gpm
Time - 9:02 Heavy Sediment

Time	DTW	
		32 sec = 5 gallon
9:04	16.~~22~~	OK ~~20~~ GPM
9:06	17.72	
9:07	18.30	
9:12	19.62	Light Rain
9:16	20.18	
9:22	20.28	
9:27	20.28	9:30 35 sec / 5 gallon
9:32	20.30	
9:43	20.08	GPM
10:00	19.88	~9.5 Turbid

Tony (SSB) offsite @ 9:45 to p/u 2" Pump
Returned @ 10:50

ExxonMobil Buffalo Terminal 6/12/02

Increased pumping rate

1000	19.88 DTW	25 sec / 5 gallons
1006	21.85	12 gpm
1017	Pump Malfunction 14.75 DTW	

MW-41 Surge Block - Completed during pumping @ RW-7 10:15

DTP 15.95
DTW 16.40
DTB 32.35 TOC
29.40 surface

Bailed ~10-15 gallons of water w/ heavy sediment from bottom of well

DTB 34.5 - will start to surge block

FROM : GES BUFFALO NEW YORK FAX NO. : 716 873 4175 Feb. 13 2003 10:34AM P12

ExxonMobil Buffalo Terminal 6/12/02

Depth Interval	Time
30-25	10 55
25-20	11 10
20-15	11 25

After surging heavy sediment remains in well, used bailer to remove 40 gallons

Installed Redi Flow -2 in well pumped @ 5 gpm, removed 60 gallons, water has slt turbidity

Setting concrete pads @ RW-7 + MW-40

2:30P MW-45

DTP - 13.85
DTW - 13.86 TOC
DTB - 31.95

ExxonMobil Buffalo Terminal 6/12/02

Pumped 5 gal / 3 minutes

Removed 40 gallons water - clear

400P Setup @ RW-8

DTP - NP
DTW - 21.24 ~~TOC~~ TOC
DTB - 38.70

Surge block well

Depth Interval	Time
40-35	4 00
35-30	4 15
30-25	4 30
25-20	4 45

MF + SJB offsite @ 5 00

ExxonMobil Buffalo Terminal 6/13/02

MC arrives at site @ 745
met w/ SSB, obtained
work permit, Complete
tailgate mtg.

Setup to pump RW-8
will pump into ~~that~~ FRAK
tank

DTP - NP
DTW - 22.11

Initial pumping @ ~~5 gal / 10~~ 10sec / 5 gal = 30gpm
removed 40 gallons,
reduced flow to ~12gpm
pump stopped

DTW - 28.62 - changed pump
rate 25sec / 5 gallons
12gpm

6/13/02

Time	DTW	Rate
8:40	28.82	12gpm

Pump Shutdown - will
repair & restart
using new pump.

9:15 28.82
9:19 Pump Shutdown

Tony offsite (SSB) from
9:45 to 10:45, worked
on ~~—~~ pads until 10:45
10:45-12:45 Loaded up new
pump, picked up concrete,
finished pads.

12:52 Returned to develop
RW-8

DTW - 23.35 ft

ExxonMobil Buffalo Terminal 6/13/02

Time	DTW	Pumping Rate
12:53	23.35	
12:59	34.64	20sec / 5 gallon
1:02	35.22	≈15gpm
		23 sec / 5 gallon
		~13 gpm

Shutdown @ 1:03

Rebound

1:05	34.58
1:10	34.64

Await recharge @ RW-8
moved to MW-44

DTP - NP
DTW - 16.54
DTB - 21.10

Bailed 3 gallons of water w/
heavy sediment

ExxonMobil Buffalo Terminal 6/13/02

Time	DTW	Rate
1:59	NC	65 sec / 5 gallons
2:07	NC	
2:10	NC	Turbid

shutdown pump
2:10 removed ~50 gal
of water, wet
s/t turbid

Rate
60 sec / 5 gallons
s/t turbid

Return to RW-8

Time	DTW
2:22	24.78
2:43	23.94

Started pump - 10-12 gpm

2:49	30.78

reduced pump rate to 8 gpm

2:52	33.76	- Pump stopped
3:29	27.52	

ExxonMobil Buffalo Terminal 6/13/03

Per discussion w/ NC + SSB avert

Reattempt Pumping

@ 8 gpm

Swab well - pull

pump from 5' Below w.l.

to 39.86

Calgon - check on amt of

Calgon required to dissolve clay

Airburst well

Time	DTW	
3:44	25.38	8-10 gpm
3:49	27.98	- lowered flow
3:52	NC	to 8 gpm
3:55	33.78	40 sec = 5 gallons 7.5 gpm

Pump shutdown

SJB offsite @ 5:00

MF offsite @ 5:30

ExxonMobil Buffalo Terminal 6/14/03

MF arrives on site @ 7:50

met w/ SSB @ 8:00

obtained work permit

complete fail safe mtg

Checked intervals for

2" piezo @ RW-1 well

RW-1

Screen 5-30' BG - 25' screen

Solid 0-5' BG - 10' riser

Solid 30-35' BG

MW-40

Screen 17-32

riser 17-TOC

MW-41

Screen 17-32

riser 17' TOC

MW-18

MW-35

MW-33

2" no piezo

RW-8 6/14/02

Time	DTW	Pumping Rate
10:02	22.50	
10:12	22.50	Started pump 4 gpm
10:15	NC	55sec / 5 gallons = 5.45 gpm
10:17	25.82	water - turbid
10:21	27.88	
		Light Rain
10:23	28.57	
10:25	29.62	Slowed rate 65sec / 5 gallons = 4.61 gpm
10:36	34.49	
		Slowed rate
10:44	34.71	140sec / 5 gal
10:51	34.94	

6/14/02

Time	DTW	
10:56	34.95	
11:10	34.95	
11:44	30.00	← Pump Stopped Time Unknown Fault noted @ control box Heavy Rain
1:48	22.35	
2:34	23.15	90 / 5 gallons = 3.1 gpm
2:37	24.88	
2:55	26.82	– Moved pump from 39-34' for 10 minutes
3:35	28.28	
3:40	28.58	water slt. turbid
3:42	28.90	Increased pumping rate
3:46	30.72	52sec / 5 gall = 5.9
3:49	31.87	

6/14/02

MW-15

DTP - 10.42
DTW - 17.99
DTB - 20.90

After Bailing product ~ 20 gallons

DTP - 12.03
DTW 12.04

Moved to RW-8, poured ~50 gallons of salt solution into well.

Removed debris along monitoring well locations
Moved drums into non-haz + haz waste area

MF + SJB offsite @ 5:00

6/17

ExxonMobil Buffalo Terminal

MF arrives on site @ 6:45 met w/ GES (MR, DK + GS) ExxonMobil (Joe Abel) w/ Roux (Sin Sint) @ 7:00. Reviewed Scope + H2S plan
Setup to pump RW-8

DTP - NP
W.L. - 22.13
} RW-8

SJB arrives @ 8:00 - SJB to decon + set piezos
Started pumping @ 10:46

W.L. - 24.00

Time	DTW	Pumping Rate
10:46.	24.00	30 sec / 5 gallon
10:47	25.60	slowed flow
10:47:30	26.80	37 sec / 5 gal
10:51:30	28.75	slowed flow
10:52:00	29.00	60 sec / 5 gal

Time	DTW		Flow
10:55	29.82		65sec / 5 gallons
	~~Pump Stopped~~		
10:59	31.00		
	34.50	Pump Stopped	

Setup for pump test @ RW-7
checked Flow meter, p. transducers etc.

2:30 Setup @ RW-8 to
water jet well, jetted
5' sections frome 3:00 - 3:40

Time	DTW	Pump Rate
3:52	6.87	NC

Lightning + Thunder - stopped
pumping @ ~4:00.

ExxonMobil Buffalo Terminal 6/18/02

MF arrived on site @ 7:15 Am
obtained work permit.
SDR arrives on site @ 7:45 Am
discussed work plan,
completed tailgate mtg.

Setup to pump at RW-8

Time	DTW	Pumping Rate
8:01	22.40	
8:07	24.40	100sec / 5 gallons
		increased Flow
8:08	26.35	40sec / 5 gallons
		~~reduced Flow~~
8:14	29.62	38 / 5 gallons

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ExxonMobil Buffalo Terminal 6/18/02

Reduced Flow

8 17 31.10 — 42 sec / 5 gallons

increased

8 20 31.90 — 62 sec / 5 gallons

8 23 32.64

8 28 Pump shutdown

8 36 30.89

SSB to install piezos @ RW-9, wait for recharge @ RW-8

930 Returned to RW-8
Started to jet 39-34
30 minutes each section

ExxonMobil Buffalo Terminal 6/18/02

32.64
31.90 .7

Stopped pump Recharge

11:27:15	35.13	Pump off
11:29:25	34.13	
11:29:40	34.00	
11:32:00	33.06	
11:34:50	31.90	
11:39:10	30.50	

Await recharge

12:38	29.78	30 sec / 5 gall
12:48	26.79	slowed flow 85 sec / 5 gallons
12:51:12	27.08	
12:54:50	27.91	90 sec / 5 gall water turbid
12:58:00	28.60	
1:04:30	29.90	

ExxonMobil Buffalo Terminal 6/18/02

1:11:12	30.98	1/2 Sec. / 5 gallon
1:16:10	31.87	3 held 1/2
1:56	33.90	
	Pump Stopped Restart @	
2:06	33.60	
2:30	Started jetting @ 3-35' BG, setup to seal T.O.C.	
2:55	Started pumping @ 15 gpm	

ExxonMobil Buffalo Terminal 6/18/02

3:06	27.18	Slowed flow 9 gpm
3:07	27.72	
3:09	28.34	
3:11	29.36	
3:13	30.00	
3:15	31.00	
3:18	32.18	
3:22	33.70	

FROM : GES BUFFALO NEW YORK FAX NO. : 716 873 4175 Feb. 13 2003 10:40AM P21

ExxonMobil Buffalo Terminal 6/18/02

LF-1S

DTP	DTP
24.11	NA

DTW	DTW
24.12	25.59

DTB	DTB
28.8'	38.00

LF-1S

2:46
5gpm

DTW	Time	
24.8	4:20	160 sec / 5gpm
25.0	4:26	1.9 gpm
25.0	4:29	increased flow ↑
25.2	4:37	105 / 5gal 2.7 gpm

ExxonMobil Buffalo Terminal 6/18/02

DTW	Time	
25.2	4:38	80sec / 5gal
25.9	4:44	
25.9	4:47	83sec / 5gal
25.72	5:10	"

Shutdown pump test @ LF-1S, removed equipment + cleared area.

SSB demob equipment breakdown decon pad etc.

SSB offsite @ 8:00pm

ExxonMobil Terminal 6/19/02
MF

Met w/ Sun & Mike
assisted in moving equipment
- Starting pump test in
ETIA on LF-1S.

Electrical problems w/
pump continue to be a
problem. Test postponed
until 6/24.

ExxonMobil Buffalo Terminal 8/2/02

800 MF arrive on site, met w/ SJB, reviewed scope - we completed tailgate, MF pulled permit

815 Setup @ RW-8 - Started to install remaining sandpack

915 - 1015 Sandpack in, poured 2 bags of bentonite, mixed grout

1015 - 1200 Loaded Augers - obtained Hot work Permit - cut casing below grade

Lunch

1230 Surged 15 min/5 ft 37, 32, 27
Ready to Decon

DTP - NP
DTW - 21.35
DTB - 35.00

Obtained SS Bailer - to remove sediment

XOM/MBT 8/2/02

Bailed 30 gallons
Of sediment laden
water

2:17 Set pump @ 35' BG
DTP - NP
DTW - 21.68
DTB - 35.30

2:19:30 Started pump

5gal/21sec = 14 gpm

DTW - 25.71 2:20:30
DTW 26.72 2:22:30

2:22:45 Filled 53 gallon drum

DTW 29.42 2:25:20
DTW 32.40 2:26:50
DTW 34.70 2:30:00 Pump Stopped

XOM/MBT 8/2/02

Recharge

DTW 24.90 2:42
23.45 2:45

Start Pump @ 2:46:30, DTW 22.8

5gal/21sec

DTW
23.30 - 2:46:30
28.95 - 2:50:05
31.02 - 2:51:50
32.40 - 2:52:10 — Flow changed to ~8 gpm b/c Top of Pump
34.70 - 2:55:10
34.75 - 2:57:00
34.72 - 2:58:00
34.72 - 3:03:10
34.72 - 3:30:00 Shutdown pump water cloudy

5gal/16sec
23.40 - 3:45 Pumped additional 55 gallon water cloudy

DTB - 35.20

XOM/MBT 8/2/03

Sediment Removal heavy
@ well bottom actual
depth from surface 22'
measuring 35.20 from TOC
estimate 1.5' of sediment
@ well bottom

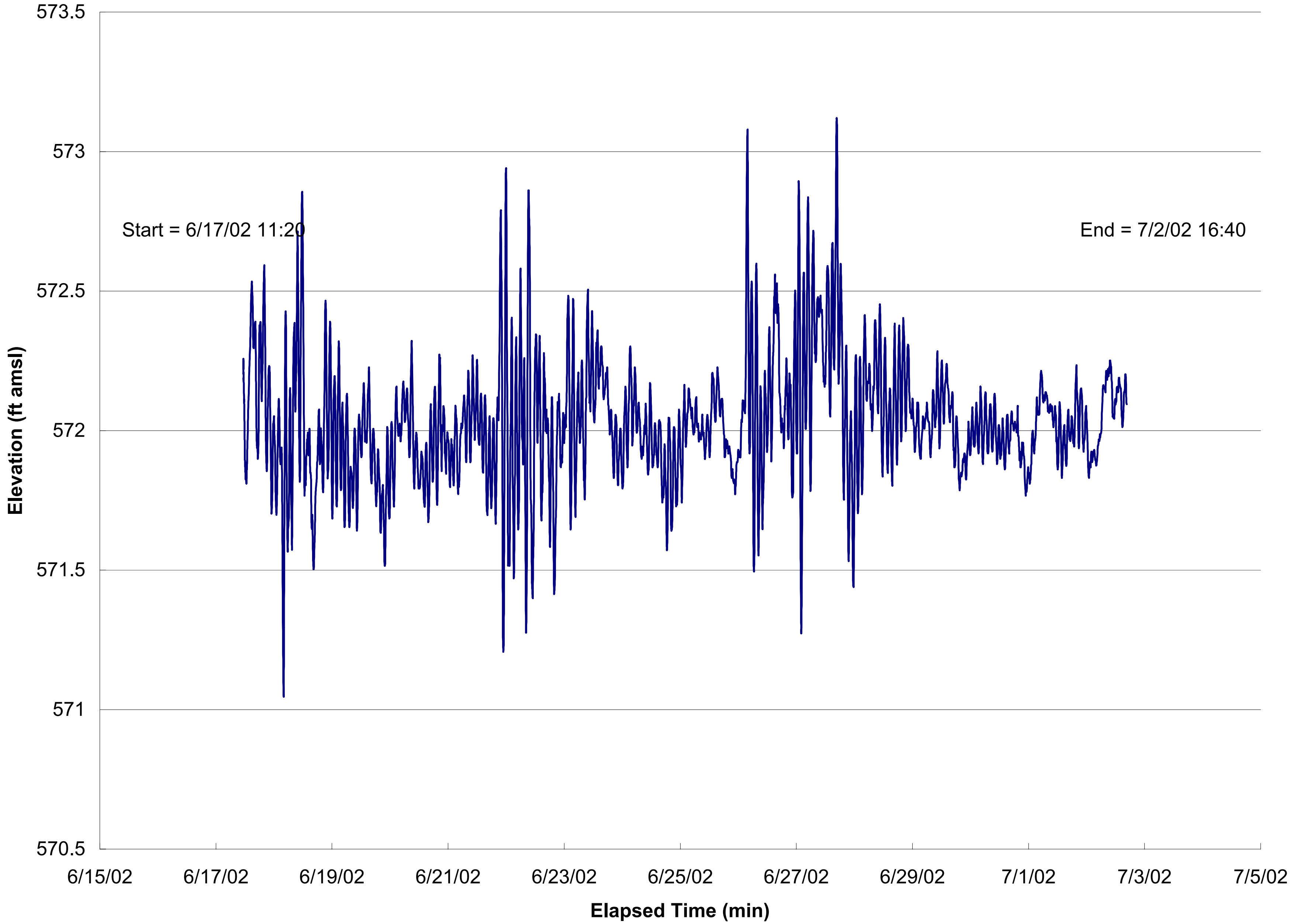
Packed up equipment
cleaned area
Decon water into Train 2

SSB offsite @ 4:50
MF offsite @ 4:55

APPENDIX D

Hydrograph of the Buffalo River

Buffalo River Hydrograph



APPENDIX E

Roux Associates, Inc. Standard Operating Procedure
for Conducting a Constant-Rate
(Pumping) Test and Recovery Test

Date: May 5, 2000

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to describe the methods to be used for conducting constant-rate (pumping) tests and recovery tests. Constant-rate tests are designed to measure the response of an aquifer to stress imposed on it (i.e., pumping or injection of water). In the constant-rate test, the well is pumped or recharged at a constant rate for a significant period of time, usually 24 hours or longer. Pumping tests are conducted to quantify hydraulic coefficients and characterize boundary conditions. Pumping tests can also be used to qualitatively or quantitatively evaluate the degree of hydraulic connection between and within flow systems which is particularly applicable to bedrock ground-water systems where hydraulic parameter determination may not be possible.

Drawdown is measured throughout the test at preselected time intervals to provide the data necessary to quantitatively characterize the aquifer. Automatic water-level records may be used which provide a detailed, continuous drawdown record and are periodically checked by manually measuring the water level with a steel tape and chalk or an electronic sounding device (m-scope).

Pumping tests are generally the easiest aquifer tests to interpret, and can provide the most accurate, quantitative information; thus pumping tests are favored when conditions are suitable (i.e., when hydrogeologic conditions are such that the system can sustain a properly designed constant-rate pumping test).

Measurements of water-level recovery after the pump is shutdown may be used to confirm the results of the drawdown test. Additionally, problems such as those created by a fluctuating pumping rate and corresponding drawdown measurements during the drawdown phase can be eliminated during the recovery phase (which is not effected by pumpage). Therefore, data loggers and/or the automatic recorders should remain in operation to measure the extended recovery period of the water levels to provide a suitable database in the event that recovery data analysis is undertaken.

2.0 EQUIPMENT AND MATERIALS

2.1 The following items may be needed for aquifer testing:

a. Electronic sounding device (m-scope).

b. Steel tape (in 0.01-foot increments) and chalk (e.g., blue carpenter's).

c. Data loggers and pressure transducers.

d. Field forms (i.e., Daily Log, Pumping Test, and Well Inspection Checklist) and study notebook.

e. Rain gauge.

f. Barometer.

g. Stop watch or watch with second display/hand.

h. Pump.

i. Extension cord(s) or generator and fuel/power supply.

j. Water-level recorders (e.g., Stevens type).

k. Flashlights/illumination.

l. Stream gauge and/or tide gauge.

m. Shelter.

n. In-line flow meter and/or orifice and manometer.

o. Valve(s).

p. On-site holding tanks or tank trucks, or treatment capability.

q. Discharge line (leak free).

r. Water-quality meters (pH, conductivity, temperature).

s. Extra batteries (flashlight, meters).

t. Non-absorbent cord (e.g., polypropylene).

u. Portable personal computer (PC), appropriate cables, software, and floppy disks.

v. Five-gallon bucket.

w. Clean cloth or paper towel.

x. Non-phosphate, laboratory-grade detergent solution.

y. Distilled or deionized water and potable water.

3.0 DECONTAMINATION

3.1 Make sure all equipment that enters the well(s) is(are) decontaminated and cleaned before use. Use new, clean materials when decontamination is not appropriate (e.g., non-absorbent cord, disposable gloves). Document, and initial and date the decontamination procedures on the appropriate field form (e.g., Daily Log) and in the field notebook.

a. Decontaminate a pump by: 1) wearing disposable gloves, 2) flushing it and the discharge hose (if not disposable) with non-phosphate, laboratory-grade detergent and distilled/deionized or potable water solution, 3) rinsing with potable water, and 4) rinsing or wiping pump-related equipment (electrical lines, cables, discharge hose) with a clean cloth and potable water. If a turbine pump is used, then ensure that all materials that are set in the well or above it (well head) are steam cleaned for decontamination purposes.

b. Decontaminate a transducer and cable by: 1) wearing disposable gloves, 2) wiping transducer-related equipment (e.g., probe, cables) with a clean cloth and non-phosphate, laboratory-grade detergent solution, and 3) rinsing or wiping equipment with a clean cloth and distilled/deionized water or potable water.

c. Decontaminate a float/probe and cable (water-level recorder) by: 1) wearing disposable gloves, 2) wiping equipment with a clean cloth and non-phosphate, laboratory-grade detergent solution, and 3) rinsing or wiping equipment with a clean cloth and distilled/deionized water or potable water.

d. Decontaminate a steel measuring tape or electronic sounding device (m-scope) by: 1) wearing disposable gloves, 2) wiping water-level measurement equipment with a clean cloth and non-phosphate, laboratory-grade detergent solution, and 3) rinsing or wiping equipment with a clean cloth and distilled/deionized water or potable water.

4.0 PROCEDURE

4.1 Inspect the protective casings of the wells and the well casings, and note any items of concern such as a missing lock, or bent or damaged casing(s). Complete a Well Inspection Checklist for each well, and initial and date upon completion.

4.2 Enter all pertinent data concerning the pumping well, piezometers and/or observation wells, to be measured on the Pumping Test form, appropriate field forms (e.g. Daily Log form) and the study notebook.

4.3 Measure water levels (depth to water below a predetermined measuring point [MP]) in the pumping well and all piezometers and/or observation wells (synoptic round of water-level measurements) to an accuracy of 0.01 foot at least one day prior to the pumping test. Document the water levels, and initial and date data entries. The synoptic round of water-level measurements will include wells and piezometers inside and outside of the influence (impact) of the area tested.

4.4 Sound (measure the total depth) the test well and each well and/or piezometer measured in the synoptic round to an accuracy of 0.01 foot. Document the sounded depth, and initial and date data entries. Compare the sounded depth to the as-built total well/piezometer depth to ensure no appreciable sanding or silting (clogging) has occurred. If appreciable clogging has taken place, then the well or piezometer must be redeveloped to re-establish good hydraulic connection between the well or piezometer and the aquifer. Wells and piezometers must respond quickly to changes in water levels.

4.5 Establish background wells and/or piezometers to measure water-level trends outside the influence of the pumping well.

4.6 Install precleaned transducers and program data loggers, and/or install precleaned floats/probes and set up recorders on several, select wells and/or piezometers for an extended period of time (e.g., one week) prior to the test to monitor water-level trends throughout the test area. At least two hours of readings at quarter-hour to half-hour intervals should be collected immediately prior to start-up of the test. If water levels in the aquifer are fluctuating, then more readings will be necessary. Water-level fluctuation data may be needed to correct aquifer test data.

4.7 Obtain as many pretest (nonpumping), synoptic water-level readings as possible to provide a sound background water-level data base. If available, dedicate an individual to collect continuous, synoptic water-level measurements on the day of the test, from the time of arrival onsite to the start of the test.

4.8 Set up a rain gauge onsite to measure precipitation before, during, and after the test. Monitor the rain gauge on a regular basis, particularly if the tested aquifer is shallow. If precipitation is occurring at the beginning of the test, then the test should be postponed until optimum meteorological conditions prevail and water levels, if changing, return to static conditions. If needed, precipitation data collected during the test (after start-up) will be used to correct aquifer test data affected by recharge.

4.9 Set up a continuous recording barometer onsite to measure barometric pressure before, during, and after the test. If needed, data from this instrument will be used to correct aquifer test data for changes in barometric pressure during the pumping test.

4.10 Install a stream or tide gauge to measure changes in stream stage or tidal fluctuations before, during, and after the test if the pumping test site is located near a surface-water body. If needed, this data will be used to correct aquifer test data for changes in surface-water body elevations.

4.11 Ensure that the pumping system selected for the test is properly installed including the power supply and leak-free discharge line complete with a valve(s), flow meter, or manometer and orifice.

4.12 Make arrangements to dispose of the pumped water in an appropriate manner. If the pumped water is contaminated, then disposal may be via treatment and discharge, trucking offsite, etc. Water that is discharged onsite must be a substantial distance from the test site to preclude adversely affecting the test (e.g., recharging the aquifer during testing and influencing water levels).

4.13 Make sure that the proper transducers (data loggers) and gear ratios (water-level recorders) are used to measure the full anticipated range of drawdown in the wells and/or piezometers.

4.14 Install a precleaned transducer (which is preferred over manual measurement devices, e.g., steel tape and chalk or m-scope) in the test well, connect it to the data logger, and verify that the equipment is working. Program the data logger accordingly, using the PC and appropriate software.

4.15 Install precleaned transducers and program data loggers, and/or install precleaned floats/probes and set up recorders in select piezometers and/or observation wells to be monitored during the test (e.g., those impacted by the test, those serving as background). Verify that the equipment is working.

4.16 Conduct a step-drawdown (step) test several days before the scheduled constant-rate pumping test to check the performance of the pumping well and establish the pumping rate to be used for the final test. (Refer to the SOP for conducting a step-drawn test.) Use both automatic and manual water-level measuring devices to measure water levels in the wells and record appropriate measurements on the Pumping Test form and in the field notebook. The rate chosen for the pumping test will be the maximum rate the well can produce and sustain in order to stress the aquifer as much as possible.

4.17 Set the discharge line valve(s) so they will be preset and marked for the desired pumping rate (obtained from the step test).

4.18 Check that the in-line flow meter and/or manometer is indicating that the pumping rate is the same as that selected from the step test. It is preferred to use both devices to measure and monitor discharge to provide a check and a back up.

4.19 Begin the pumping test only after the water level in the aquifer has returned to the nonpumping (static) conditions observed prior to the step test.

4.20 Check that all equipment is functioning properly before starting the test (e.g., transducers and data loggers, automated water-level recorders, m-scopes, valves in proper position, generator running properly and sufficient fuel [if needed], power supply, etc.)

4.21 Synchronize all watches prior to the test.

4.22 Begin the pumping test on the hour or half-hour and pump at a constant rate until sufficient data is collected to analyze the test (at least 24 hours or longer if needed). Some pumping tests may require several days (sometimes up to and exceeding 1 week) to collect the data needed to analyze the test.

4.23 Measure water levels (drawdown) on a specified schedule. An example of the frequency of measurements to produce a uniform plot of water-level data on a logarithmic scale follows:

Elapsed Time (minutes)	Frequency of Measurement
0 - 1	Every 15 seconds
1 - 5	Every 30 seconds
5 - 10	Every minute
10 - 30	Every 2 minutes
30 - 60	Every 5 minutes
60 - 120	Every 10 minutes
120 - 180	Every 20 minutes
180 - 360	Every 30 minutes
360 - 1,440	Every hour
1,440 - 2,880	Every 2 hours
2,880 - end of test	Every 4 hours

4.24 Check the drawdown measurements obtained with the automated water-level measuring devices (on a regular basis) manually using a m-scope and/or a steel tape and chalk to an accuracy of 0.01 foot. If a recorder is used, then "tick" recorders and document the time next to each "tick" in the chart. Manual measurements should be made as close to the established schedule as possible. However, if a reading is missed, then take a measurement as soon as possible after the scheduled reading and record the actual time. This will maintain the time versus drawdown relationship needed to analyze the test data. Record water-level data on the Pumping Test form, and initial and date data entry.

4.25 Check the discharge rate using the in-line flow meter and/or manometer on a regular basis. If adjustments have to be made to maintain the constant pumping rate, then adjust the valve. Record readings and adjustments (if made) on the Pumping Test form and the field notebook, and initial and date data entry.

4.26 Measure temperature, pH, and conductivity of discharged water on a periodic, regular basis. Record data on the Pumping Test form and in the field notebook, and initial and date data entry.

4.27 Note any changes, throughout the pumping test, that are pertinent to the test such as changes in water color or turbidity, time and length of any temporary pump shut down, effects of any nearby pumping wells, precipitation events, etc. Document these notes on the Pumping Test form and in the field notebook, and initial and date data entry.

4.28 Measure water levels in the pumping well and as many piezometers and/or wells as practical (to an accuracy of 0.01 foot) following recovery procedures if there is a shutdown, no matter how brief.

4.29 Measure water levels together during a change in personnel for at least one period of measurement to ensure consistency. Note the personnel change and time on the Pumping Test form and in the field notebook, and initial and date data entry.

4.30 Begin plotting the drawdown verses time data, when time allows, on the appropriate graph paper (semi-logarithmic and/or full logarithmic) to perform a preliminary analysis of the data for hydraulic coefficients and determine if the pumping test can be terminated or has to be extended. Correct drawdown data as needed before plotting (e.g., for dewatering, barometric efficiency, tidal fluctuations, regional trends, etc.)

4.31 Shut down the pumping test at the specified time or when sufficient data has been collected to analyze the pumping test data. Shut down should occur on the hour or half-hour so that recovery starts on the hour or half-hour.

4.32 Close the valve (closest to the pump) as quickly as possible to prevent back flow of water into the pumping well.

4.33 Measure recovery (rise in water levels) to an accuracy of 0.01 foot until water levels return as close as possible to pretest levels. The identical measurement schedule followed for the drawdown phase should be followed during the recovery phase. Automated water-level recorders should be left in select wells and/or piezometers (same ones monitored during pretest) to monitor water levels for an extended period of time (one or more days).

4.34 Collect at least one round of synoptic water-level measurements after water levels have recovered following the test.

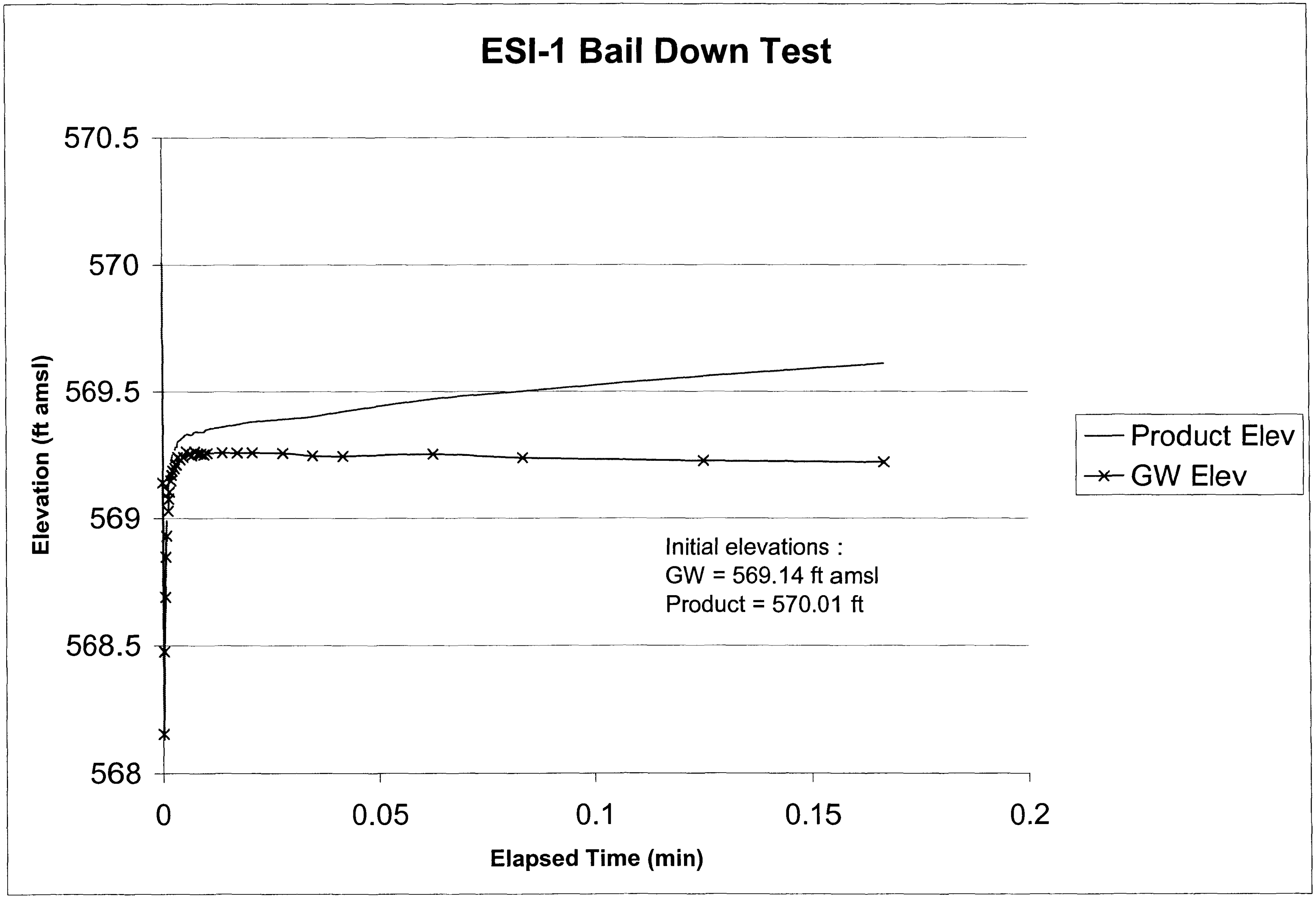
4.35 Secure all wells and/or piezometers after the collection of water-level data is completed (i.e., replace cap and/or cover, and lock).

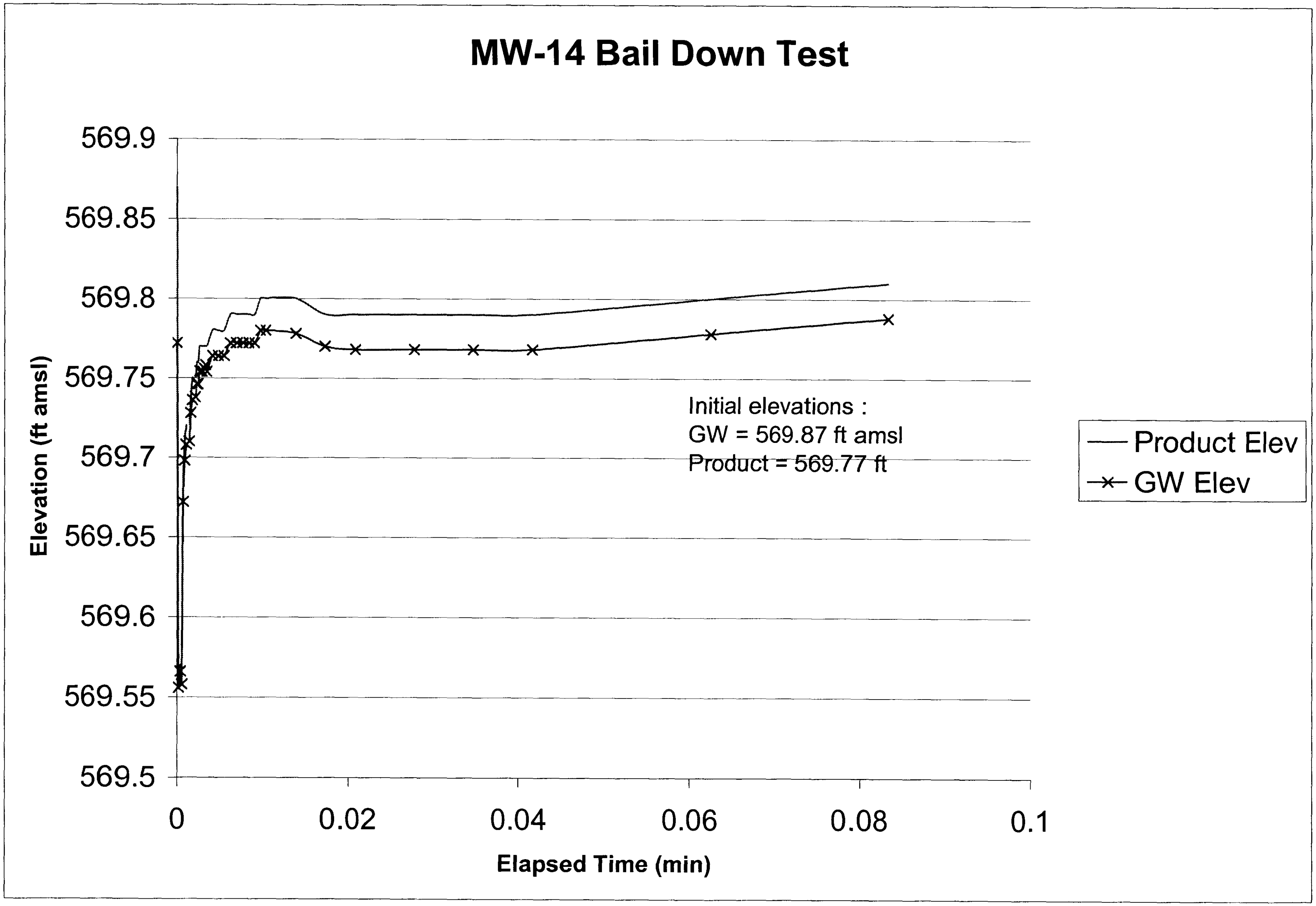
4.36 Clean (decontaminate) all test equipment that came in contact with the ground water according to the appropriate protocol given in Section 3.0. Dispose of all materials that cannot be decontaminated in an appropriate manner (e.g., discharge hose, etc.).

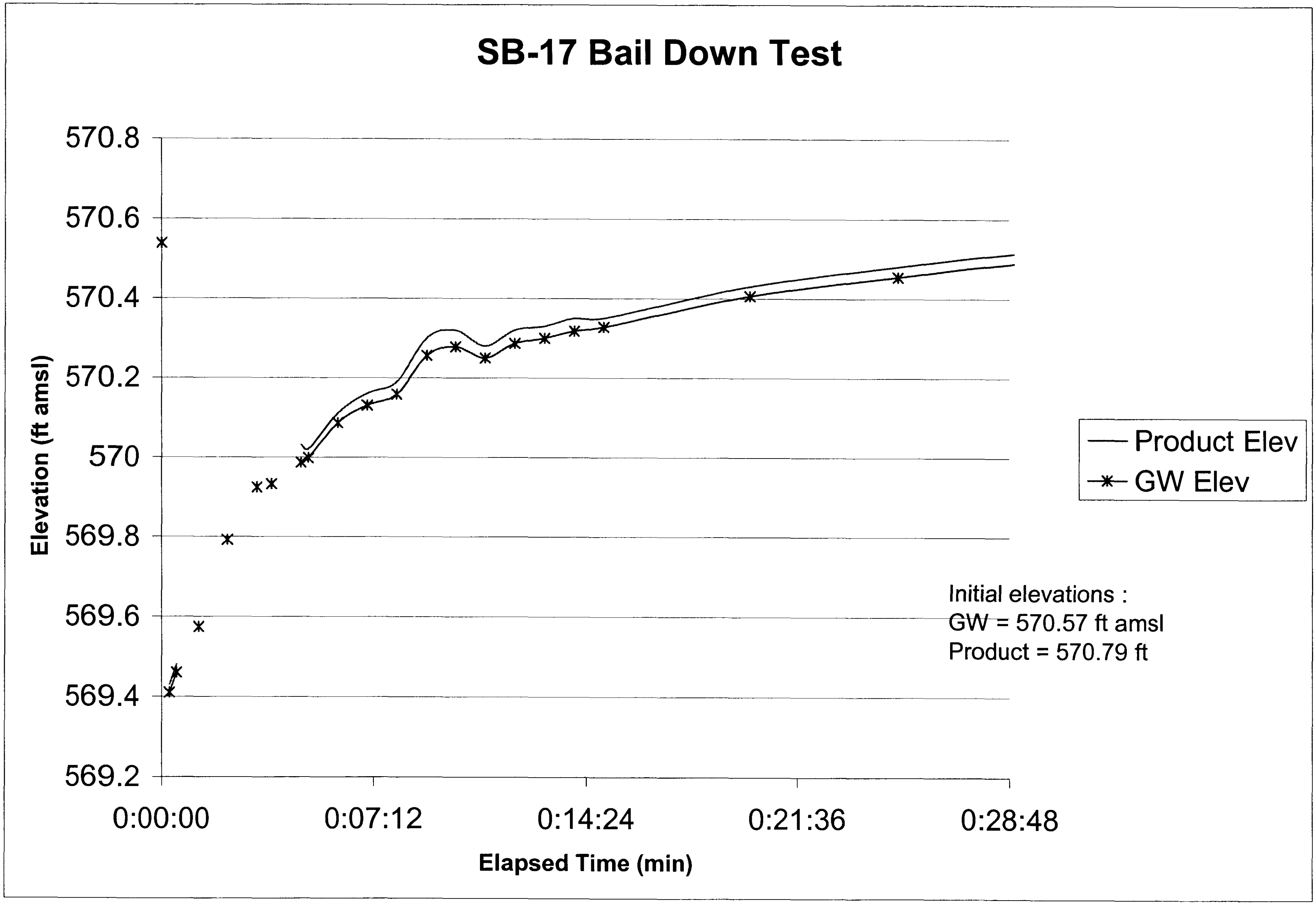
END OF PROCEDURE

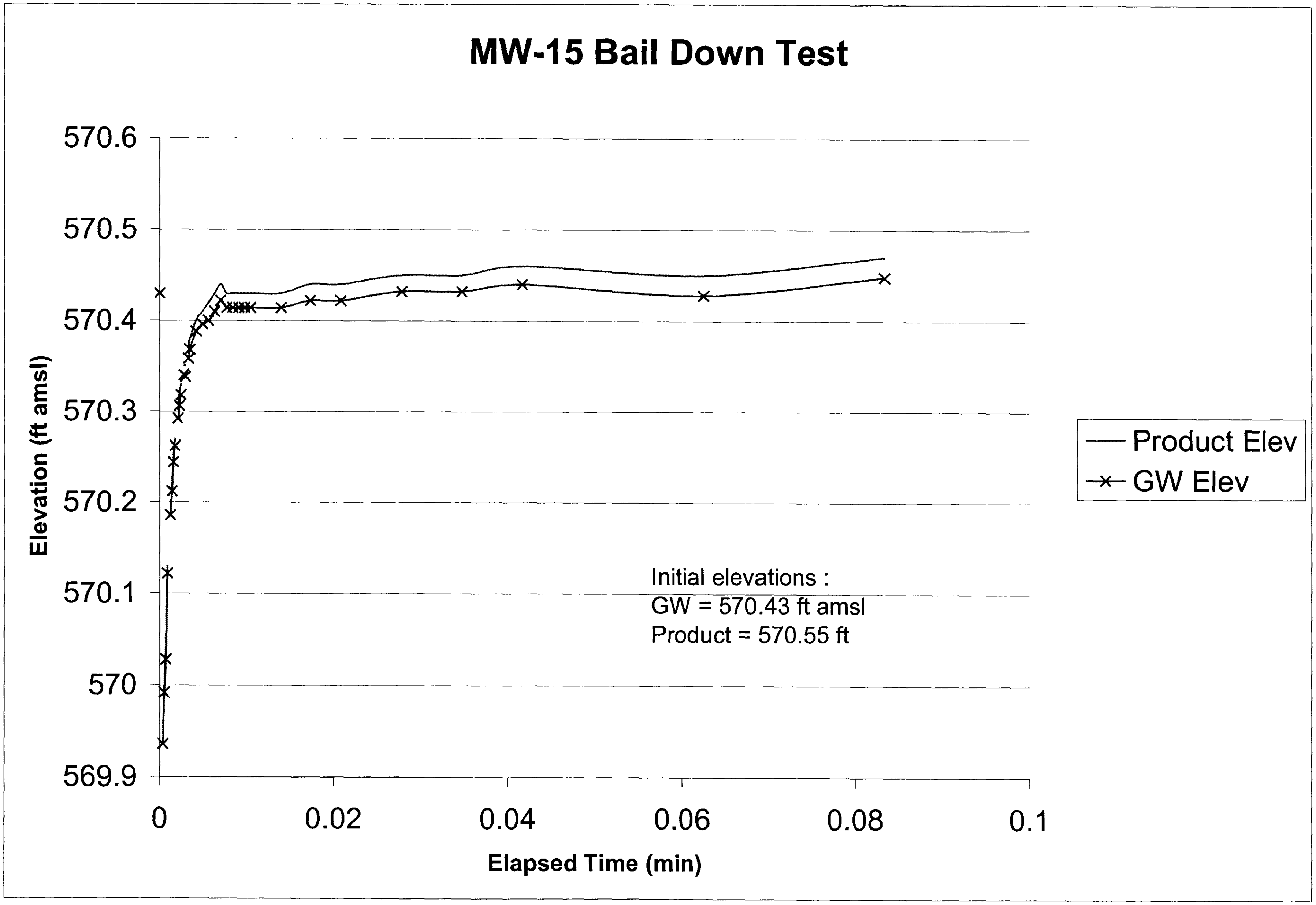
APPENDIX F

Results From Bail-Down Tests


ESI-1 Bail Down Test
570.5
570
569.5
569
568.5
568
Elevation (ft amsl)
0
0.05
0.1
0.15
0.2
Elapsed Time (min)
Product Elev
GW Elev
Initial elevations :
GW = 569.14 ft amsl
Product = 570.01 ft


MW-14 Bail Down Test
569.9
569.85
569.8
569.75
569.7
569.65
569.6
569.55
569.5
Elevation (ft amsl)
0
0.02
0.04
0.06
0.08
0.1
Elapsed Time (min)
Initial elevations :
GW = 569.87 ft amsl
Product = 569.77 ft
Product Elev
GW Elev


SB-17 Bail Down Test
570.8
570.6
570.4
570.2
570
569.8
569.6
569.4
569.2
Elevation (ft amsl)
0:00:00
0:07:12
0:14:24
0:21:36
0:28:48
Elapsed Time (min)
Product Elev
GW Elev
Initial elevations :
GW = 570.57 ft amsl
Product = 570.79 ft


MW-15 Bail Down Test
570.6
570.5
570.4
570.3
570.2
570.1
570
569.9
Elevation (ft amsl)
0
0.02
0.04
0.06
0.08
0.1
Elapsed Time (min)
Product Elev
GW Elev
Initial elevations :
GW = 570.43 ft amsl
Product = 570.55 ft

APPENDIX G

Hydrocarbon Characterization (gas chromatographs)

ROUX — CHAIN OF CUSTODY

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

PAGE 1 OF 1

PROJECT NAME: ExxonMobil Buffalo Terminal
PROJECT NUMBER: 1725Z404
PROJECT LOCATION: Buffalo, NY
PROJECT MANAGER: Noelle Clarke
SAMPLER(S): SS

ANALYSES

SAMPLE DESIGNATION / LOCATION	DATE COLLECTED	TIME COLLECTED	SAMPLE MATRIX	Viscosity	Density	Interfacial Tension	Surface Tension	Hydrocarbon characterization	TOTAL BOTTLES	NOTES
LF-6/RW-8	6/28/02	2000	WG	✓	✓	✓	✓	✓	3	
LF-6/RW-8	6/28/02	2000	Product	✓	✓	✓	✓	✓	3	
RW-7	6/28/02	2045	WG	✓	✓	✓	✓	✓	3	
RW-7	6/28/02	2045	Product	✓	✓	✓	✓	✓	3	
RW-9	6/27/02	840	WG	✓	✓	✓	✓	✓	3	
RW-9	6/27/02	840	Product	✓	✓	✓	✓	✓	3	

RELINQUISHED BY: (SIGNATURE)	FOR	DATE	TIME	SEAL INTACT Y OR N	RECEIVED BY: (SIGNATURE)	FOR	DATE	TIME	SEAL INTACT Y OR N
[signature]		7/2	1000		Bruce Torkelson	TGI	7/4/02	1030	Y

DELIVERY METHOD: Fed Ex

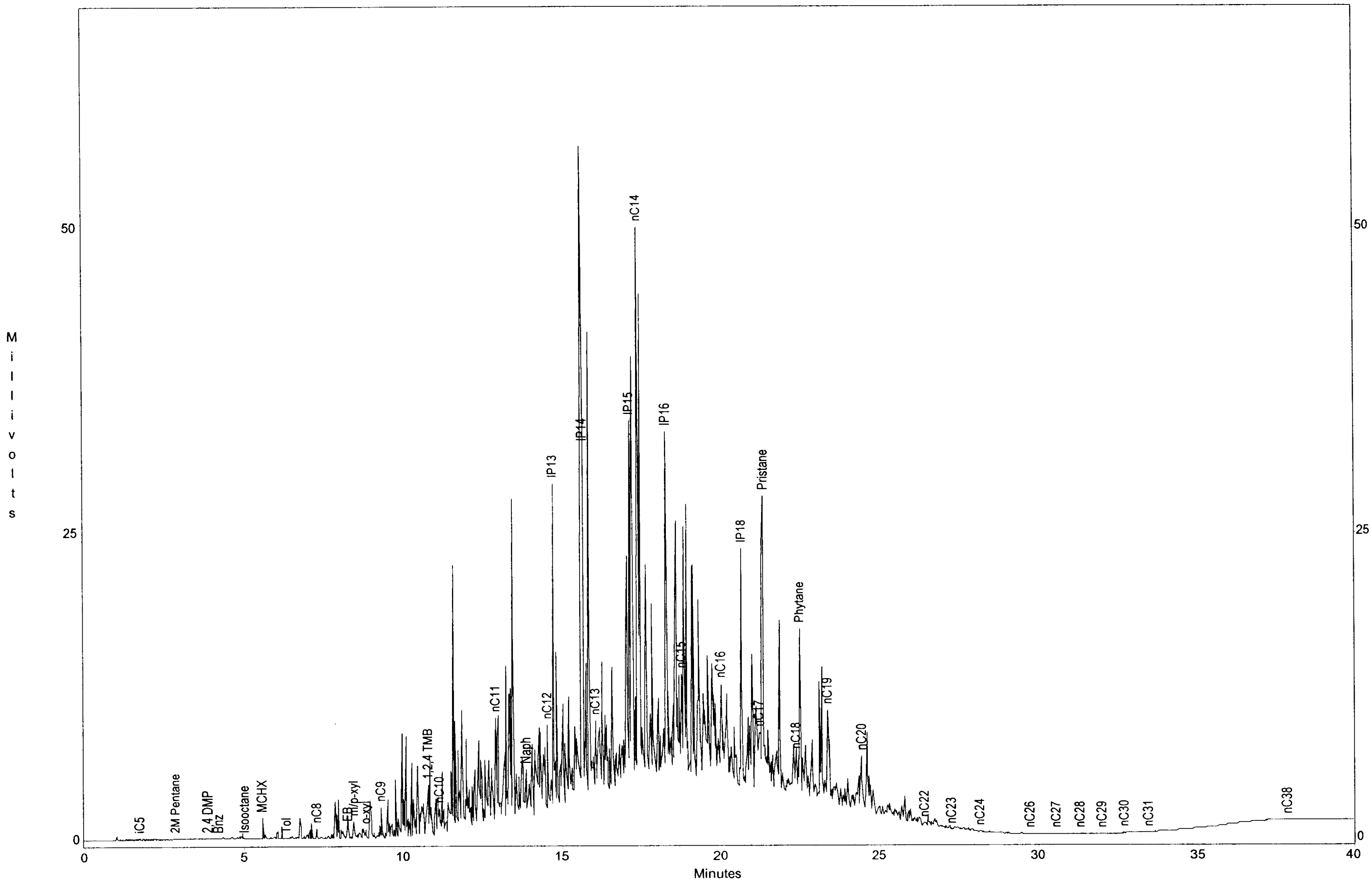
ANALYTICAL LABORATORY: Torkelson Geochemistry

COMMENTS: S.T.A.T. – please email results to "ssenh@rouxinc.com"

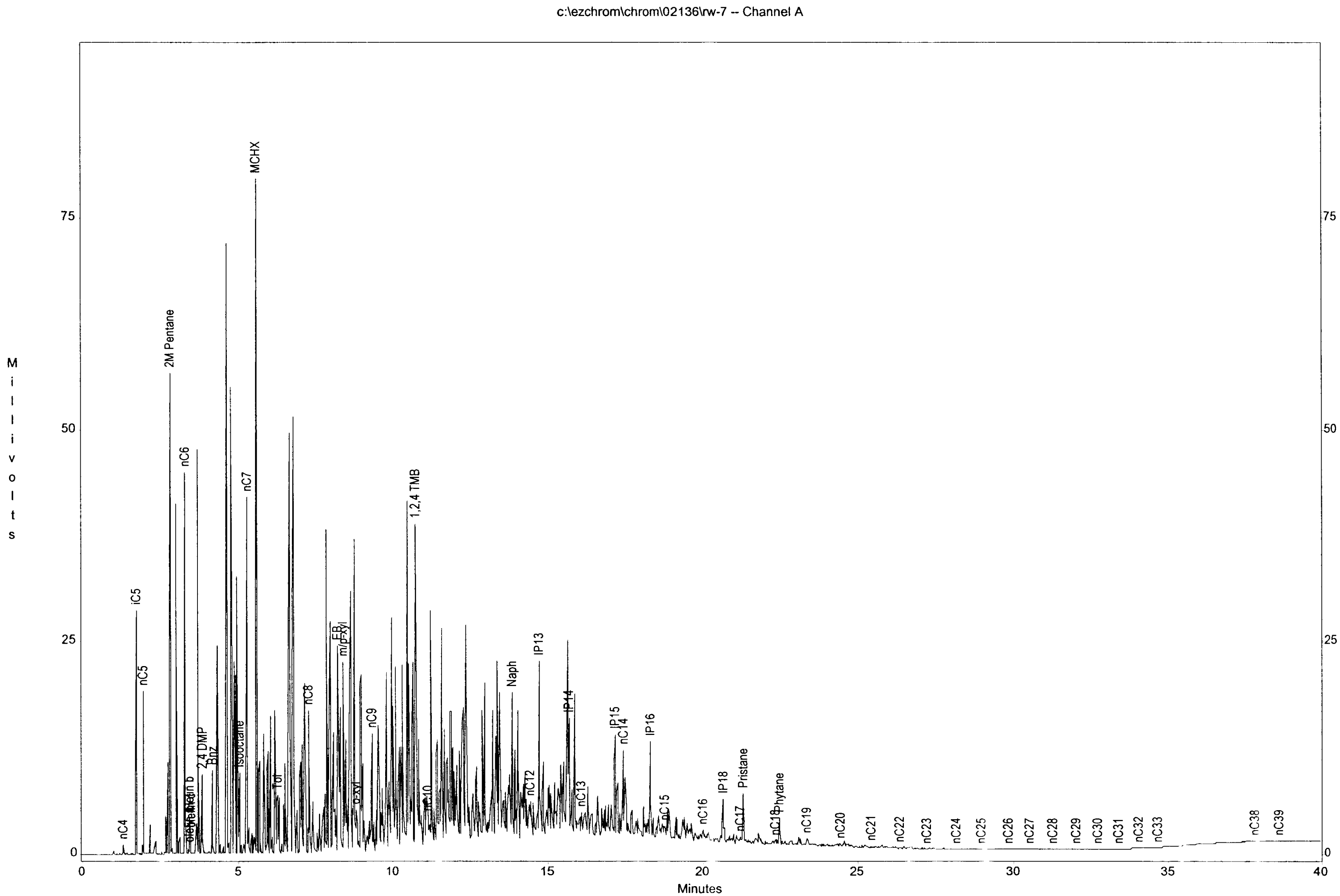
CHAINOF.CDR 12AUG98

Exxon Mobil Buffalo Terminal
Sample ID : LF-6/RW-8
Acquired : Jul 08, 2002 11:28:14

c:\ezchrom\chrom\02136\lf6-rw8 -- Channel A

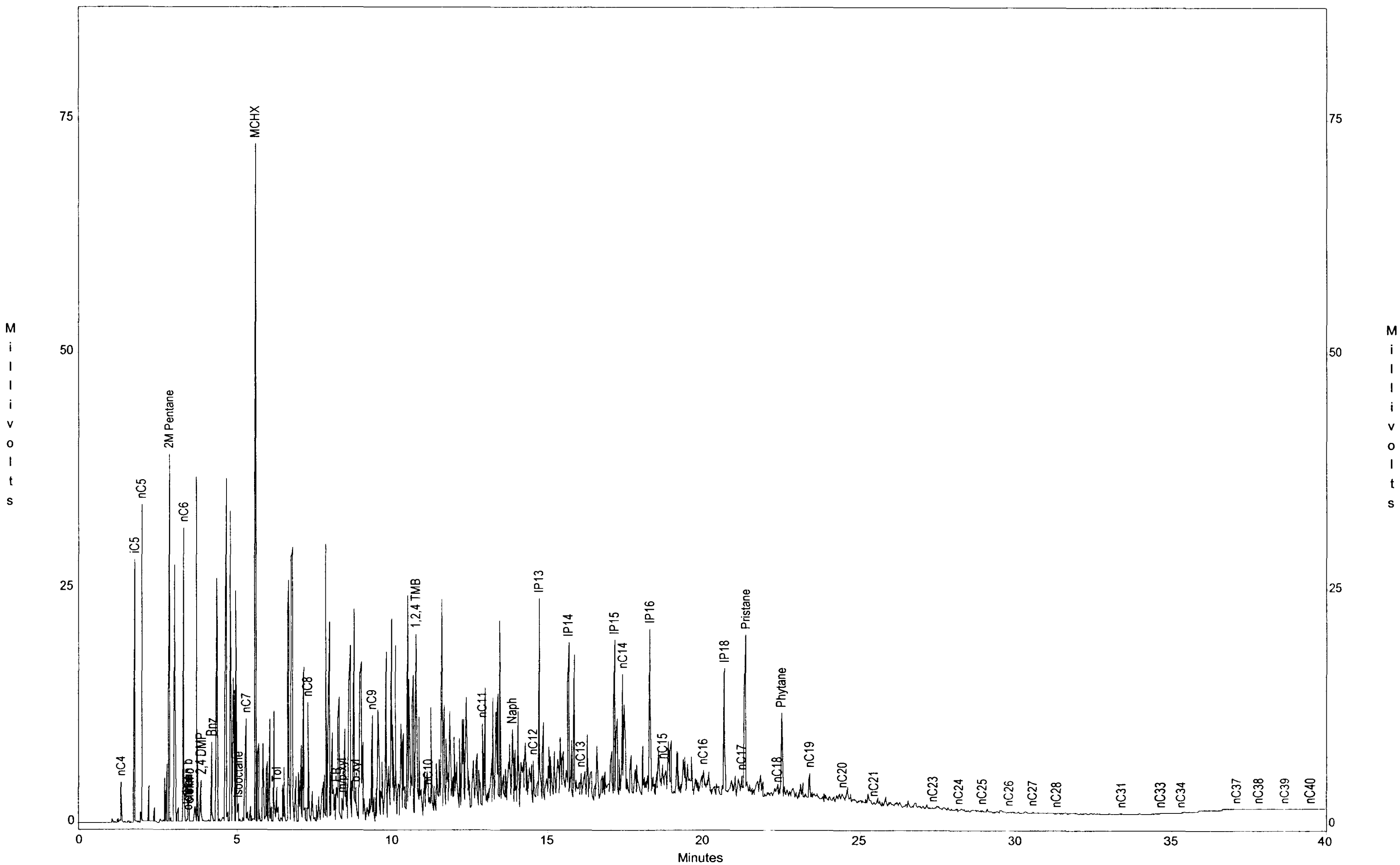


Exxon Mobil Buffalo Terminal
Sample ID : RW-7
Acquired : Jul 08, 2002 14:00:31



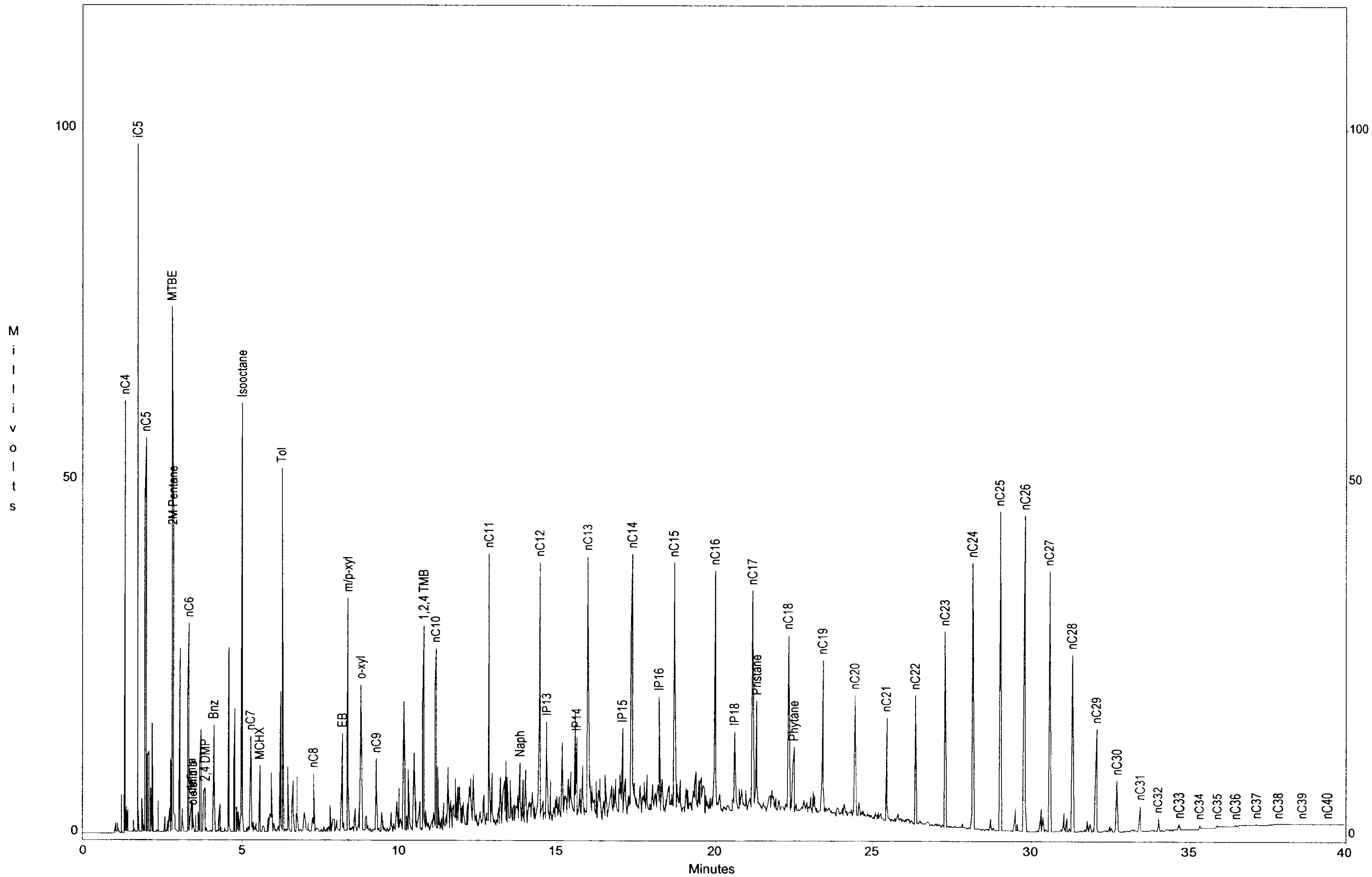
Exxon Mobil Buffalo Terminal
Sample ID : RW-9
Acquired : Jul 08, 2002 13:10:33

c:\ezchrom\chrom\02136\rw-9 -- Channel A



Exxon Mobil Buffalo Terminal
Sample ID : Gas/Dies/Wax std
Acquired : Jul 08, 2002 12:18:51

c:\ezchrom\chrom\02136\gadiwax2 -- Channel A



Torkelson Geochemistry, Inc.							
Physical Properties Measurements							
Sample	TGI Job	Density (gm/ml)	Viscosity (centipoise)	Surface Tension Air/Water (dynes/cm)	Interfacial Tension NAPL/Water (dynes/cm)	Surface Tension Air/NAPL (dynes/cm)	Temperature of Measurements (Fahrenheit)
LF-6/RW-8	02136	0.8830	4.33	69	17.7	26.7	60
RW-7	02136	0.8102	1.51	58.3	10.5	23	60
RW-9	02136	0.8329	2.82	68	6.6	24.7	60

Torkilson Geochemical labs
Tulsa Oklahoma

~~TestAmerica~~
~~INCORPORATED~~

~~Nashville Division~~
2960 ~~Foster~~ Creighton
Nashville, TN 37204

Phone: ~~615-726-0177~~
Toll Free: ~~800-765-0980~~
Fax: 615-726-3404

Torkelson Geochemical Labs
2528 South Columbia Place
Tulsa Oklahoma 74114

ExxonMobil

Consultant Name: Roux Assoc / Sin Sohn
Address: 1377 Motor Pkwy
City/State/Zip: Islandia N.Y. 11749
ExxonMobil Project Mgr: J. Abel
Telephone Number: 631 232 2600 Fax No.: 631 232 9898
Sampler Name: (Print) Mike Reisch / GES 716 873 4021
Sampler Signature: [signature]

Report To: Roux / Sin
Invoice To: (ExxonMobil PM unless otherwise indicate)
Account #:
PO #:
Facility ID # 31010 Buffalo Terminal
Site Address 625 Elk st
City, State, Zip Buffalo N.Y.

Regulatory District (CA)

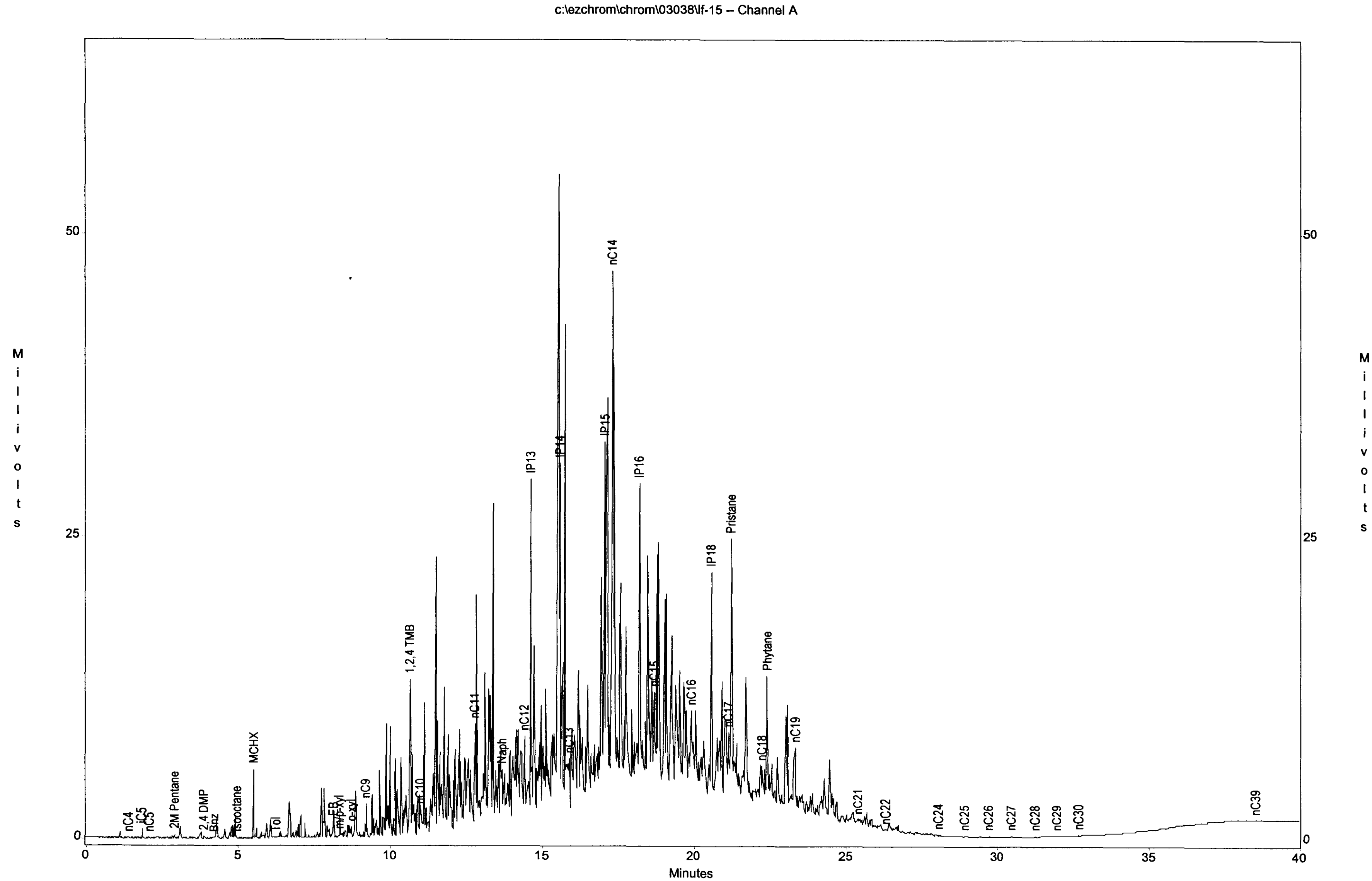
Sample ID / Description	Date Sampled	Time Sampled	No. of Containers Shipped	Grab	Composite	Field Filtered	Preservative: Ice	HNO_3 (Red Label)	HCl (Blue Label)	NaOH (Orange Label)	H_2SO_4 Plastic (Yellow Label)	H_2SO_4 Glass (Yellow Label)	None (Black Label)	Other (Specify)	Matrix: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify): Hydro Carbon	Analyze For: Viscosity	Interfacial Tension	Surface Tension	Hydrocarbon Characterization	Specific Gravity	RUSH TAT (Pre-Schedule)	TAT request (in Bus. Days)	STD TAT	Fax Results
MW-43	3/3	1002	6	X									X		3					3	/	/	/	/	/			X	
MW-15	3/3	0900	6												3					3	/	/	/	/	/				
MW-18	3/3	1145	6												3					3	/	/	/	/	/				
MW-41	3/3	1215	6												3					3	/	/	/	/	/				
RW-5	3/3	1355	6												3					3	/	/	/	/	/				
MW-25	3/3	1030	6												3					3	/	/	/	/	/				
MW-46	3/3	1100	6												3					3	/	/	/	/	/				
LF-15	3/3	0925	6												3					3	/	/	/	/	/				

Special Instructions:

Laboratory Comments:
Temperature Upon Receipt:
Sample Containers Intact? Y N
VOCs Free of Headspace? Y N

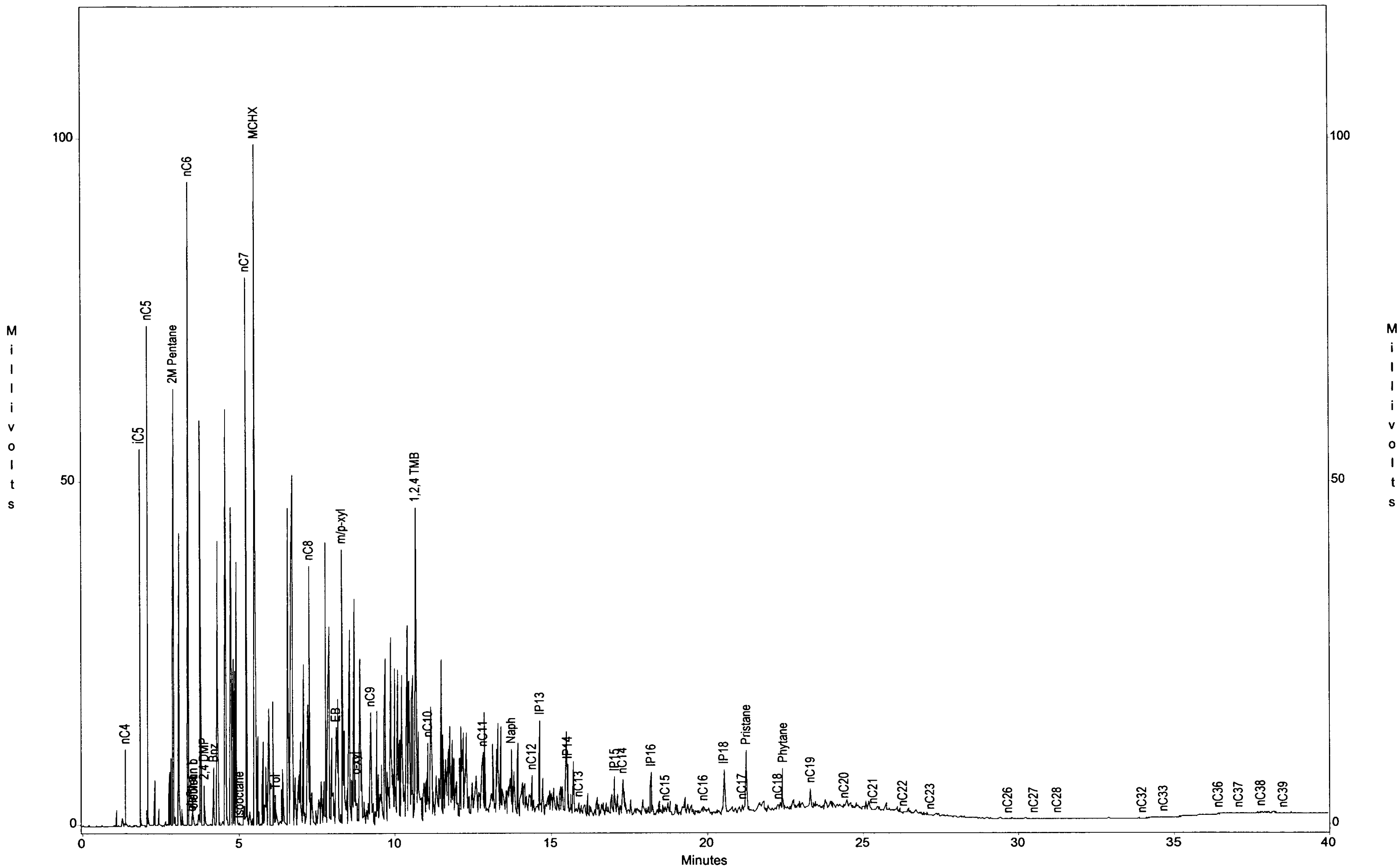
Relinquished by:	Date	Time	Received by:	Date	Time
[signature]	3/3/03	1500	[signature] Bruce Torkelson	3-4-03	1056
Relinquished by:	Date	Time	Received by TestAmerica:	Date	Time

31010 Buffalo Terminal, 625 Elk St., Buffalo, NY
Sample ID : LF-15
Acquired : Mar 05, 2003 11:15:59

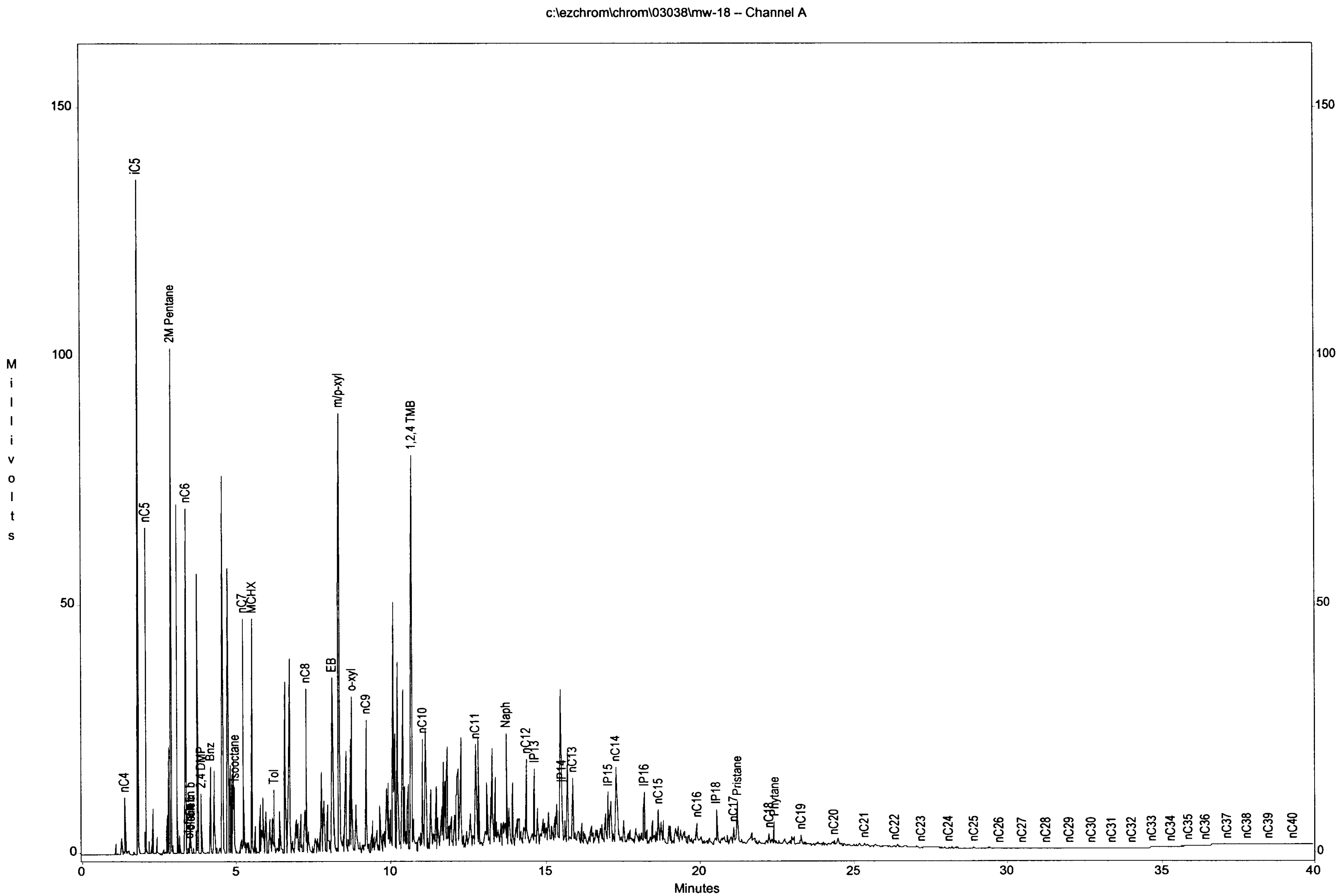


31010 Buffalo Terminal, 625 Elk St., Buffalo, NY
Sample ID : MW-15
Acquired : Mar 05, 2003 12:05:03

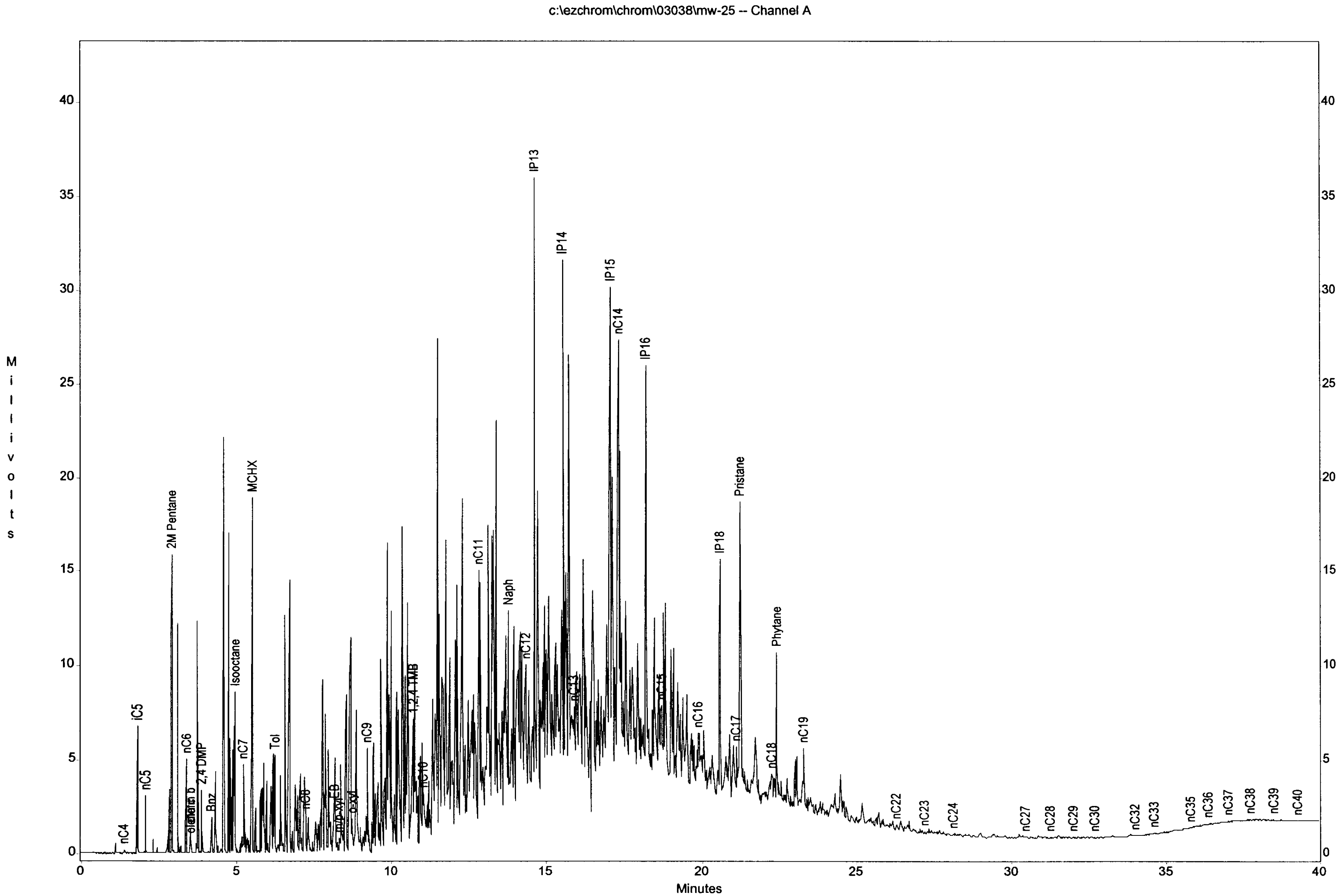
c:\ezchrom\chrom\03038\mw-15 -- Channel A



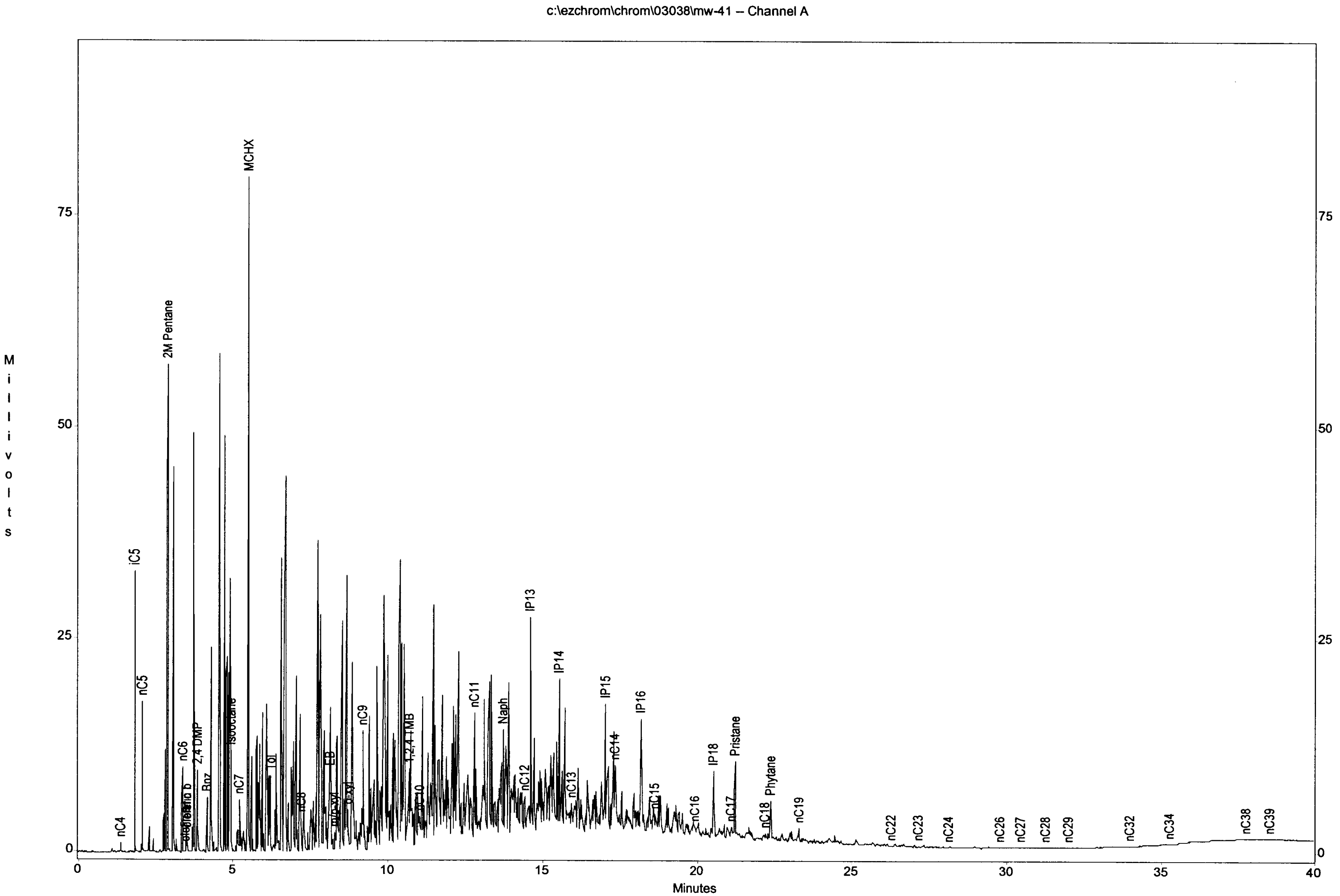
31010 Buffalo Terminal, 625 Elk St., Buffalo, NY
Sample ID : MW-18
Acquired : Mar 05, 2003 12:53:09



31010 Buffalo Terminal, 625 Elk St., Buffalo, NY
Sample ID : MW-25
Acquired : Mar 05, 2003 13:42:27

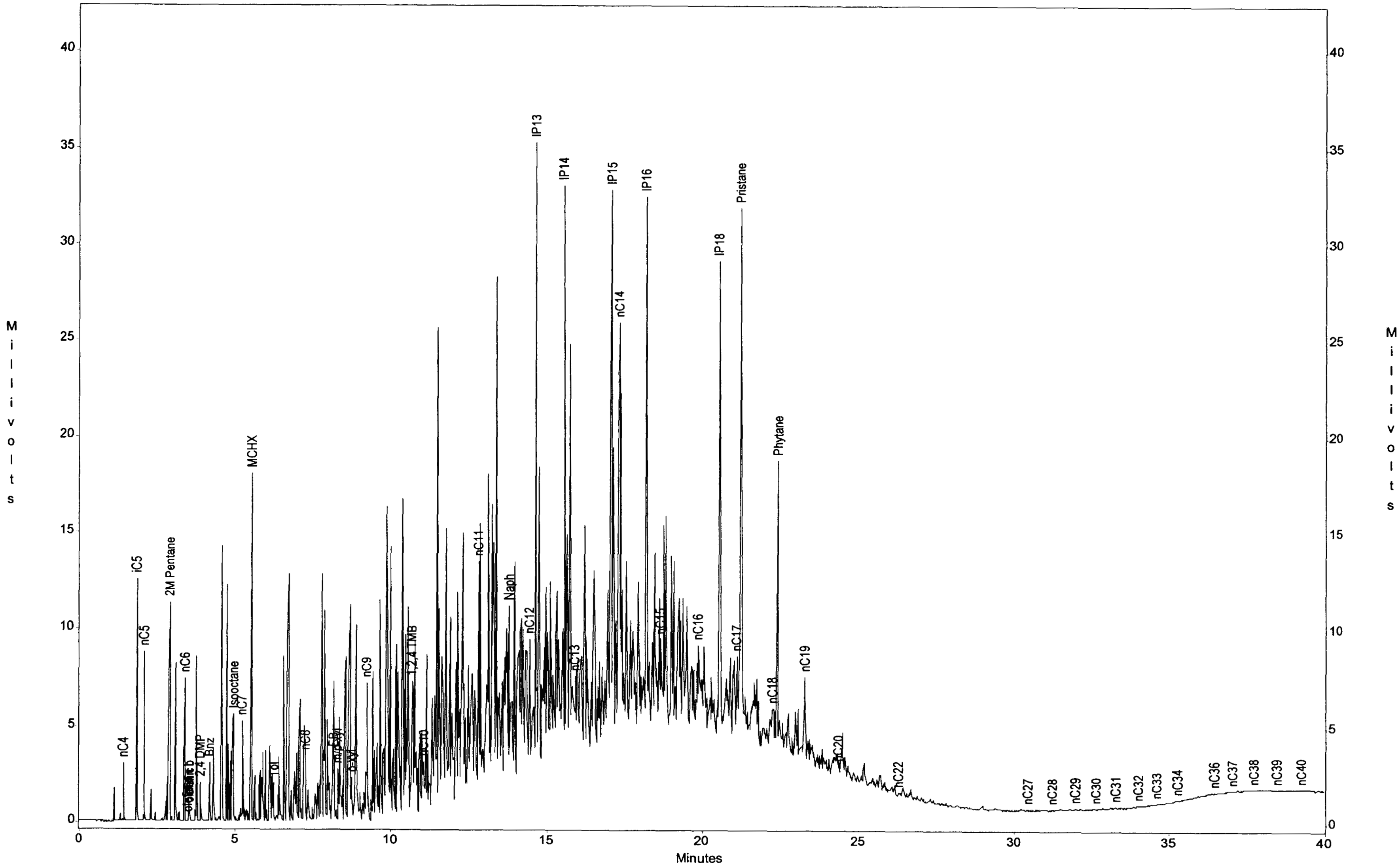


31010 Buffalo Terminal, 625 Elk St., Buffalo, NY
Sample ID : MW-41
Acquired : Mar 05, 2003 14:32:19



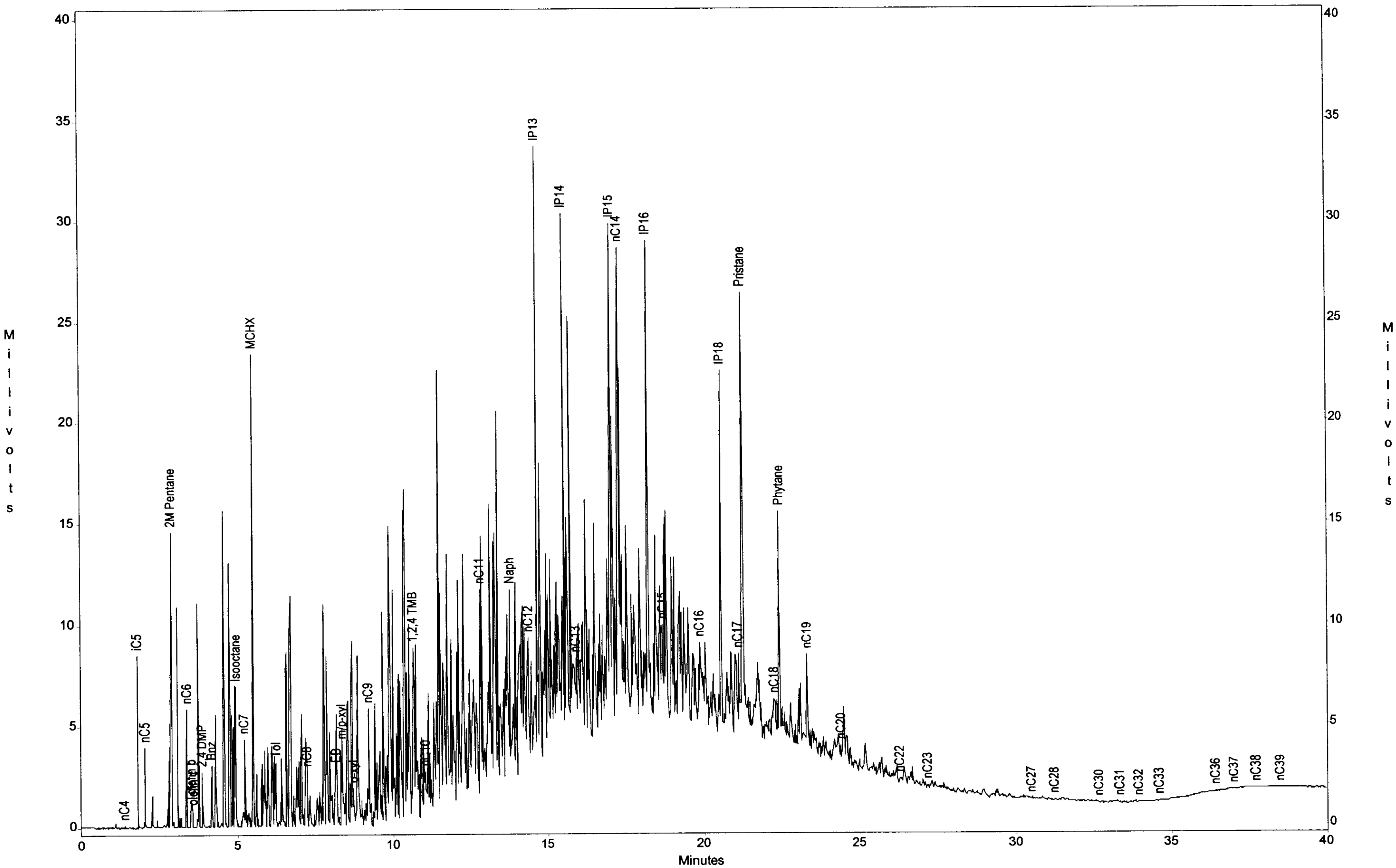
31010 Buffalo Terminal, 625 Elk St., Buffalo, NY
Sample ID : MW-43
Acquired : Mar 05, 2003 15:21:30

c:\ezchrom\chrom\03038\mw-43 -- Channel A



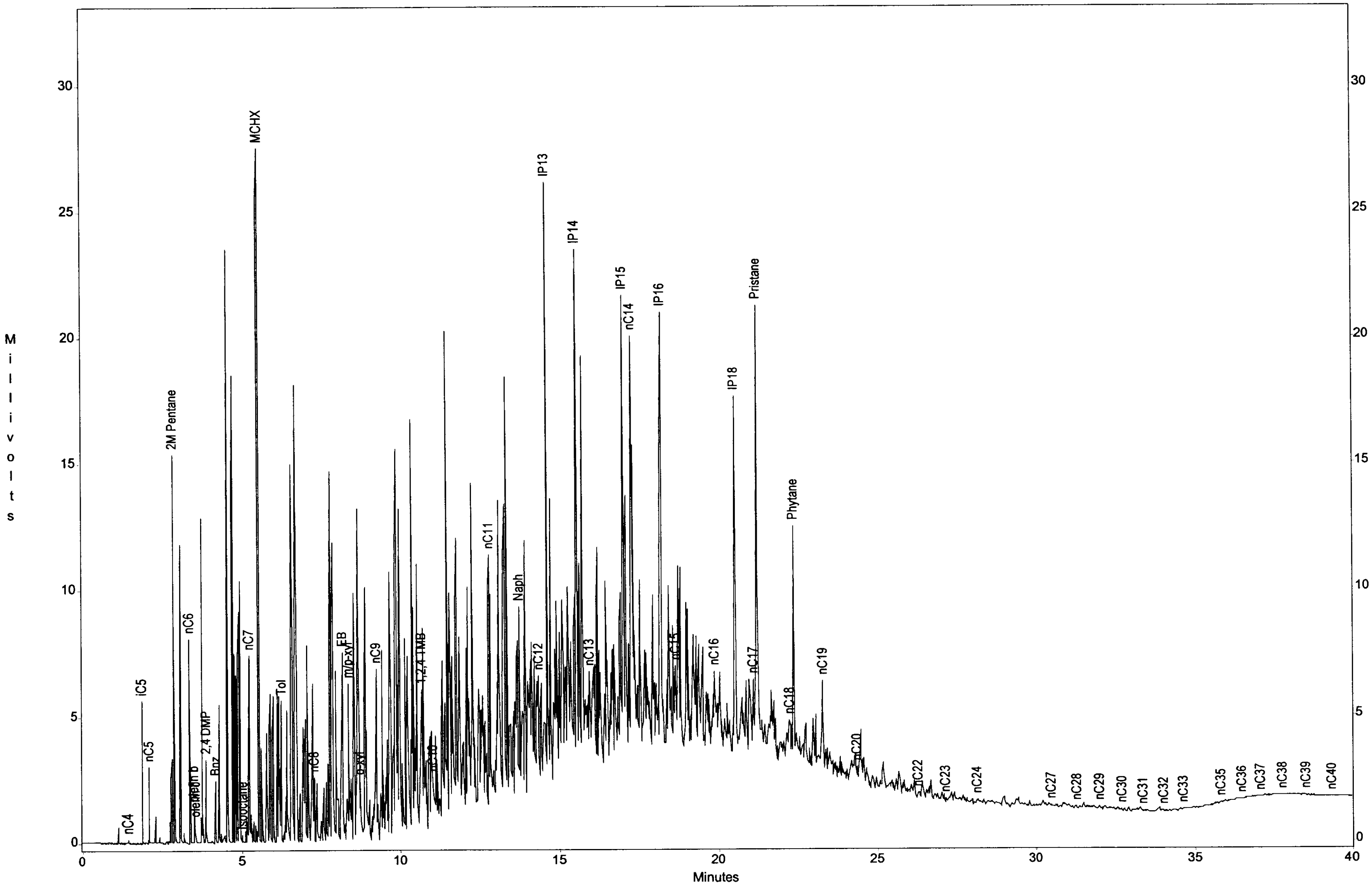
31010 Buffalo Terminal, 625 Elk St., Buffalo, NY
Sample ID : MW-46
Acquired : Mar 05, 2003 16:10:07

c:\ezchrom\chrom\03038\mw-46 -- Channel A



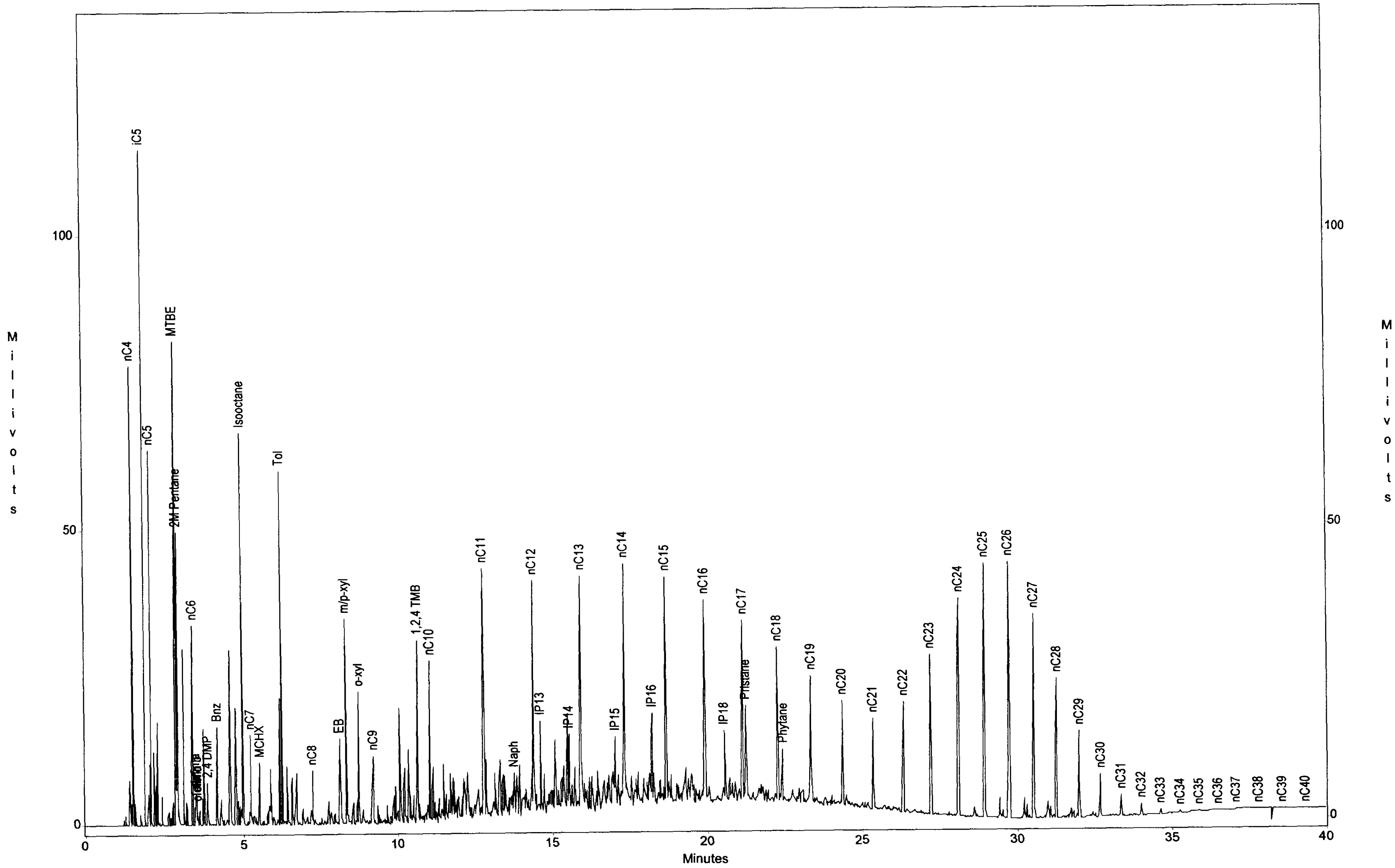
31010 Buffalo Terminal, 625 Elk St., Buffalo, NY
Sample ID : RW-5
Acquired : Mar 05, 2003 17:07:37

c:\ezchrom\chrom\03038\rw-5 -- Channel A



31010 Buffalo Terminal, 625 Elk St., Buffalo, NY
Sample ID : Gas/Dies/Wax std
Acquired : Mar 05, 2003 10:25:39

c:\ezchrom\chrom\03038\gadiwax2 -- Channel A



Torkelson Geochemistry, Inc.

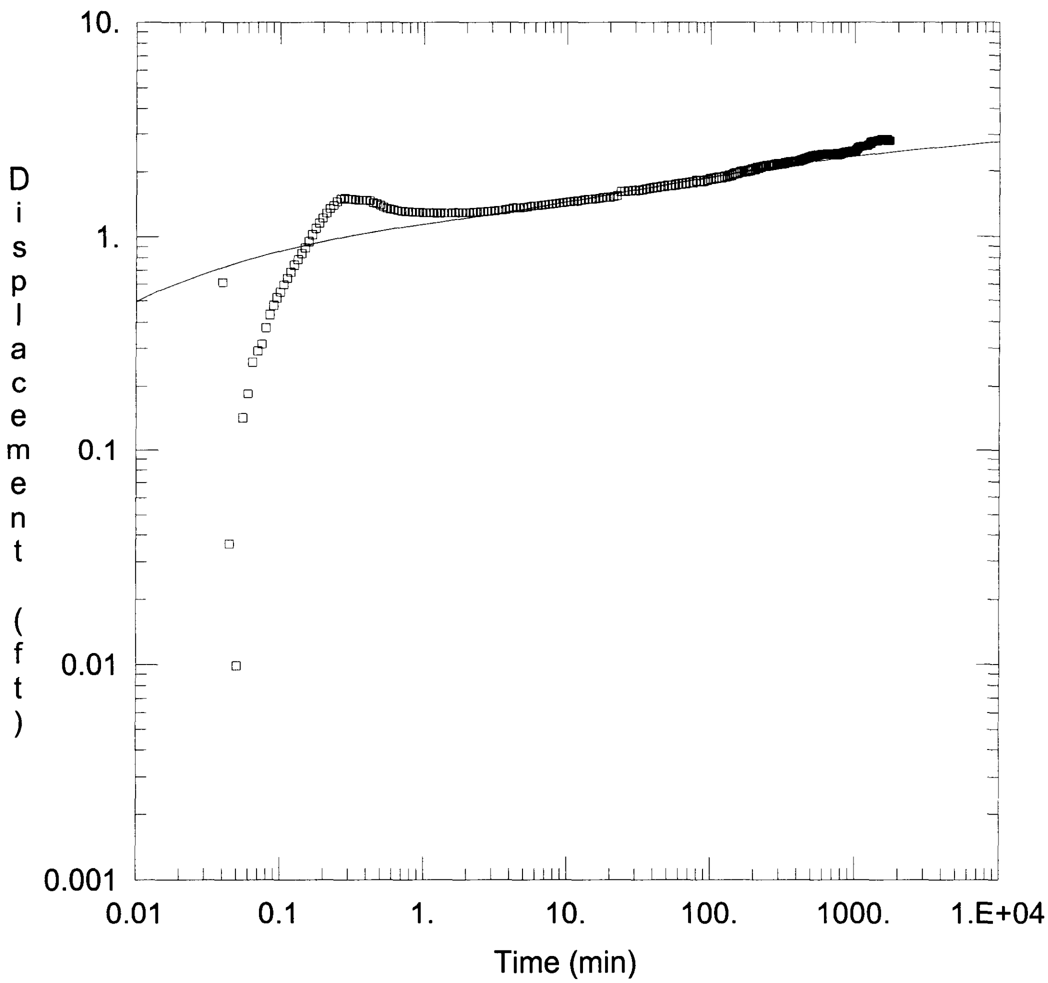
Physical Properties Measurements

Sample	TGI Job	Density (gm/ml)	Viscosity (centipoise)	Surface Tension Air/Water (dynes/cm)	Interfacial Tension NAPL/Water (dynes/cm)	Surface Tension Air/NAPL (dynes/cm)	Temperature of Measurements (Fahrenheit)
LF-15	03038	0.8835	4.26	58.97	15.17	26.11	60
MW-15	03038	0.8110	1.89	60.76	13.75	23.39	60
MW-18	03038	0.8304	2.03	52.68	3.55	23.50	60
MW-25	03038	0.8533	3.96	58.28	13.31	25.53	60
MW-41	03038	0.8182	1.92	67.34	10.85	22.67	60
MW-43	03038	0.8523	4.04	53.17	5.58	24.07	60
MW-46	03038	0.8570	4.24	61.15	11.61	26.17	60
RW-5	03038	0.8571	4.90	54.84	10.59	25.80	60
MW-18 repeat analysis*	03038	NA	NA	51.02	3.72	23.77	60

*The tension analyses were repeated to confirm the rather low NAPL/Water interfacial tension for this sample.

APPENDIX H

Pump Test Analysis



WELL TEST ANALYSIS

Data Set: E:\Buffalo\Aquifer Testing\Pump Tests\RW-7 Pump Test\Aqtesolv data\RW-7 corrected.aqt
Date: 03/21/03 Time: 09:34:24

PROJECT INFORMATION

Company: Roux Associates, Inc.
Client: ExxonMobil
Project: 17252Y05
Test Location: Buffalo, New York
Test Well: RW-7
Test Date: 6/24/02

AQUIFER DATA

Saturated Thickness: 20. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
RW-7	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ RW-7	0.4167	0

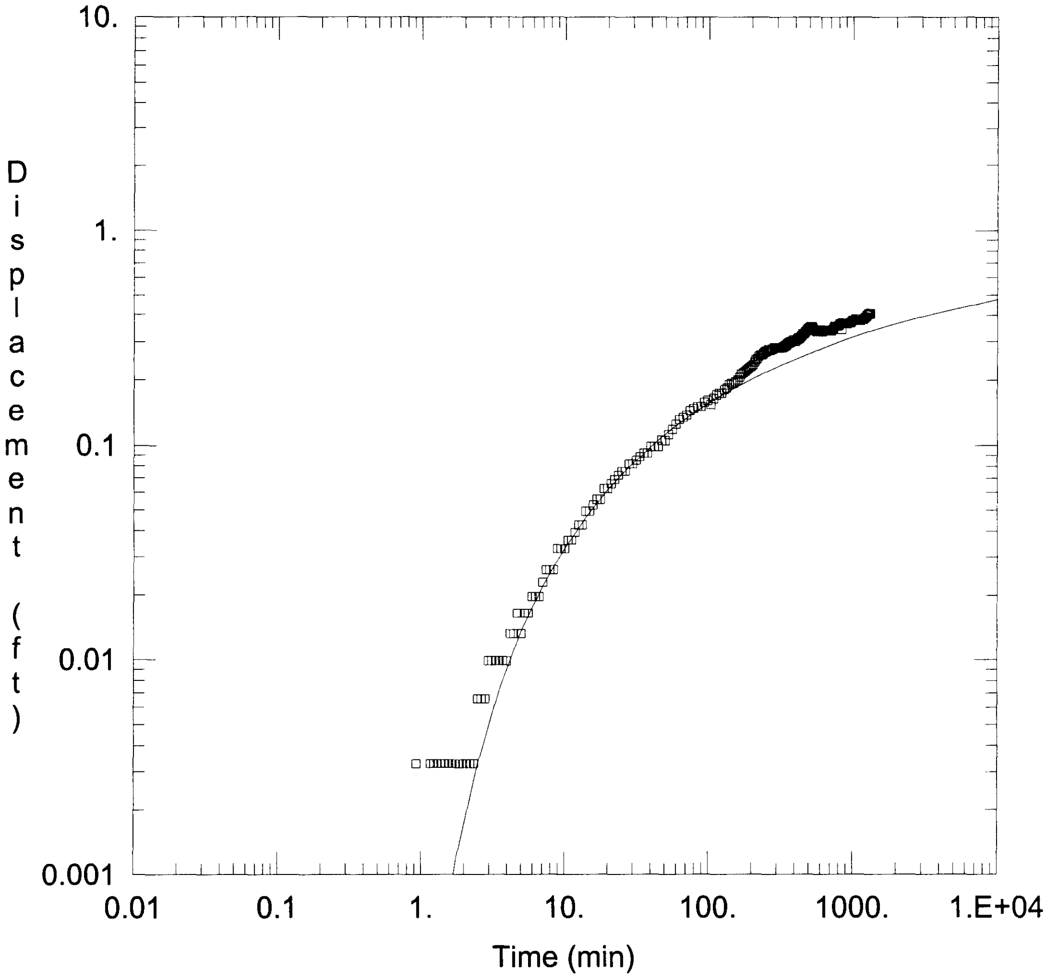
SOLUTION

Aquifer Model: Unconfined

Solution Method: Neuman

T = 1262.9 ft^2/day
Sy = 0.04177

S = 0.007374
ß = 0.001



WELL TEST ANALYSIS

Data Set: E:\Buffalo\Aquifer Testing\Pump Tests\RW-7 Pump Test\Aqtesolv data\MW-40.aqt
Date: 03/21/03 Time: 09:35:20

PROJECT INFORMATION

Company: Roux Associates, Inc.
Client: ExxonMobil
Project: 17252Y05
Test Location: Buffalo, New York
Test Well: RW-7
Test Date: 6/24/02

AQUIFER DATA

Saturated Thickness: 20. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
RW-7	0	0

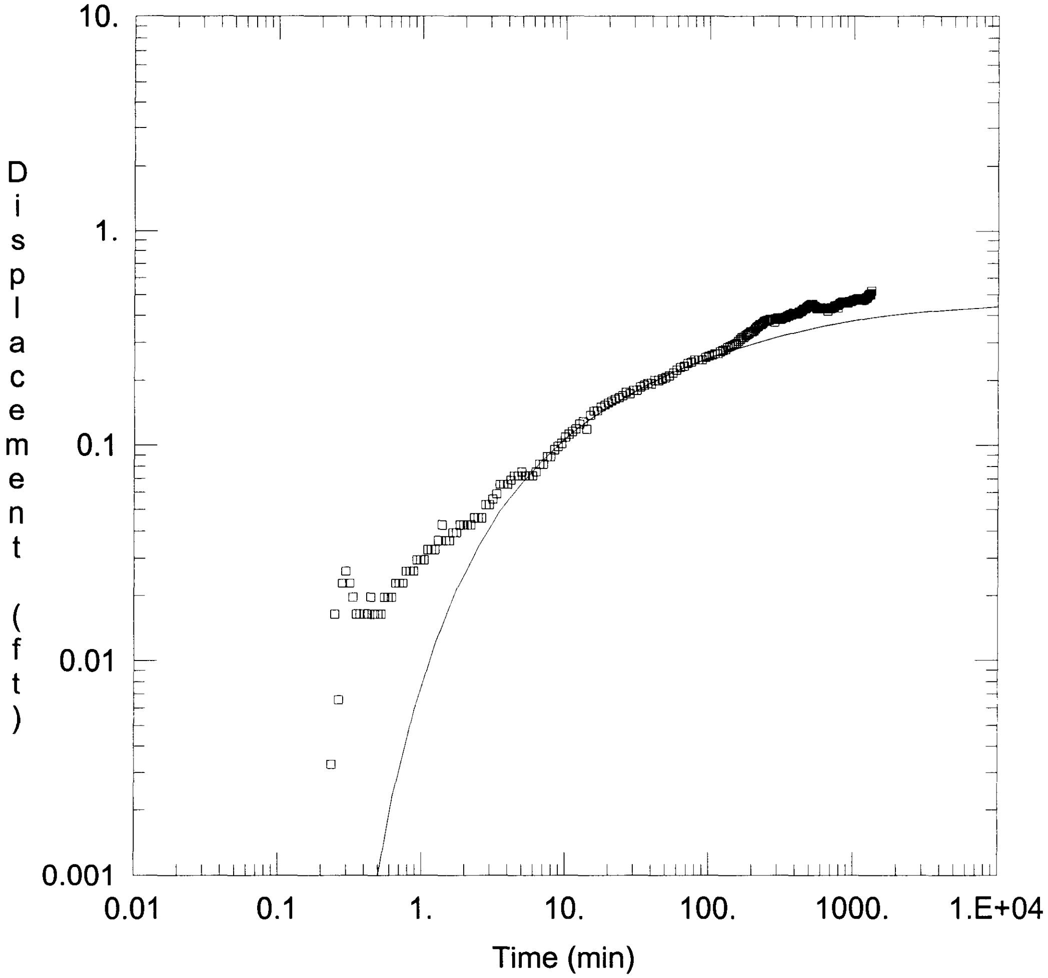
Observation Wells

Well Name	X (ft)	Y (ft)
□ MW-40	30.2	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 3357.7 ft^2/day
S = 0.04803
Sy = 0.01975
ß = 0.3388



WELL TEST ANALYSIS

Data Set: E:\Buffalo\Aquifer Testing\Pump Tests\RW-7 Pump Test\Aqtesolv data\MW-41.aqt
Date: 03/21/03 Time: 09:36:32

PROJECT INFORMATION

Company: Roux Associates, Inc.
Client: ExxonMobil
Project: 17252Y05
Test Location: Buffalo, New York
Test Well: RW-7
Test Date: 6/24/02

AQUIFER DATA

Saturated Thickness: 20. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
RW-7	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ MW-41	29.8	0

SOLUTION

Aquifer Model: Unconfined

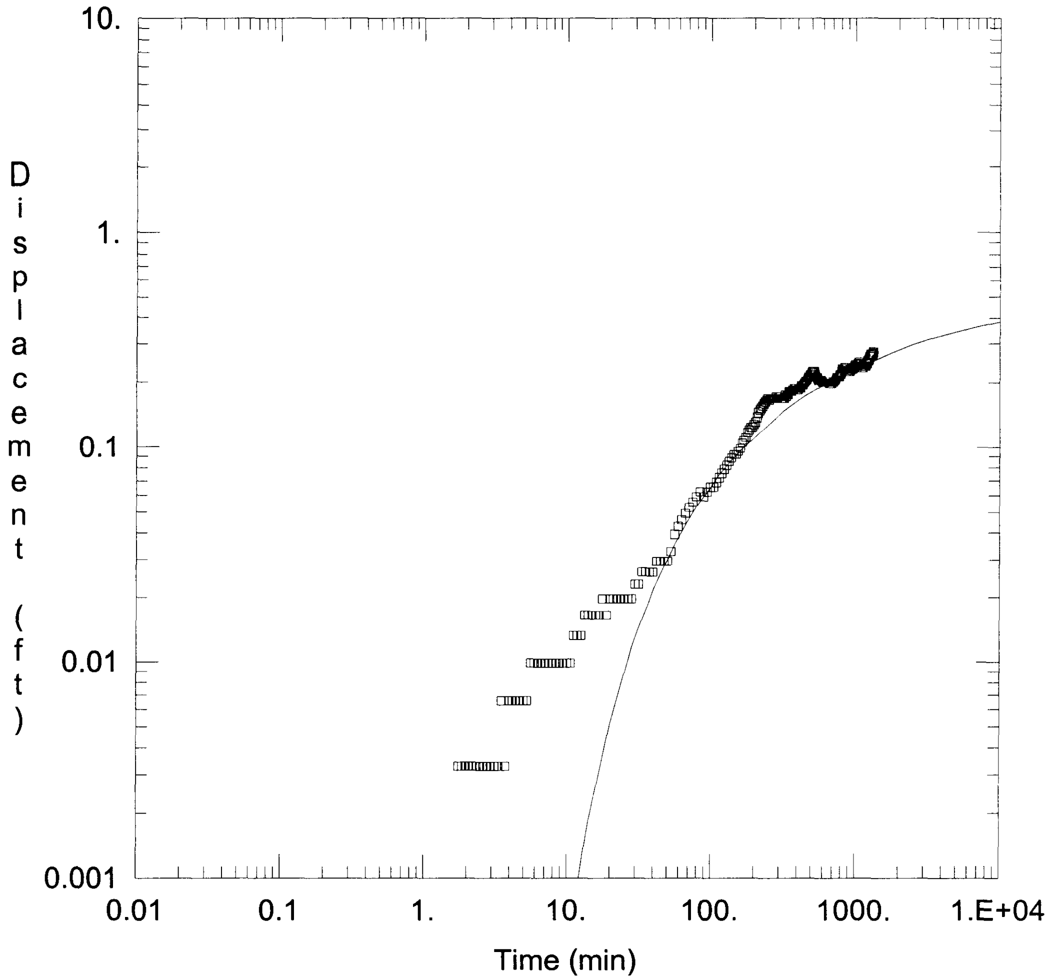
Solution Method: Neuman

T = 3198.1 ft^2/day

S = 0.01466

Sy = 0.5

ß = 0.001



WELL TEST ANALYSIS

Data Set: E:\Buffalo\Aquifer Testing\Pump Tests\RW-7 Pump Test\Aqtesolv data\MW-45.aqt
Date: 03/21/03 Time: 09:37:00

PROJECT INFORMATION

Company: Roux Associates, Inc.
Client: ExxonMobil
Project: 17252Y05
Test Location: Buffalo, New York
Test Well: RW-7
Test Date: 6/24/02

AQUIFER DATA

Saturated Thickness: 20. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
RW-7	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ MW-45	68	0

SOLUTION

Aquifer Model: Unconfined

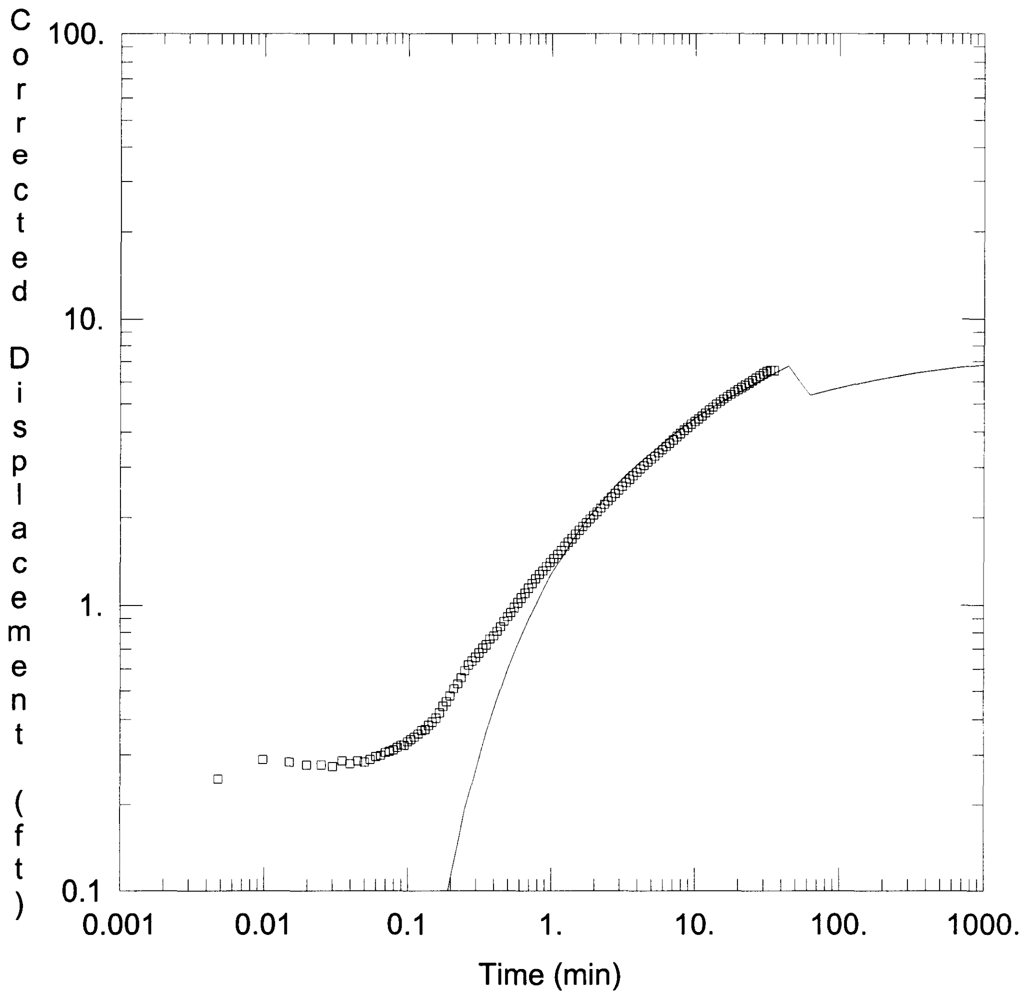
Solution Method: Neuman

T = 2558.6 ft^2/day

S = 0.05789

Sy = 0.3335

ß = 0.004



WELL TEST ANALYSIS

Data Set: E:\Buffalo\Aquifer Testing\Pump Tests\RW-8R Pump Test\Aqtesolv\RW-8R.aqt
Date: 03/21/03 Time: 09:38:19

PROJECT INFORMATION

Company: Roux Associates, Inc.
Client: ExxonMobil Corporation
Project: 17252Y05
Test Location: Buffalo Terminal, NY
Test Well: RW-8R
Test Date: 8/8/02

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
RW-8R	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ RW-8R	0.01	0

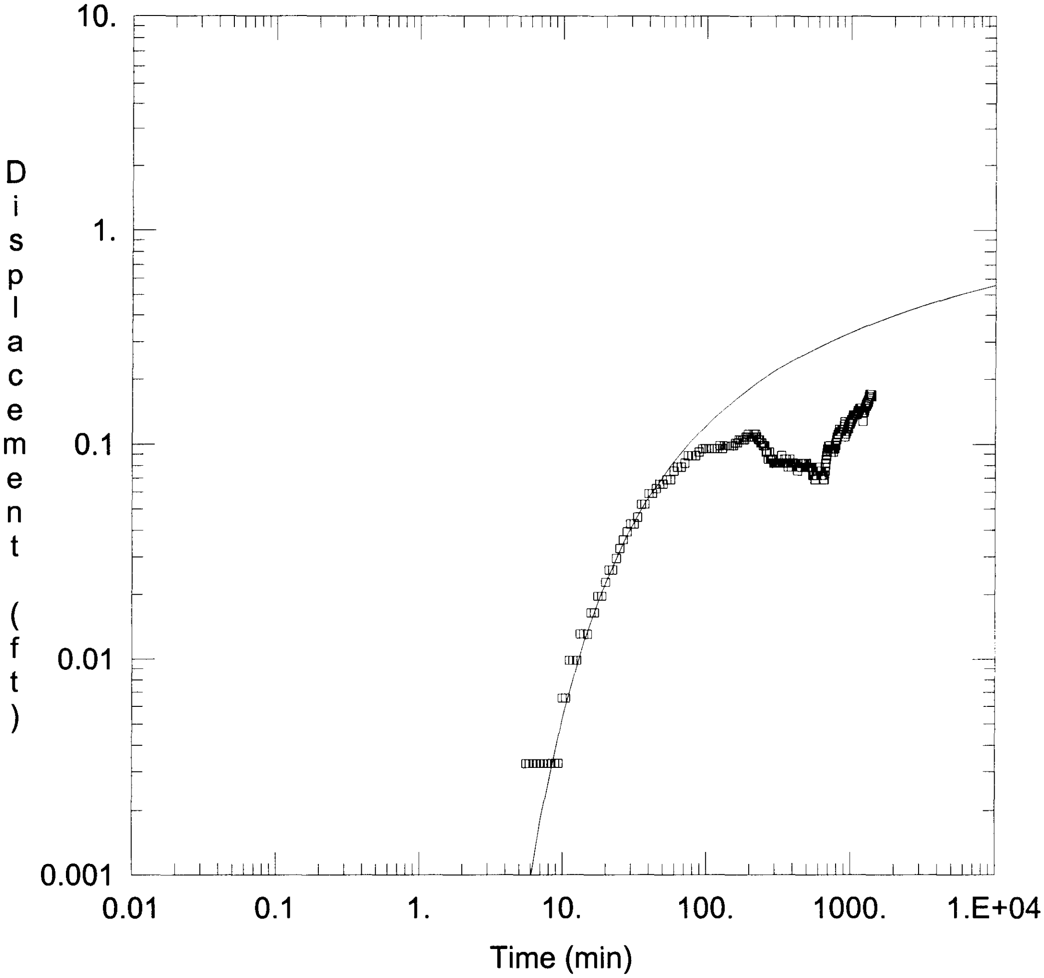
SOLUTION

Aquifer Model: Unconfined

Solution Method: Theis

T = 107.4 ft^2/day
Kz/Kr = 0.1

S = 1023.7
b = 14. ft



WELL TEST ANALYSIS

Data Set: E:\Buffalo\Aquifer Testing\Pump Tests\RW-9 Pump Test\Aqtesolv data\MW-42.aqt
Date: 03/21/03 Time: 09:56:50

PROJECT INFORMATION

Company: Roux Associates, Inc.
Client: ExxonMobil
Project: 17252Y05
Test Location: Buffalo, New York
Test Well: RW-9
Test Date: 6/26/02

AQUIFER DATA

Saturated Thickness: 15. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
RW-9	0	0

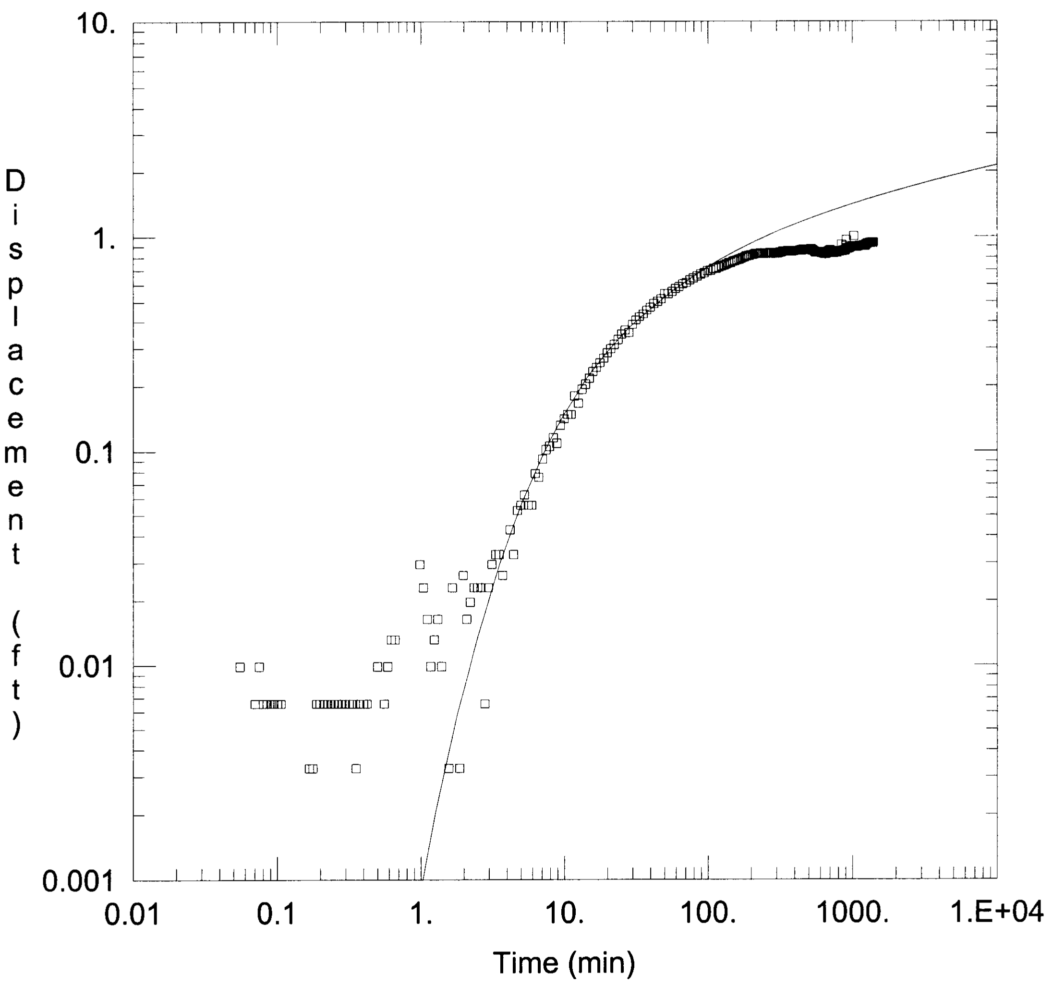
Observation Wells

Well Name	X (ft)	Y (ft)
□ MW-42	25.5	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Neuman

T = 2032.8 ft^2/day S = 0.1637
Sy = 0.002986 ß = 10.



WELL TEST ANALYSIS

Data Set: E:\Buffalo\Aquifer Testing\Pump Tests\RW-9 Pump Test\Aqtesolv data\MW-43.aqt
Date: 03/21/03 Time: 10:18:28

PROJECT INFORMATION

Company: Roux Associates, Inc.
Client: ExxonMobil
Project: 17252Y05
Test Location: Buffalo, New York
Test Well: RW-9
Test Date: 6/26/02

AQUIFER DATA

Saturated Thickness: 15. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
RW-9	0	0

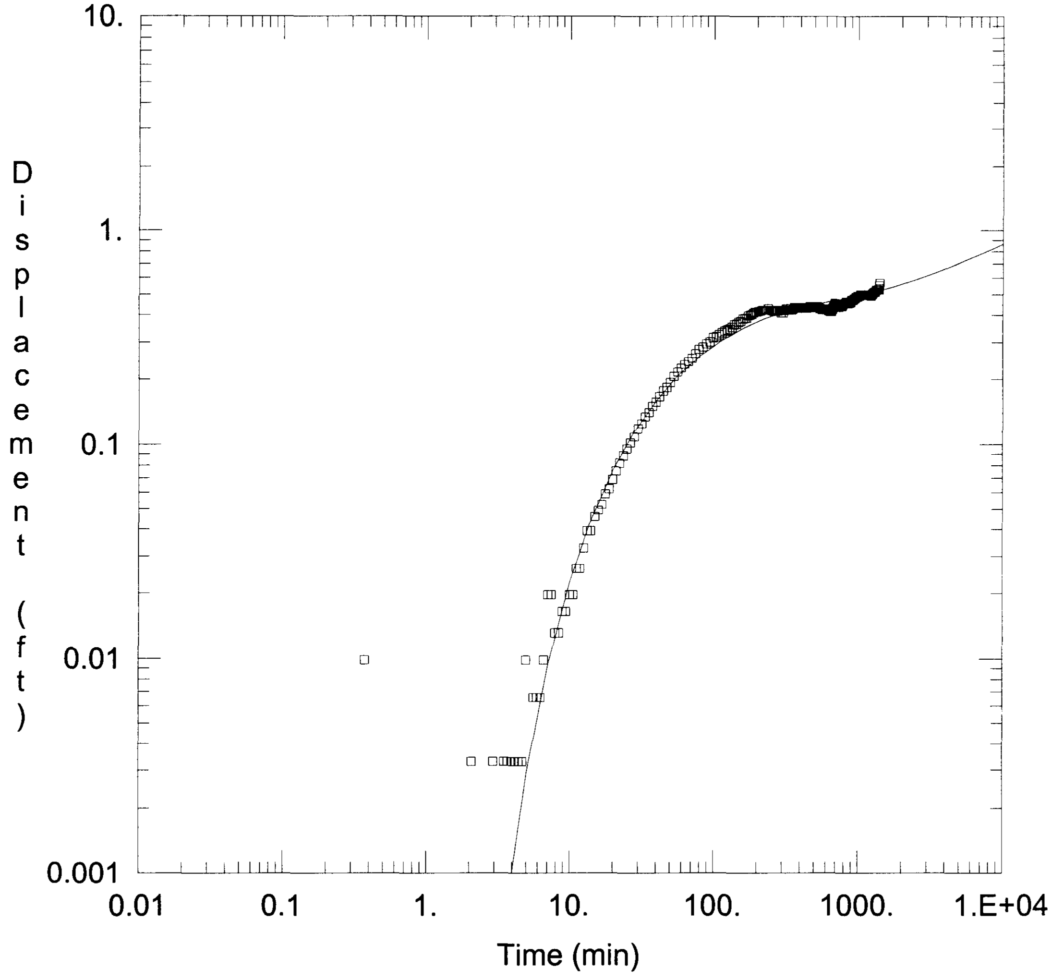
Observation Wells

Well Name	X (ft)	Y (ft)
□ MW-43	39	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 642.8 ft^2/day
S = 0.003788
Sy = 0.002986
ß = 10.



WELL TEST ANALYSIS

Data Set: E:\Buffalo\Aquifer Testing\Pump Tests\RW-9 Pump Test\Aqtesolv data\ESI-4.aqt
Date: 03/21/03 Time: 10:20:12

PROJECT INFORMATION

Company: Roux Associates, Inc.
Client: ExxonMobil
Project: 17252Y05
Test Location: Buffalo, New York
Test Well: RW-9
Test Date: 6/26/02

AQUIFER DATA

Saturated Thickness: 15. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
RW-9	0	0

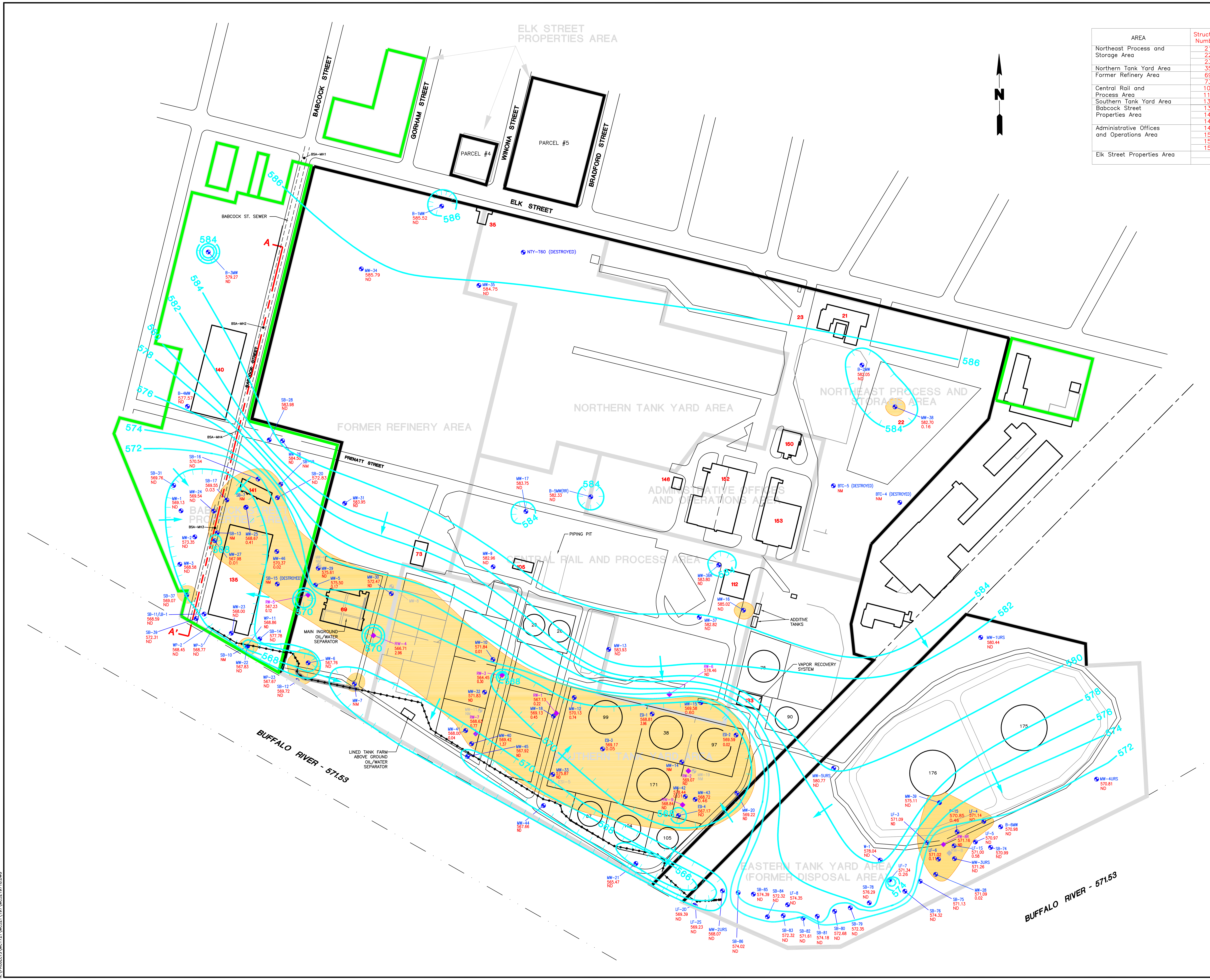
Observation Wells

Well Name	X (ft)	Y (ft)
▫ ESI-4	32.1	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 711.8 ft^2/day
S = 0.02986
Sy = 0.5
ß = 0.1



AREA	Structure Number	Current Structure Name (Original Structure Name)
Northeast Process and Storage Area	21	Leased to Police Community Services (Main Office)
	22	Former Biotreatment Cell
	23	Gated Entrance
Northern Tank Yard Area	35	Sub–Station C
Former Refinery Area	69	Main Inground Oil/Water Separator
	73	Remediation Building (Pump House #25, Fire House)
Central Rail and Process Area	105	Brick Building (Dehydrator/Pipe Line Pump House #38)
	112	Tank Truck Loading Rack
Southern Tank Yard Area	133	Vapor Recovery Unit
Babcock Street Properties Area	135	One Babcock Street Offices (Barrel House)
	140	Various Tenants of One Block of Babcock Street (Lakes Division Garage)
	141	One Babcock Street Storage Building (Truck Loading Rack)
Administrative Offices and Operations Area	146	Electrical Sub–Station A (Furnace Room)
	150	Laboratory Building
	152	Main Office/Mechanical Shops
	153	Store House
Elk Street Properties Area		Parcel #4
		Parcel #5

LEGEND

- EXISTING TANK
- 153 EXISTING STRUCTURE
- CURRENT PROPERTY LINE (BASED ON DENLUCK–O'NEILL ENGINEERING AND SURVEYING, DEC. 15, 1988; AND NUSSBAUMER & CLARKE, INC. FEBRUARY 6, 1995)
- LIMITS OF PROPERTY FORMERLY OWNED BY EXXONMOBIL OIL CORPORATION
- GEOGRAPHIC AREA BOUNDARY AND/OR FORMER PROPERTY LINES
- MW–1 LOCATION AND DESIGNATION OF MONITORING WELL
- MW–4 LOCATION AND DESIGNATION OF MONITORING WELL ABANDONED IN 2001 OR 2002
- RW–5 LOCATION AND DESIGNATION OF RECOVERY WELL
- 569.07 GROUNDWATER ELEVATION, MEASURED IN FEET ABOVE MEAN SEA LEVEL
- 5.20 FREE–PRODUCT THICKNESS IN FEET
- RW–8 LOCATION AND DESIGNATION OF ABANDONED RECOVERY WELL
- NM NOT MEASURED
- ND NOT DETECTED
- NA NOT APPLICABLE
- 586 LINE OF EQUAL GROUNDWATER ELEVATION, MEASURED IN FEET ABOVE MEAN SEA LEVEL (DASHED WHERE INFERRED)
- APPROXIMATE GROUNDWATER FLOW DIRECTION
- WELL POINT SYSTEM
- SECTION OF WELL POINT SYSTEM NOT OPERATIONAL
- MH LOCATION AND DESIGNATION OF MANHOLE
- HISTORICAL AND CURRENT SEPARATE–PHASE PRODUCT

WELL DESIGNATION	AVERAGE FLOW RATE FOR OCTOBER 2002 (GALLONS PER MINUTE)
RW–1	4.4
RW–2	0.4
RW–3	0.2
RW–4	0.1
RW–5	0.8
EASTERN WPS	83.7
WESTERN WPS	–

NOTE:

1. LF–2D GROUNDWATER ELEVATION NOT USED; SCREENED AT DEEPER INTERVAL.
2. SB–7, SB–13 AND SB–10 WERE NOT GAUGED AS THEY WERE REPLACED BY MW–25, MW–27 AND MW–22, RESPECTIVELY.
3. SB–19 WAS NOT GAUGED BECAUSE IT WAS SUBMERGED UNDER STANDING WATER.
4. WATER–TABLE ELEVATION AT MW–2, SB–14, RW–6 AND MW–42 NOT USED FOR CONTOURING DUE TO ANOMALOUSLY HIGH READING. WATER–TABLE ELEVATION AT MW–33 WAS NOT USED FOR CONTOURING DUE TO ANOMALOUSLY HIGH GROUNDWATER TABLE ELEVATION (LOCALIZED PERCHED WATER ZONE SUSPECTED).
5. MW–14 WAS NOT GAUGED DUE TO THE PRESENCE OF PRODUCT PUMP IN WELL.
6. MW–7 WAS NOT GAUGED BECAUSE THE PRODUCT WAS TOO THICK TO BE GAUGED.
7. FLOW METER ON THE WESTERN WELL POINT SYSTEM WAS NOT OPERATING PROPERLY THROUGHOUT THE QUARTER.
8. PRODUCT WAS OBSERVED IN LF–7 FOR THE FIRST TIME DURING THE OCTOBER 2002 GAUGING ROUND, HOWEVER IT WAS NOT OBSERVED WHEN GAUGED ON JANUARY 10, 2003 AND DURING THE JANUARY 2003 GAUGING INDICATING A POSSIBLE ERRONEOUS READING DURING THE OCTOBER 2002 GAUGING.
9. SB–20 GAUGING DATA USED WAS FROM OCTOBER 16, 2002 DUE TO ANOMALITY FROM THE OCTOBER 17, 2002 DATA.

120' 0 120'

Title:

GROUNDWATER POTENTIOMETRIC MAP OCTOBER 2002

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: W.S.	Date: 26FEB03	PLATE
Prepared by: G.M.	Scale: AS SHOWN	1
Project Mgr: N.C.	Office: NY	
File No: MC5219718	Project: 17252Y05	

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AREA	Structure Number	Current Structure Name (Original Structure Name)
Northeast Process and Storage Area	21	Leased to Police Community Services (Main Office)
	22	Former Biotreatment Cell
	23	Gated Entrance
Northern Tank Yard Area	35	Sub-Station C
Former Refinery Area	69	Main Inground Oil/Water Separator
	73	Remediation Building (Pump House #25, Fire House)
Central Rail and Process Area	105	Brick Building (Dehydrator/Pipe Line Pump House #38)
	112	Tank Truck Loading Rack
Southern Tank Yard Area	133	Vapor Recovery Unit
Babcock Street Properties Area	135	One Babcock Street Offices (Barrel House)
	140	Various Tenants of One Block of Babcock Street (Lakes Division Garage)
	141	One Babcock Street Storage Building (Truck Loading Rack)
Administrative Offices and Operations Area	146	Electrical Sub-Station A (Furnace Room)
	150	Laboratory Building
	152	Main Office/Mechanical Shops
	153	Store House
Elk Street Properties Area		Parcel #4
		Parcel #5

LEGEND

EXISTING TANK

153 EXISTING STRUCTURE

CURRENT PROPERTY LINE (BASED ON DENLUCK-O'NEILL ENGINEERING AND SURVEYING, DEC. 15, 1988; AND NUSSBAUMER & CLARKE, INC. FEBRUARY 6, 1995)

LIMITS OF PROPERTY FORMERLY OWNED BY EXXONMOBIL OIL CORPORATION

GEOGRAPHIC AREA BOUNDARY AND/OR FORMER PROPERTY LINES

MW-1 LOCATION AND DESIGNATION OF MONITORING WELL

MW-4 LOCATION AND DESIGNATION OF MONITORING WELL ABANDONED IN 2001

RW-5 LOCATION AND DESIGNATION OF RECOVERY WELL

WELL POINT SYSTEM

SECTION OF WELL POINT SYSTEM NOT OPERATIONAL

MH LOCATION AND DESIGNATION OF MANHOLE

HISTORICAL AND CURRENT SEPARATE-PHASE PRODUCT

SAMPLE LOCATION — SAMPLE DATE

SB-12	04/25/01	07/25/01	10/16/01	01/21/02	04/16/02	
Total BTEX	ND	NS	ND	NS	NS	TOTAL BTEX CONCENTRATION IN ug/L
MTBE	ND	NS	0.2	NS	NS	MTBE CONCENTRATION IN ug/L
Total VOC's	0.2	NS	0.3	NS	1.3	TOTAL VOC CONCENTRATION IN ug/L
Total SVOC's	1.0	NS	ND	NS	NS	TOTAL SVOC CONCENTRATION IN ug/L

ND NOT DETECTED

NS NOT SAMPLED (SEE NOTES)

BTEX BENZENE, TOLUENE, ETHYLBENZENE AND XYLENES

MTBE METHYL TERTIARY-BUTYL ETHER

VOC VOLATILE ORGANIC COMPOUNDS

SVOC SEMI VOLATILE ORGANIC COMPOUNDS

ug/L MICROGRAMS PER LITER

NOTES:

1. MW-2, SB-11/LB-1 AND SB-12 WERE NOT SAMPLED IN JULY 2001 BECAUSE THE WELLS DID NOT RECHARGE AFTER PURGING.
2. SB-19 WAS NOT SAMPLED IN JULY 2001 BECAUSE PRODUCT WAS PRESENT. SB-19 WAS NOT SAMPLED IN OCTOBER 2001, JANUARY, APRIL AND OCTOBER 2002 BECAUSE IT WAS SUBMERGED UNDER STANDING WATER.
3. SB-12 AND BTC-5 WERE NOT SAMPLED IN JANUARY 2002 BECAUSE THEY WERE BURIED UNDER SNOW.
4. MW-27, MW-15 AND ESI-3 WERE NOT SAMPLED FROM APRIL 2001 TO JULY 2002; MW-22, MW-24, SB-37 AND MW-38 WERE NOT SAMPLED IN JULY 2002; AND MW-22, MW-27, MW-15, MW-38, ESI-3, SB-16 AND SB-20 WERE NOT SAMPLED IN OCTOBER 2002 BECAUSE PRODUCT WAS PRESENT.
5. BTC-5 HAS NOT BEEN SAMPLED SINCE JANUARY 2002 BECAUSE THE WELL WAS DESTROYED DURING SNOW PLOWING OPERATIONS.
6. SB-37 WAS NOT SAMPLED IN OCTOBER 2002 BECAUSE THE WELL WAS DRY PRIOR TO BAILING.

120' 0 120'

Title: **SUMMARY OF QUARTERLY GROUNDWATER SAMPLING DATA FROM OCTOBER 2001 AND JANUARY, APRIL, JULY AND OCTOBER 2002**

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For: EXXONMOBIL OIL CORPORATION

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: N.C.	Date: 26FEB03	PLATE
Prepared by: G.M.	Scale: AS SHOWN	2
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