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MANTECH ENVIRONMENTAL CORPORATION
A ManTech International Subsidiary

CleanOX® PILOT TEST REPORT FINAL

Tow Way Fuel Farm
Naval Station Roosevelt Roads
Ceiba, Puerto Rico

Prepared for:

Baker Environmental, Inc.
Airport Office Park, Building 3
420 Rouser Road
Coraopolis, Pennsylvania 15108

Prepared by:

ManTech Environmental Corporation
14290 Sullyfield Circle, Suite 100
Chantilly, Virginia 20151

October 1999

ManTech Project No. 8207-000

MANAGEMENT TECHNOLOGY

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Revision 1

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1.0 INTRODUCTION

This report documents the procedures, results, and evaluation of the pilot test of the CleanOX® Process completed by ManTech Environmental Corporation (ManTech) at the Naval Station Roosevelt Roads (NSRR) Tow Way Fuel Farm (TWFF) in Ceiba, Puerto Rico (Figure 1). The pilot test was conducted under Subcontract No. 62470-277, Delivery Order No. 277-16000. Pilot test procedures were consistent with the Revised Pilot Scale Remediation Work Plan, dated February 1999, and approved by the Puerto Rico Environmental Quality Board (EQB).

The purpose of the pilot test was to verify the applicability of the CleanOX® Process, an *in-situ* chemical oxidation remediation technology:

- To remediate groundwater containing free product and to produce desired oxidation reactions in the uppermost saturated soil zone at the TWFF;
- To evaluate the potential for the CleanOX® Process to recover free product; and
- To refine the site-specific formulation of CleanOX® Process reagents to be used in any future applications of the process.

The scope of work that was performed during the pilot test, ManTech's observations during pilot testing, a summary of the analytical results of pre- and post-treatment sampling, and ManTech's recommendations for full-scale application of the CleanOX® Process at the TWFF are presented in this report.

A typical CleanOX® project is conducted in three phases. The first phase includes a bench test to develop site-specific chemical formulations to be applied in pilot-scale testing. Next, the results of the bench test are used to design a pilot test of the process that includes the application of CleanOX® reagents to application wells at the site. Saturated soil and groundwater samples are collected from borings and monitoring wells located in proximity to the pilot test treatment area before and after application of the CleanOX® Process reagents so that its effectiveness on a pilot-scale basis can be evaluated and engineering parameters for subsequent application can be determined. The results of the pilot test can then be used to develop a full-scale application of the process which typically includes two to three rounds of reagent application to a network of application wells installed within the full-scale treatment area.

This pilot test report is divided into five sections. The remainder of this section includes an overview of the CleanOX® Process, a review of the site background, and the objectives of the pilot test. Sections 2 and 3 discuss the pilot test field activities, results and interpretation of results.

Section 4 presents conclusions and recommendations. Section 5 provides ManTech's conceptual approach and cost estimate for full-scale CleanOX® Process application at the TWFF.

1.1 Overview of the CleanOX® *In-Situ* Chemical Oxidation Process

CleanOX® is a patented *in-situ* process that involves the staged application of Fenton Reaction chemistry to create oxidation-reduction reactions leading to degradation of organic compounds present in groundwater. The CleanOX® process can remediate these organic compounds within a short period, is suitable for most urban and developed sites without disruption to site operations, and eliminates the long-term operation and maintenance (O&M) associated with conventional remediation technologies. Because the CleanOX® Process is an *in-situ* groundwater remediation technology, it produces no significant quantities of waste that require permitting, treatment, or disposal.

The basis of the CleanOX® Process is related to the well-known Fenton's Reaction wherein hydrogen peroxide reacts with ferrous ions to produce a hydroxyl radical in an acidified aqueous medium. The resultant hydroxyl free radical (•OH) is an extremely powerful oxidizer that progressively reacts with organic constituents through a series of oxidation reactions. The hydroxyl radicals do not selectively target specific organic constituents. It is a contact chemistry process, and the hydroxyl radicals will oxidize any organic compounds encountered. During the process, the oxidation reactions proceed by degrading the organic constituents to progressively less complex and shorter chemical chains, ultimately yielding carbon dioxide and water.

CleanOX® results in a reduction of the total organic compound mass in free product, dissolved, and sorbed phases. The Fenton Reaction and associated oxidation reactions are vigorous creating turbulent conditions and changing the chemical equilibrium conditions present within the saturated soil matrix. Therefore, application of the CleanOX® reagents results in not only oxidation of dissolved and adsorbed constituents, but also serves to liberate residual product and to desorb pockets of absorbed constituent mass which may be present in the capillary fringe or beneath the water table surface. This effect is often most pronounced during the initial round of reagent application where dissolved phase concentrations may be found to increase above the baseline concentrations. The constituent mass that has been desorbed and dissolved is more easily remediated by subsequent rounds of CleanOX® reagent application. A typical, full-scale CleanOX® remediation program involves the application of two to three rounds of reagents in order to reach the desired cleanup levels.

CleanOX® uses a proprietary, empirically-derived computer modeling program that has been developed from laboratory and field applications over the last several years. This Geo-Environmental Modeling Software (GEMS) is used to model and design each CleanOX® Process application. Using the bench test and relevant site data (e.g., hydrogeology, water chemistry, and organic constituent types and concentrations), a customized, site-specific treatment design and

dosage application is developed for each pilot-scale remediation project. This approach was used for the pilot test performed at the TWFF. For example, baseline laboratory data were incorporated into the GEMS model to estimate the volume of CleanOX® reagents for pilot testing at the site. Because the organic contaminants of concern and naturally-occurring Total Organic Carbon (TOC) will compete for the hydroxyl radicals, baseline concentrations for these parameters at the TWFF were used as input to the GEMS model.

Application of the CleanOX® Process at petroleum-contaminated sites has demonstrated significant mass reductions of a variety of organic compounds present in the free product phase, sorbed to saturated soils, and dissolved in groundwater within a short time period following multiple rounds of reagent application. Based on bench, pilot, and full-scale applications, the CleanOX® Process has been determined to be applicable for the treatment of fuels, solvents, pesticides, and other organic constituents in groundwater.

The principal advantage of the CleanOX® Process over other *in-situ* treatments is the very rapid and complete degradation of organic constituents in the free product phase, sorbed to saturated soil, and dissolved in groundwater. More conventional technologies, such as groundwater pump-and-treat, oil skimmers, vapor extraction, air sparging, and bioventing, require years to produce concentration reductions of 50 to 90 percent, depending on soil type and the volatility or biodegradability of the organic compound. The CleanOX® Process is primarily directed toward remediation of dissolved-phase organics and also has been applied to address free-phase product. With respect to soil, the technology addresses organic degradation within the saturated matrix and the capillary fringe. The CleanOX® Process can be designed to target the specific layers of contaminant found in the subsurface for remediation.

1.2 Site Background

Our initial understanding of the site's history and hydrogeologic characteristics was based on information provided in the Revised Draft RCRA Facility Investigation (RFI) Report for Operable Unit 2 (SWMU 7/8) at NSRR dated June 1997 prepared by Baker Environmental, Inc. (Baker). During installation of the wells used as part of the CleanOX® Process, ManTech refined its conceptual model of the hydrogeologic conditions at the TWFF for pilot testing. Since remediation is on-going at the TWFF, the most recent McLaren/Hart data was used to evaluate free product levels for full-scale remediation.

NSRR is located in Ceiba, Puerto Rico and the TWFF area that comprises SWMU 7/8 ("the Site") has been operated by the U.S. Navy since the early 1940s. Based on the Site's elevations, the TWFF has been divided into an upper and lower TWFF where seven large fuel storage tanks have been partially buried. Reports reviewed by ManTech indicate that petroleum products, such as jet fuel (JP-5) and marine diesel fuel, were released at the site over a period of 30 years from piping and tank leaks, overfills, and past disposal practices. These past maintenance practices included the

common industry standard of disposing of accumulated sludge from the tanks in excavated pits adjacent to the tanks during tank cleaning operations.

Previous site investigations indicate that petroleum constituents have been detected in soil and groundwater. According to the Baker RFI, free product has also been identified at the site and a product recovery system has operated since 1994 recovering approximately 5% of the estimated 996,000 gallons of free product released. Previous studies have been conducted to define the extent of groundwater and soil contamination, to locate sludge burial pits, to characterize the site lithology and the underlying aquifer, and to identify risk-based contaminant concentrations for chemicals of concern. Although chemicals of concern and their respective risk-based cleanup goals have been proposed in the Task 1 Corrective Measures Study (CMS), the list of chemicals and cleanup goals have not been finalized.

According to the RFI report prepared by Baker, several feet of free product have been detected around the sloped area between the upper and lower tank farms, on the north side of Forrestal Drive, and identified as our pilot treatment area (Figure 2). The low permeability soils underlying the site and the difficulty in accessing the product plume (i.e., buildings, utilities, and other obstructions) are limiting factors in implementing remedial strategies at the site.

A review of site boring logs (Appendix A) from previous investigations indicates that the subsurface had been investigated to a depth of approximately 35 feet bgs in the pilot test area around UGW-3 and RW-1. There is heterogeneity reported in the boring logs, likely due in part to the clean fill material used to partially bury the fuel storage tanks. At UGW-3, the subsurface generally consists of the following vertical profile:

- Silty clay from ground surface to a depth of approximately 10 feet bgs; and
- Sand with layers of gravel from 10 to 35 feet.

At RW-1, located approximately 36 feet south of UGW-3, the subsurface generally consists of the following vertical profile:

- Silty clay from ground surface to a depth of approximately 13 feet bgs;
- Gravel from approximately 13 to 19 feet bgs;
- Rock, subangular cobbles of gabbro, from approximately 19 to 22 feet bgs;
- Silty clay from approximately 22 to 35 feet bgs.

In both wells, strong petroleum odors and gravel layers wet with petroleum product were reported. The gravel, rock, and sand sequences were believed to act as the surficial water-bearing zone. Groundwater was reportedly detected at an approximate depth of 25 feet bgs in the study area during drilling activities. However, water equilibrates to a depth of approximately 15 feet bgs within the monitoring wells, indicating semi-confined or confined aquifer conditions. Potentiometric surface

analysis in the study area suggests some local fluctuations in potentiometric head measurements and flow directions potentially due to tidal effects; however, the predominant component of horizontal groundwater flow in the study area appears to be to the southeast.

This information was important to the design and the objectives of the CleanOX® pilot study. As discussed above, ManTech screened the application wells in order to intercept the observed free product in the gravel layer and lenses located approximately two feet above the semi-confined or confined aquifer. Further, given the observed free product and groundwater, it was expected that application of the process would likely result in increased dissolved-phase petroleum constituent concentrations because the intensity of the Fenton Reaction chemistry would enhance dissolution of sorbed petroleum constituents. In such cases, there is potential that the effects of oxidation could be masked in laboratory analyses of saturated soil and groundwater samples collected after the pilot test application. Therefore, ManTech developed estimates of the contaminant mass present before and after the pilot test in order to gauge contaminant destruction potential at the site.

1.3 Purpose of the CleanOX® Pilot Test

The principal objectives of the pilot test were to verify that the CleanOX® Process reagents can be applied safely, in a controlled manner, and can induce desorption, dissolution, and desired oxidation reactions at the TWFF. The specific objectives for the pilot test are described below.

Assess the Infiltration Capacity of the Impacted Aquifer Material - This is accomplished by measuring the rate at which CleanOX® conditioning agents and oxidizer can be added to the aquifer through the application wells. Infiltration rates, which are related to *in-situ* permeability values, are important for evaluation of the effectiveness of the CleanOX® Process because they govern the field time required for application and are a factor in determining the lateral extent of aquifer material that can be treated from each application well.

Validate Bench Test Assumptions for Reagent Requirements - The quantities of conditioning reagents and oxidant to be applied at each application well are estimated for the pilot test by the GEMS model based on experience at similar sites, site-specific data, and the results of the bench test. The amount of conditioning agents and oxidizer needed during each application is verified during the pilot test. This is accomplished by periodic measurements of dissolved oxygen, oxidation-reduction potential (ORP), specific conductance, temperature, and pH during the pilot test and by laboratory analyses completed on groundwater samples before and after the pilot test.

Estimate Application Well Radius of Influence (ROI) - The radial influence of the CleanOX® Process from application wells is determined by field observations of bubbling and steam vapor in off-set groundwater monitoring wells; field measurements of free product levels, dissolved oxygen, ORP, specific conductance, temperature, and pH; and the laboratory measurements of dissolved concentrations in these same off-set wells.

Estimate Mass Removal Potential Per Application - This is determined primarily by the change in contaminant concentrations detected from analysis of soil and groundwater samples collected from borings and monitoring wells after application of the CleanOX® reagents as compared to the concentrations prior to the pilot-scale CleanOX® application. The change in contaminant concentrations is important because it helps in determining the extent of mass desorption that has occurred relative to the extent of oxidation that occurred during the pilot-scale application. These data are then used to refine the estimate of volume of CleanOX® reagents and number of applications that are needed to meet the project objective of contaminant mass removal.

ManTech initially estimated that the CleanOX® Process applied to free product at the TWFF would result in an immediate up-welling of liquid in the application and possibly the off-set wells. A free-product contaminant approach was developed to direct fluids from the pilot test treatment area wells to 55-gallon drums. By applying the CleanOX® Process in a slow, controlled manner, we were able to demonstrate effective destruction of contaminants *in-situ* and thereby minimize project waste streams.

2.0 FIELD ACTIVITIES

ManTech performed a two-well pilot test of the CleanOX® Process at the TWFF between January 11 and January 29, 1999. Field activities included application well and monitoring well installation, baseline soil and groundwater sampling, two rounds of CleanOX® reagent application, waste disposal, and post treatment soil and groundwater sampling.

Table 1 summarizes the sampling performed by ManTech as part of the pilot test. Soil and groundwater samples were analyzed by Severn Trent Laboratories (STL) in University Park Illinois, an USEPA-approved CLP laboratory. Level IV QA/QC data review was completed by Heartland Environmental Services, Inc. (Heartland). Waste disposal analyses were performed by Transglobal Environmental Geochemistry (TEG), a laboratory located in Puerto Rico. The disposal facilities required these analyses to be performed by a local laboratory.

Pilot test laboratory analyses included BTEX, TPH gasoline, TPH diesel, iron, lead, sulfate and pH. Field parameters measured at the time of sample collection included water levels, product thickness, temperature, pH, ORP, specific conductance, and dissolved oxygen. Waste disposal analyses included reactivity, corrosivity, ignitability, TCLP benzene and metals, and TOX.

2.1 Well Installation and Sample Collection

This section describes the activities associated with installation of the application wells and monitoring wells at the TWFF and describes the soil and groundwater sampling and analyses completed in order to evaluate the effectiveness of the CleanOX® pilot-scale reagent application.

2.1.1 Application and Monitoring Well Installation

Well drilling was performed by Soil Tech, Inc.under contract to ManTech and was supervised by a ManTech geologist. Wells AW-1, AW-2, MTMW-1, MTMW-2, MTMW-3 and MTMW-4 were installed and baseline soil samples from AW-1, AW-2 and MTMW-4 were collected the week of December 14, 1998. Total well depths and the screened intervals were based on ManTech's field observations of petroleum product and groundwater elevations at each location. Complete boring logs and well completion records are provided in Appendix A. Construction details for the wells used as part of the pilot test are summarized in Table 2.

AW-1 and AW-2 were constructed of two-inch diameter, stainless-steel risers with 15 feet of 0.01-inch, slotted stainless-steel screens. AW-1 was drilled to a total depth of 35.5 feet below ground surface (bgs), and screened from a depth of 20.5 to 35.5 feet bgs. AW-2 was drilled to a total depth of 31 feet bgs and screened from a depth of 16 to 31 feet bgs. Four new monitoring wells (MTMW-1, MTMW-2, MTMW-3 and MTMW-4) were constructed of two-inch diameter, Schedule

40 PVC with 0.01-inch slotted screens. MTMW-1 was drilled to a total depth of 39.5 feet bgs, and screened from a depth of 19.5 to 39.5 feet bgs. MTMW-2 was drilled to a total depth of 38 feet bgs and screened from a depth of 18 to 38 feet bgs. MTMW-3 was drilled to a total depth of 35 feet bgs, and screened from a depth of 15 to 35 feet bgs. MTMW-4 was drilled to a total depth of 36 feet bgs and screened from a depth of 16 to 36 feet bgs.

The two application wells, AW-1 and AW-2, were spaced approximately 15 feet apart and are located approximately 11 feet south of UGW-3 and 10 feet north of RW-1, respectively. The four off-set monitoring wells (MTMW-1, MTMW-2, MTMW-3, and MTMW-4) were installed approximately 10 to 15-feet from the application wells. The application wells, the four newly installed wells, and four existing wells (RW-1, UGW-3, UGW-14, and UGW-25) were used to monitor pre- and post-treatment free product levels, and to measure site parameters during the application (Table 2).[1]

The boreholes were drilled with a hollow stem auger approximately eight inches in diameter and two-inch diameter risers and screens were installed. The borehole annulus was filled with a silica sand filter pack from the base of the borehole to approximately two feet above the screened interval. A minimum of two feet of hydrated bentonite pellets were installed above the filter pack, and a bentonite/cement grout was installed to complete each well. A flush-mounted, 8-inch diameter protective manhole was used at each location. At least four inches of riser section was exposed within the manhole. For the two application wells, the riser section was provided with a carbon-steel threaded coupling to allow connection of ManTech's CleanOX® well heads. The surface was completed with three foot by three foot concrete pads around each manhole. A generic CleanOX® application well construction diagram is provided as Figure 7.

Each application and monitoring well was developed by ManTech. Slug tests were performed on each application well to verify the hydraulic conductivity (K) around the application points. Based on the estimated K values of 10^{-5} cm/sec, application well radii of influence (ROI) of approximately 15 feet were estimated. Slug test measurements and K calculations are presented in Appendix B.

During ManTech's subsurface investigation, we refined our conceptual model of the hydrogeologic conditions at the TWFF. The same lithology was identified at various depths as indicated in the cross-sections (Figures 3, 4 and 5). The overlying clay layer results in a semi-confined or confined surficial aquifer. Gravel layers and lenses of gravel within silty clay wet with petroleum product and groundwater were observed at each of ManTech's six drilling locations. It appears that the petroleum product is preferentially moving through these gravel layers and lenses approximately two feet above where the semi-confined or confined aquifer is encountered. Given these

[1]UGW-14 and UGW-25 are located outside the application wells ROI at distances of approximately 180 feet downgradient and 60 feet up/cross gradient, respectively, from the treatment area.

observations, ManTech screened the application and monitoring wells to intercept the petroleum product observed in these gravel layers and lenses, and thereby direct the CleanOX® Process at the petroleum product.

2.1.2 Baseline Soil and Groundwater Sampling

Soil and groundwater samples were collected prior to the CleanOX® reagent application in order to establish baseline concentrations of target organic constituents and select inorganic parameters within the treatment area and just outside the treatment area at the TWFF.

ManTech collected soil samples using split-spoon sampling methods during installation of the two application wells and one of the off-set monitoring wells (MTMW-4) during the week of December 14, 1998. Split-spoon soil samples were collected at the depth intervals having the greatest PID readings as follows: 30 to 34 feet bgs at AW-1, 24 to 28 feet bgs at AW-2, and at 18 to 20 feet bgs at MTMW-4.

ManTech also performed baseline free product measurements at the ten wells used for the pilot study the week of January 4, 1999. Corrected groundwater elevations were obtained using the apparent free product measurements collected in the field and using a petroleum product density compensation factor of 0.87 as follows:

$$\text{Corrected Groundwater Elevation} = \text{Measured Groundwater/Oil Interface Elevation} + \left\{ 0.87 * \text{Oil Thickness} \right\}$$

2.1.3 Post-Treatment Soil and Groundwater Sampling and Product Thickness Measurements

ManTech collected soil samples from three locations at three post-treatment time intervals (one-week, 60-day, and 120-day post-treatment) and groundwater samples from the ten monitoring wells at four post-treatment time intervals (one-week, three-week, 60-day, and 120-day post-treatment) to evaluate the effectiveness of the CleanOX® Process at the site. Samples were collected during the weeks of February 8 (one-week), February 22 (three-week), April 12, 1999 (60-day), and June 28, 1999 (120-day), respectively.

Split-spoon soil samples were advanced adjacent to the two application wells and at the most downgradient application well, MTMW-4, to mimic the soil sampling locations in the baseline sampling event. Soil samples were collected from the same depth intervals as in the baseline

sampling. Laboratory analyses completed on soil and groundwater samples are outlined in Table 1.[2]

2.2 CleanOX® Process Application

A site-specific formulation of CleanOX® Process reagents was applied to two application wells at the TWFF from January 11 through January 29, 1999. As described in the workplan, two rounds of reagent application were completed.

The pilot test treatment area at the TWFF near existing RW-1 was selected due to its location near the upgradient portion of the free product plume and the general accessibility of the area. Well information specific to the application wells (AW-1 & AW-2) and off-set monitoring locations (MTMW-1, MTMW-2, MTMW-3, MTMW-4, RW-1, UGW-3) used for pilot testing is presented in Table 2.

CleanOX® reagents were added to AW-1 and AW-2 at the TWFF. The application wells are located near RW-1, within a topographic low nearest to the fuel farm's southern-most entrance from Forrestal Drive. The pilot test design estimated a ROI of the CleanOX® reagents of approximately 15 feet from the application well based on an estimated hydraulic conductivity of 10^{-4} cm/sec for the saturated, silty gravel matrix of the surficial, semi-confined or confined aquifer at the site.

ManTech's chemical delivery system consists of a well head assembly having a chemical feed string and a return line. The chemical feed string is generally placed at the depth of the application well's screen to add reagents to the vertical depth interval designated for treatment. At the TWFF, the strings were placed in AW-1 and AW-2 at the depths corresponding to the depth intervals of the product layers observed at during well installation.

CleanOX® reagents were transferred through the chemical feed string to the application well. The chemical feed string is equipped with a valve for manually controlling the volume and flow rate of reagents added to the application well. The application well return line allows visible observation by ManTech personnel of any vapor, foam, and/or fluid returning after oxidizer application to estimate the site-specific inhibit time of the reaction. The inhibit time is the time duration between starting the oxidizer application and the observation of fluid in the return line; it signifies the beginning of the hydroxyl radical formation and contaminant degradation reactions. At the TWFF, application well return lines and off-set well return lines were attached to 55-gallon drums designed to recover any liquid that may have refluxed through the return lines during the application.

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[2]Any discrepancies in sample collection and laboratory analyses from Table 1 are noted in the analytical summary tables, and Figures 3 and 4.

The CleanOX® well head assemblies were secured to each application well by threading a metal well seal on the threaded riser of each well head, forming an air tight seal. CleanOX® reagents were then applied into the well on a controlled basis. Initially, acetic acid was applied to AW-1 and AW-2 to reduce the pH of the groundwater immediately surrounding the application wells to below 5 standard units. Next, an aqueous solution of ferrous sulfate was applied to each application well. Finally, hydrogen peroxide was added to each application well. The volumes and infiltration rates of reagents added to the application well were based on GEMS modeling but are often regulated by site conditions determined during pilot testing.

2.3 Derivative Waste

This section describes the liquid and solid wastes derived during the course of implementation of the CleanOX® Pilot Test at the TWFF. Descriptions of the wastes, the samples completed on the derived wastes, and the disposition of the wastes are described below.

Waste Generation Summary

Waste derived at the TWFF as part of the pilot test included soil cuttings from well installation activities, purge water from sampling and development of the wells, reflux fluid, groundwater saturated sand, and other non-hazardous trash. Soil cuttings were generated by well drilling activities during the week of December 14, 1998. During the same period, purge water was generated by well development. Purge water was also generated during groundwater sampling events the weeks of January 4, 1999; February 8, 1999; February 22, 1999; April 15, 1999; and June 28, 1999. Reflux fluids from application well return lines and those surfacing near AW-2 were collected in drums during CleanOX® reagent application from January 11 through January 29, 1999. Additional wastes generated during reagent application included empty and rinsed plastic reagent drums, plastic tarps, garden hoses, and PPE.

Waste Sampling and Results

Samples of potentially hazardous wastes were collected and sent to TEG for analysis. Soil cuttings were analyzed for TCLP benzene and purge and reflux fluids were analyzed for reactivity, corrosivity, ignitability, TCLP benzene and metals, and TOX.

A composite sample of soil cuttings was collected by ManTech and sent to TEG and analyzed on January 4, 1999. Analytical results of the composite sample show that BTEX constituents were below detectable limits; therefore, soil cuttings could be disposed as non-hazardous petroleum contaminated soil. Soil cuttings analytical results are presented in Appendix C.

Purge water samples that were collected during the three-week post-application groundwater sampling event were analyzed by TEG on February 24, 1999. Analytical results show BTEX levels

to be below detection limits and pH to be 4.34 standard units. Based on these results, purge water could be disposed of as non-hazardous waste. Purge water analytical results are provided in Appendix D. These data were used to characterize purge water generated in subsequent (60-day and 120-day) sampling events.

Reflux fluids were sampled on January 21, 1999, and a composite sample was sent to TEG for analysis. Laboratory analysis determined that the reflux fluid is negative in terms of reactivity, corrosivity, and ignitability. TCLP benzene and TOX were not detected, and TCLP metals concentrations are all below regulatory limits. Reflux fluid analytical results are presented in Appendix E.

Waste Disposal

Thirteen drums of non-hazardous soil cuttings were removed from the site by USA Waste, a licensed non-hazardous waste hauler, on January 25, 1999 and were disposed at Protecto Landfill Unit 14 in Penuelas, Puerto Rico; a Subtitle D landfill approved for disposal of non-hazardous waste. USA Waste removed four drums of non-hazardous reflux fluid surfacing near AW-2, twenty empty plastic reagent drums, and three cubic yards of miscellaneous trash (cinder blocks, plastic tarps, and garden hoses) from the site on January 29, 1999, and disposed of them at Protecto Landfill Unit 14. On March 16, 1999, two empty metal drums were removed from the site by USA Waste and disposed at Protecto Landfill Unit 14. Ten drums of non-hazardous purge water were removed from the site by USA Waste and disposed at Protecto Landfill Unit 14 on March 17, 1999. On April 21, 1999 and June 30, 1999, USA Waste removed three drums and four drums, respectively, of non-hazardous reflux fluid from the site and disposed of them at El Coqui Landfill in Humacao, Puerto Rico; a Subtitle D landfill approved for disposal of non-hazardous waste. El Coqui Landfill was used for this disposal due to the temporary closing of Protecto Landfill Unit 14. Acknowledgement of receipts documenting proper disposal are provided as Appendix F.

3.0 PILOT TEST RESULTS

This section presents the results of laboratory analyses of soil and groundwater samples collected from the soil borings and monitoring wells to evaluate the effectiveness of the CleanOX® pilot test. Specifically, ManTech examined the changes in organic constituent concentrations detected in the soil and groundwater samples collected before, and one week, three weeks, and eight weeks after the pilot test application at the TWFF. The results of the laboratory analyses of these soil and groundwater samples are provided in Appendix F and summarized in Tables 3 and 4, respectively. Heartland Environmental, Inc.performed a Quality Assurance (QA) review of the analytical data. The results of this QA review are provided in Appendix H.

Soil and groundwater samples were collected by ManTech at locations designated in the Work Plan:

- Soil samples were collected from three borings (AW-1, AW-2, and MTMW-4) positioned to coincide with the downgradient groundwater flow direction to determine the effects of the CleanOX® Process. During the drilling of each boring, soil samples were collected at the most contaminated interval based on field observations. Soil samples were collected from AW-1, AW-2, and MTMW-4 at the 30 to 32 foot depth interval (identified as the saturated zone); 24 to 28 foot depth interval (identified as the observed water table); and 18 to 20 foot depth interval (identified as the capillary fringe or smear zone), respectively. Soil sample collection took place before the CleanOX® application and one week, eight weeks, and 120 days after the application.

- Groundwater samples were collected from the two application wells (AW-1 and AW-2) and eight off-set monitoring wells (MTMW-1, MTMW-2, MTMW-3, MTMW-4, RW-1, UGW-3, UGW-14, and UGW-25). Groundwater sample collection and analyses took place before the CleanOX® application to establish baseline conditions, and one week, three weeks, eight weeks, and 120 days after the CleanOX® application to evaluate post-treatment conditions.

ManTech has focussed the presentation and interpretation of the laboratory analyses to include the petroleum constituents of concern: BTEX, TPH gasoline, and TPH diesel. Summaries of the soil and groundwater laboratory data used by ManTech in our evaluation are provided as Tables 3 and 4, respectively. The results of our evaluation of the data are presented in the remainder of this section.

3.1 CleanOX® Process Application Observations

ManTech personnel recorded field observations and measurements during the pilot test. These parameters provide indications of how well the CleanOX® Process is proceeding in the field. They are also used to modify the CleanOX® Process design to yield maximum chemical efficiency better suited to site-specific conditions for full-scale application at the TWFF. Static water level,

temperature, conductivity, pH, dissolved oxygen, and ORP measurements were collected periodically during the application (Table 5). The effects of application to AW-1 and AW-2 were periodically monitored at six locations (MTMW-1, MTMW-2, MTMW-3, MTMW-4, RW-1, and UGW-3) throughout each day as well as at application wells AW-1 and AW-2 each morning. The following discussion relates to the parameters monitored during the field application.

Reagent Application

The field application consisted of two rounds of reagent application to AW-1 and AW-2 applied as two continuous applications. First, ManTech applied conditioning agents and the catalyst (i.e., acetic acid and ferrous sulfate) to the wells. Second, oxidizer (hydrogen peroxide) was added over two cycles in a two week period. Additional acid and ferrous sulfate were added periodically, as needed, to maintain the pH and catalyst in the proper ranges during the pilot test. At the TWFF, conditioning agents infiltrated at an average rate of 0.3 gallons per minute (gpm) in AW-1 and 0.5 gpm in AW-2. Oxidizer infiltrated at an average rate of 0.3 gpm in AW-1 and 0.2 gpm in AW-2. In total, the following quantities of reagents were added to each application well:

	Acetic Acid (lb.)	Ferrous Sulfate (lb.)	Hydrogen Peroxide (lb.)
AW-1	915	80	945
AW-2	1050	180	1250

As indicated above, greater quantities of reagents were applied to AW-2 than to AW-1. There are several factors that limited the quantity of reagents that could be added during the field application, including the reactivity of the aquifer in response to the reagent application discussed below and infiltration rates.

Infiltration of any fluid (i.e., rain, CleanOX® reagents, etc.) is a function of site-specific hydrogeologic conditions, such as soil porosity and moisture conditions, that can vary considerably across a site. ManTech boring logs and cross-sections demonstrate the variable lithologies encountered at AW-1 and AW-2 and the variable depths at which each lithology was encountered. At the TWFF, the application wells' 15-foot screens were placed to intercept the observed gravel layer and lenses containing petroleum product within a silty clay matrix (unsaturated zone) and the underlying semi-confined or confined surficial aquifer (saturated zone). Therefore, CleanOX® reagent application during the pilot test was directed towards both unsaturated and saturated zones that varied in thickness, and probably varied in porosity and moisture, at each application well location. These variable hydrogeologic conditions resulted in the observed variable infiltration rates at each application well.

Further, as reaction vapors (carbon dioxide and water vapor) accumulate and subsurface pressure

increases, reflux fluids and/or groundwater may exit at the surface if permeable pathways exist. Several abandoned boreholes/auger refusals near AW-1 served as more permeable pathways. As a result of some reflux fluids surfacing near AW-1, the flow rate of oxidizer was slowed by ManTech personnel to minimize the volume of reflux fluids in the treatment area.

Field Observations

CleanOX® reaction inhibit time is a term used to characterize an application well's reactivity and to roughly determine the time at which hydroxyl radical formation takes place. It is the time it takes ManTech field personnel to observe a reaction after applying the CleanOX® reagents. Exothermic reactions of the CleanOX® reagents began immediately after application of hydrogen peroxide, as evidenced by the presence of reflux fluids through the return lines of both application wells. Based on these observations, ManTech determined that there was a zero CleanOX® reaction inhibit time at the TWFF; i.e., hydroxyl radical formation took place immediately. Significant volumes of reflux were expected due to the historical levels of free product in the application area, and return lines were connected to 55 gallon drums for free product collection per ManTech's pilot test application design.

The reactivity of the aquifer in response to the addition of hydrogen peroxide was very strong. As discussed earlier, ManTech personnel observed reflux fluid emerging to the surface near AW-1 and AW-2 during the initial phases of application. The rate of peroxide application was reduced, which temporarily eliminated the fluid return to the surface. Return line valves were manually operated to minimize the volume of reflux and the volume of oxidizer in the reflux fluid.

After approximately 125 lb. of peroxide at 8% dilution was applied, reflux fluid began emerging to the surface near AW-1 in greater volumes. This may be due to several auger refusals during the drilling that resulted in boreholes that were grouted by ManTech. However, these locations could still act as pathways for fluids to preferentially flow to the ground surface. ManTech personnel contained the fluid by constructing a sand and cinder block berm around AW-1 and continued with reagent application to both AW-1 and AW-2. Generally, this method of containment is temporarily used when strong reactions are observed. As discussed in Section 3.1, the variable hydrogeologic conditions in the study area resulted in the observed variable infiltration rates at each application well. Further, it was difficult to maintain an adequate flow of peroxide because of the intensity of the reactions and subsequent pressurization of the application wells resulting in fluid surfacing at the application wells. As a result, only about 20 % of the design volume of oxidizer was added to the application wells.

Throughout the pilot test, ManTech personnel observed reactions in downgradient wells RW-1 and MTMW-4 (bubbling at RW-1 and bubbling and visible water vapor within the casing at MTMW-4) located approximately 10 feet southwest and 11 feet southeast of AW-1, respectively. These field observations indicate that the CleanOX® Process produced effects in the aquifer at locations at least

11 feet away from the application well and that reactions were somewhat stronger downgradient from the application wells.

In summary, the infiltration rate of CleanOX® reagents at the TWFF was limited during the pilot test for the following reasons: 1) the semi-confined or confined aquifer conditions and the predominantly silty clay matrix; 2) very exothermic reaction created due to the presence of free product, and 3) the high water vapor generation from the CleanOX® Process due to the free product. While the infiltration rate was limited, subsequent groundwater sampling and analysis suggests that the pilot test was successful in oxidizing a significant mass of contaminants and the CleanOX® Process is technically feasible for TWFF. This is discussed in more detail in Section 4.0.

Static Water Level Measurements

Static water level measurements were collected periodically during the application, and minor water level fluctuations were observed during the treatment. Temporary drops and rises in the water level ranging from approximately 0.30 to 0.35 feet and 0.10 to 2.37 feet, respectively, were observed in the application wells and surrounding monitoring wells within a radius of 14 feet from AW-1 and AW-2. Likewise, fluctuations of free product thickness were observed in both application wells and off-set observation wells ranging from decreases of 0.92 feet to increases of 2.59 feet. These fluctuations were expected and occurred due to mounding of the potentiometric surface created by the application of reagents to the wells. These effects are temporary and equilibrate within a short period of time, typically within a matter of days. At the TWFF, ManTech's one-week post-treatment monitoring data indicates that the potentiometric head measurements had equilibrated to pre-treatment levels.

Pressure

CleanOX® well head assemblies used to apply CleanOX® reagents to AW-1 and AW-2 are equipped with gauges to measure pressure and temperature at the return line valve. These measurements give ManTech personnel indications of application well conditions and help to gauge and regulate the rate of application. Pressures observed at AW-1 during the application of oxidizer remained at 10 pounds per square inch gauge (psig) or less and ranged from 10 to 50 psig at AW-2. Pressures at both wells were kept within design parameters by manual operation of the return valves by ManTech personnel in order to minimize fluid surfacing and to regulate collection of reflux liquid.

Temperature

Temperature observations at the CleanOX® well head assembly, which measure vapor temperature within the return line, were monitored at both application wells during reagent application and ranged from 32 to 98 ^{0}C. Groundwater temperature measurements were also monitored during the pilot test in both application and monitoring wells. As expected, the greatest rises in temperature

occurred at the application wells. A 9.58 °C rise in temperature from 29.05°C (baseline) to 38.63°C (mid-application) was observed at AW-1, and a 14.61 °C rise in temperature from 29.03°C (baseline) to 43.64 °C (post-application) was observed at AW-2. These temperature increases are within the range of temperature changes expected and demonstrate that exothermic reactions are taking place.

Temperature monitoring in the off-set wells during the CleanOX® application are indicative of the large heat capacity of the treatment area aquifer. Off-set well temperature changes ranged from 0.04°C at UGW-3 to 0.34°C at RW-1.

Specific Conductivity

Specific conductivity is an indication that the ferrous ion concentration is within the expected range for a field application and that the catalyst is dispersed in the aquifer as needed for hydroxyl radical formation. During the pilot testing, off-set well RW-1 showed the greatest increase in specific conductivity of 13,039 µS/cm, from 2,570 µS/cm (baseline) to 15,609 µS/cm. This increase indicates possible preferential flow to RW-1 from AW-2. An increase of 5,782 µS/cm was observed at application well AW-1, from 7,491 µS/cm (baseline) to 13,273 µS/cm (post-application); and 4,693 µS/cm at AW-2, from 3,411 µS/cm to 8,104 µS/cm. Specific conductivity increases ranging from 157 µS/cm (MTMW-1) to 13,039 µS/cm (RW-1) and decreases from 28 µS/cm (MTMW-2) to 389 µS/cm (MTMW-4) were measured in the observation wells within 14 feet of AW-1 and AW-2. The greatest decreases were observed at MTMW-3 and MTMW-4 which are located hydraulically downgradient from AW-1 and cross-gradient to AW-2.

Increases in specific conductivity in off-set wells are not critical for hydroxyl radical formation and do not dictate the ROI of the CleanOX® Process. Instead, these values are used to evaluate continuity between the application well and the monitoring locations. Hydroxyl radical formation takes place in the immediate vicinity of the application wells and then migrate outward to some distance (i.e., ROI) determined based on site-specific factors. As a result, catalyst does not need to be dispersed throughout the entire pilot study area for successful hydroxyl radical formation.

pH

Measurements of pH indicate whether the proper acidified aqueous medium is present for hydrogen peroxide to react with ferrous ions to produce hydroxyl radicals. The optimum pH range is from 3 to 5 s.u. for Fenton Reaction chemistry. Since the Fenton Reaction production of hydroxyl radical occurs near the application well, reduction of pH to below 5 s.u. is only critical for the application well. Reduction of pH in off-set monitoring wells, similar to specific conductivity, is not critical and is used to evaluate application well/monitoring well continuity.

Both application well and off-set well pH measurements were collected periodically throughout the

application process. At AW-1, decreases in pH from 7.06 s.u. (baseline) to 2.12 s.u. (post acidifier application) and 4.72 s.u. (post-application) were measured. Decreases in pH from 7.04 s.u. (baseline) to 2.02 s.u. (post-acidifier application) and 4.29 s.u. (post-application) were measured at AW-2. These measurements indicate that satisfactory acidified conditions were present in the vicinity of the application wells to initiate and maintain hydroxyl radical production.

In the off-set monitoring wells, pH reduction was most pronounced in RW-1 (3.69 s.u.), which is a very significant change for a monitoring point 10 feet from an application point. RW-1 also showed the greatest change in specific conductivity. This suggests preferential flow of CleanOX® reagents to RW-1 due to site-specific geologic conditions. Cross-sections indicate an increasing thickness of the gravel layer and the rock fragment layer in the direction of RW-1 through which CleanOX® reagents and hydroxyl radicals could be expected to move more easily than the silty clay matrix. Other monitoring wells generally showed a decrease in pH from 0.14 s.u. at UGW-3 to 0.50 s.u. at MTMW-3 which are more typical for monitoring wells about 10 feet from application wells, which indicates that a general reduction in pH occurred radially from the application wells.

Dissolved Oxygen

Dissolved oxygen is an indicator of the oxidation process. Increases in dissolved oxygen were measured at all six of the monitoring locations, from 16.21 ppm to 65.53 ppm. These observations indicate that the Fenton reaction was occurring throughout the pilot study area. However, the presence of elevated dissolved oxygen is typically transitory in CleanOX® Process applications and results from simple decomposition of hydrogen peroxide to oxygen and water. This decomposition is a normal, but unwanted, inefficiency in the chemical oxidation processes that use hydrogen peroxide. The conditioning of the aquifer with acid and ferrous ions is intended to promote peroxide decomposition to hydroxyl radical via a Fenton Reaction. Table 4 indicates at three weeks after application the dissolved oxygen measurements decreased to at or below background levels in seven of the eight wells located within 15 feet of the application wells. The return of dissolved oxygen to background levels withing the three-week time describes the termination of peroxide decomposition, but does not directly correlate to the termination of oxidation reactions.

ORP

Like dissolved oxygen, Oxidation-Reduction Potential, or ORP, is an indicator of the oxidative process. ORP describes the likelihood that electrons will be lost (oxidizing environment) or gained (reducing environment) in a reaction. ORP readings are used in the pilot test to gauge the oxidative and reductive conditions produced by the CleanOX® Process. ORP is also a good indicator for judging whether the reactions are completed and to approximate the radial extent of the process during field applications.

A +494.5 mV increase in ORP from –31.8 mV (baseline) to +462.7 mV during the application was

observed at AW-1. AW-2 showed an increase in ORP of +512.7 mV, from -65.0 mV (baseline) to +447.7 mV (mid-application). Monitoring well MTMW-1 became more reductive indicated by decreases in ORP measurements of up to -220.3 mV from -28.2 mV (baseline) to -248.5 mV (mid-application). The other five monitoring wells all displayed increases in ORP ranging from +17.7 to +350.1 mV. These increases in ORP demonstrate that the application of CleanOX® reagents to the application well had caused the aquifer surrounding them to become more highly oxidative, indicative of Fenton Reaction chemistry. While increases in ORP are the result of oxidation reactions created by the CleanOX® Process, measurements of decreased ORP may occur anomalously when an environment is rapidly changed to oxidative conditions.

Air Quality Monitoring

Air quality within the application area was monitored on a regular basis for volatile organic compounds (VOCs), lower explosive limit (LEL), and hydrogen sulfate (H_2S). Monitoring for VOCs using a photo ionization detector (PID) ranged from 0.00 to 3.6 ppm above background levels. LEL levels were generally 0%; a maximum concentration of 5% was recorded. There was no detection of H_2S.

3.2 Soil Sample Analytical Results

One week, eight weeks, and 120 days after the pilot test, ManTech collected soil samples from well locations AW-1, AW-2 and MTMW-4 using split-spoon sampling methods over two-foot intervals. During each sampling event, the samples were collected immediately adjacent to the specified wells to monitor the post-treatment progress of the CleanOX® Process. The laboratory analytical results for soil samples collected are provided as Table 3 and Appendix G, and they are discussed below:

AW-1. Soil samples were collected from well AW-1, as follows.

A grab soil sample was collected from 30 to 32 foot bgs as a baseline during installation of AW-1. Total BTEX concentrations of 21 ug/kg, TPH Gasoline concentrations of 32,000 ug/kg, and TPH Diesel concentrations of 19 mg/kg in soil were detected in laboratory analyses.

The one-week post-treatment grab soil sample was collected from a boring drilled within 5 feet of AW-1 and at the same depth of 30 to 32 feet bgs. Analytical results show decreased concentrations to below method detection limit of 6 ug/kg, 390 ug/kg, and to below method detection limit for total BTEX, TPH Gasoline, and TPH Diesel concentrations, respectively. These results indicate substantial concentration and mass reduction occurred in the vicinity of the application well and demonstrate the destruction efficacy of the CleanOX® Process.

The 60-day post-treatment grab soil sample was collected from a boring drilled within 5 feet of AW-1 and at the same depth of 30 to 32 feet bgs. Analytical results show concentrations to below method detection limit, 290,000 ug/kg, and 790 mg/kg for total BTEX, TPH Gasoline, and TPH Diesel concentrations, respectively. These increases after eight weeks suggest reinfiltration of product into this area.

The 120-day post-treatment grab soil sample was collected from a boring drilled within 5 feet of AW-1 and at the same depth of 30 to 32 feet bgs. Analytical results show concentrations estimated at 24 ug/kg, 77 ug/kg, and not detected above 7.9 mg/kg for total BTEX, TPH Gasoline, and TPH Diesel concentrations, respectively.

AW-2. AW-2 is located approximately 15 feet southwest of AW-1. Soil samples were collected as follows.

A grab soil sample was collected from 24 to 28 feet bgs as a baseline during installation of AW-2. Total BTEX concentrations of 564 ug/kg, TPH Gasoline concentrations of 350,000 ug/kg, and TPH Diesel concentrations of 580 mg/kg were detected.

The one-week post-treatment grab soil sample was collected from a soil boring drilled within 5 feet of AW-2 and at the same depth of 24 to 28 feet bgs. Analytical results show decreased concentrations to 125 ug/kg, 61,000 ug/kg, and 140 mg/kg for total BTEX, TPH Gasoline, and TPH Diesel concentrations, respectively.

The 60-day post-treatment soil sample was collected from a boring drilled within 5 feet of AW-2 and at the same depth of 24 to 28 feet bgs. Analytical results show decreased concentrations to below method detection limits for total BTEX, TPH Gasoline, and TPH Diesel concentrations.

The 120-day post-treatment soil sample was collected from a boring drilled within 5 feet of AW-2 and at the same depth of 24 to 28 feet bgs. Analytical results show decreased concentrations estimated at 91 ug/kg, 150,000 ug/kg, and 1,400 ug/kg for total BTEX, TPH Gasoline, and TPH Diesel concentrations, respectively.

MTMW-4. MTMW-4 is located approximately 12 feet southeast of AW-2. Soil samples were collected as follows.

A grab soil sample was collected from 18 to 20 feet bgs as a baseline during installation of MTMW-4. Total BTEX concentrations of 3,956 ug/kg, TPH Gasoline concentrations of 5,600,000 ug/kg, and TPH Diesel concentrations of 8,800 mg/kg were detected.

The one-week post-treatment grab soil sample was collected from a boring drilled within 5 feet of MTMW-4 and at the same depth of 18 to 20 feet bgs. Analytical results show increased total BTEX

concentrations to 10,700 ug/kg, while decreased concentrations to 5,100,000 ug/kg and 3,400 mg/kg were detected for TPH Gasoline and TPH Diesel concentrations, respectively.

The 60-day post-treatment grab soil sample was collected from a boring drilled within 5 feet of MTMW-4 and at the same depth of 18 to 20 feet bgs. Analytical results show decreased concentrations of 410 ug/kg, 320,000 ug/kg, and 2,000 mg/kg for total BTEX, TPH Gasoline, and TPH Diesel concentrations, respectively.

The 120-day post-treatment grab soil sample was collected from a boring drilled within 5 feet of MTMW-4 and at the same depth of 18 to 20 feet bgs. Analytical results show concentrations estimated at 22,540 ug/kg, 5,100,000 ug/kg, and 110,000 ug/kg for total BTEX, TPH Gasoline, and TPH Diesel concentrations, respectively.

Soil laboratory analytical results from the 120-day sampling event compared to results from the baseline sampling event indicate that substantial concentration and mass reduction were achieved in saturated soil. Results from the 120-day sampling event at AW-1 and AW-2 indicate significant reductions in BTEX, TPH Diesel and TPH Gasoline concentrations due to desorption.

Isoconcentration maps for BTEX, TPH Diesel and TPH Gasoline results for sampling points AW-1, AW-2 and MTMW-4 for baseline, one-week post-treatment sampling, and 60-day post-treatment sampling are found in Figures 8, 9 and 10, respectively.

3.3 Groundwater Sample Analytical Results

ManTech collected groundwater samples, from well locations AW-1, AW-2, MTMW-1, MTMW-2, MTMW-3, MTMW-4, RW-1, UGW-3, UGW-14, and UGW-25. The laboratory analytical results for groundwater samples collected are provided as Table 4 and Appendix G, and they are discussed below:

AW-1. At application well AW-1, a baseline total BTEX concentration of 10 ug/L was increased to 508 ug/L during the one-week sampling event, reduced to 343 ug/L during the three-week sampling event, increased to 552 ug/L during the 60-day sampling event, and reduced to 426 ug/L during the 120-day sampling event. A baseline TPH Gasoline concentration of 640 ug/L was increased to 36,000 ug/L during the one-week sampling event, reduced to 22,000 ug/L during the three-week sampling event, increased to 160,000 ug/L during the 60-day sampling event, then decreased to 60,000 ug/L during the 120-day sampling event. A baseline TPH Diesel concentration of 0.96 mg/L was increased to 6,500 mg/L during the one-week sampling event, reduced to 1,600 mg/L during the three-week sampling event, reduced to 1,500 mg/L during the 60-day sampling event, then increased to 420,000 mg/L during the 120-day sampling event.

The increases in dissolved petroleum constituent concentrations were expected. Substantial concentration and mass reduction were achieved in saturated soil. The increases in dissolved concentrations likely resulted from desorption and dissolution of petroleum constituent mass from the vigorous reaction created in the saturated zone by the Fenton Reaction.

It is also important to note that during baseline measurements free product was not observed in the well immediately following its installation although it was very likely present at that time. During the drilling, a saturated layer of petroleum product was observed approximately 2 feet above the water table. The screened interval of AW-1 intercepts this saturated layer; however, it takes a significant amount of time for product to accumulate within a well.

AW-2. AW-2 is located approximately 15 feet southwest and hydraulically downgradient of AW-1. At application well AW-2, a baseline total BTEX concentration of 95 ug/L was increased to 159 ug/L, 182 ug/L, and 325 ug/L during the one-week, three-week, and 60-day sampling events, respectively. It then decreased to 329 ug/L during the 120-day sampling event. A baseline TPH Gasoline concentration of 1,700 ug/L was increased to 6,300 ug/L during the one-week sampling event, reduced to 5,700 ug/L during the three-week sampling event, increased to 77,000 ug/L during the 60-day sampling event, then decreased to 15,000 ug/L during the 120-day sampling event. A baseline TPH Diesel concentration of 3.6 mg/L was increased to 190 and 1,000 mg/L during the one-week and three-week sampling events, respectively. It was then reduced to 420 mg/L during the 60-day sampling event, and then increased to 200,000 mg/L during the 120-day sampling event. As discussed above, increases in dissolved concentrations were expected.

MTMW-1. MTMW-1 is located approximately 12 feet northwest and hydraulically upgradient of AW-1 within the pilot test's estimated 15-foot ROI. A baseline BTEX concentration of 59 ug/L was increased to 89 ug/L, 170 ug/L, 181 ug/L, and 312 ug/L during the one-week, three-week, and 60-day, and 120-day sampling events, respectively. A baseline TPH Gasoline concentration of 1,400 ug/L was increased to 5,000 ug/L and 12,000 ug/L during the baseline one-week and three-week sampling events, respectively. It was then reduced to 11,000 ug/L and 2,400 ug/L during the 60-day and 120-day sampling events, respectively. A baseline TPH Diesel concentration of 2 mg/L was increased to 19 mg/L, 270 mg/L, and 6,200 mg/L during the one-week, three-week, and 60-day sampling events, respectively. TPH diesel was detected in groundwater at a concentration of 110 mg/L during the 120-day sampling event. Again, increases in dissolved concentrations were expected.

MTMW-2. MTMW-2 is located approximately 15 feet southeast and hydraulically downgradient of AW-1 within the pilot test's estimated 15-foot ROI. A baseline BTEX concentration of 157 ug/L was increased to 196 ug/L and 343 ug/L one-week and three-week sampling events, respectively. It was then reduced to 85 ug/L and 84 ug/L during the 60-day and 120-day sampling events, respectively. A baseline TPH Gasoline concentration of 1,900 ug/L was increased to 15,000 ug/L

during the one-week sampling event, then reduced to 9,600 ug/L, 4,600 ug/L, and 1,800 ug/L during the three-week, 60-day, and 120-day sampling events, respectively. A baseline TPH Diesel concentration of 3.1 mg/L was increased to 290 mg/L, 450 mg/L, and 8,800 mg/L during the one-week, three-week, and 60-day sampling events, respectively. TPH diesel was detected in groundwater at a concentration of 7.7 mg/L during the 120-day sampling event. Interpretation of these results is consistent with that of the application wells. Substantial reductions in the saturated soil indicate desorption and dissolution processes were on-going and result in higher dissolved concentrations.

MTMW-3. MTMW-3 is located approximately 12 feet northwest and hydraulically upgradient of AW-2 within the pilot test's estimated 15-foot ROI. A baseline BTEX concentration of 8 ug/L was increased to 258 ug/L, 396 ug/L, and 415 ug/L during the one-week, three-week, and 60-day sampling events, respectively. It was then decreased to 97 ug/L during the 120-day sampling event. A baseline TPH Gasoline concentration of 760 ug/L was increased to 24,000 ug/L during the one-week sampling event, reduced to 18,000 ug/L during the three-week sampling event, increased to 200,000 ug/L during the 60-day sampling event, and then reduced to 44,000 ug/L during the 120-day sampling event. A baseline TPH Diesel concentration of 2.3 mg/L was increased to 1,300 mg/L and 3,200 mg/L during one-week and three-week sampling events, respectively; it was then reduced to 300 mg/L during the 60-day sampling event. TPH diesel was detected in groundwater at a concentration of 350 mg/L during the 120-day sampling event. These increases in dissolved concentrations were expected. Note the increase in free product suggests that elevated levels of adsorbed and absorbed phase petroleum constituents are present at this location. The turbulence of the Fenton Reaction results in desorption and dissolution of these petroleum constituents.

MTMW-4. MTMW-4 is located approximately 12 feet southeast and hydraulically downgradient of AW-2 within the pilot test's estimated 15-foot ROI. Baseline concentrations of BTEX of 224 ug/L were increased to 376 ug/L during the one-week sampling event, then reduced to 363 ug/L and 230 ug/L in the three-week and 60-day sampling events, respectively. It was then increased to 348 ug/L during the 120-day sampling event. TPH Gasoline concentrations increased from baseline concentrations of 2,600 ug/L to 6,800 and 42,000 ug/L during the one-week and three-week sampling events. TPH diesel was detected in groundwater at a concentration of 2,600 ug/L during the 60-day sampling event, and then increased to 8,600 ug/L during the 120-day sampling event. TPH Diesel baseline concentrations of 3.7 mg/L increased to 500 mg/L, 1,300 mg/L, 18,000 mg/L, and 420,000 mg/L during the one-week, three-week, and 60-day, and 120-day sampling events, respectively. These fluctuations in dissolved concentrations are not unusual when the CleanOX® Process is applied at a site with free product, such as the TWFF. Significant decreases in free product thickness as MTMW-4 from 2.22 feet to not detectable for six weeks were observed. The slight increase to 0.22 feet likely results from on-going desorption and dissolution, and to a lesser extent, from reinfiltration of contaminants.

RW-1. RW-1 is located approximately 10 feet southeast and hydraulically downgradient of AW-2 within the pilot test's estimated 15-foot ROI. A baseline BTEX concentration of 20 ug/L was increased to 370 ug/L in the one-week sampling event, reduced to 102 ug/L during the three-week sampling event, then increased to 310 ug/L and 449 ug/L during the 60-day and 120-day sampling events, respectively. A baseline concentration of TPH Gasoline of 2,900 ug/L increased to 240,000 ug/L during the one-week sampling event, reduced to 3,400 ug/L during the three-week sampling event, increased to 35,000 ug/L during the 60-day sampling event, then reduced to 17,000 ug/L during the 120-day sampling event. A baseline concentration of TPH Diesel of 4.7 mg/L increased to 1,300 mg/L during the one-week sampling event, reduced to 250 mg/L during the three-week sampling event, increased to 520 mg/L during the 60-day sampling event, then decreased to 50 mg/L during the 120-day sampling event. Again, these fluctuations and general increases in dissolved concentrations are typical and demonstrate that desorption and dissolution reactions are on-going.

UGW-3. UGW-3 is located approximately 12 feet northeast and hydraulically upgradient of AW-1 within the pilot test's estimated 15-foot ROI. A baseline concentration of total BTEX of 36 ug/L increased to 100 ug/L during the one-week sampling event, reduced to 11 ug/L during the three-week sampling event, then increased to 39 ug/L during the 60-day and 120-day sampling events, respectively. Baseline TPH Gasoline concentrations of 550 ug/L increased to 19,000 ug/L during the one-week sampling event, then reduced to 4,300 ug/L, 1,300 ug/L, and 1,200 ug/L during the three-week, 60-day, and 120-day sampling events, respectively. Baseline TPH Diesel concentrations of 3.8 mg/L increased to 170 mg/L during the one-week sampling event, then reduced to 33 mg/L, 28 mg/L, and 1.2 mg/L during the three-week, 60-day, and 120-day sampling events, respectively. While increases in dissolved concentrations were observed, the free product thicknesses steadily decreased from 0.35 feet to 0.15 feet, then to not detectable at the 1-week, 3-week, 60-day, and 120-day sampling events. These results indicate a significant reduction in petroleum constituent mass at this location.

UGW-14. UGW-14 is located approximately 100 feet south and hydraulically downgradient of AW-2. This is not within the pilot test's estimated 15-foot ROI. No significant change in total BTEX concentration was detected in laboratory analysis . Baseline concentrations of TPH Gasoline of 1,300 ug/L increased to 24,000 ug/L during the one-week sampling event, then reduced to 5,400 ug/L and 870 ug/L during the three-week and 60-day sampling events, respectively. TPH Gasoline concentrations were detected at 1,100 ug/L during the 120-day sampling event. Baseline concentrations of TPH Diesel of 5.8 mg/L increased to 98 mg/L during the one-week sampling event, then reduced to 34 mg/L, 5 mg/L, and 2.6 mg/L during the three-week, 60-day, and 120-day sampling events, respectively.

UGW-25. UGW-25 is located approximately 110 feet northwest and hydraulically upgradient of AW-1. This is not within the pilot test's estimated 15-foot ROI. Baseline concentrations of total BTEX of 76 ug/L were reduced to 61 ug/L and 31 ug/L during the one-week and three-week sampling events, respectively. It was increased to 41 ug/L during the 60-day sampling event, and

then decreased to 36 ug/L during the 120-day sampling event. Baseline concentrations of TPH Gasoline of 220,000 ug/L decreased to 4,000 ug/L during the one-week sampling event, then increased to 5,100 ug/L and 30,000 ug/L during the three-week and 60-day sampling events, respectively. It then decreased to 2,000 ug/L during the 120-day sampling event. Baseline concentrations of TPH Diesel of 360 mg/L decreased to 280 mg/L during the one-week sampling event, then increased to 740 mg/L and 7,400 mg/L during the three-week and 60-day sampling events, respectively. TPH diesel was detected at concentrations of 780 mg/L during the 120-day sampling event.

The variation in BTEX and TPH concentrations detected during the 60-day sampling event in this area is likely due to normal sampling variations in locations that are likely to contain free product and extensive sorbed phase.

Groundwater laboratory analytical results from the 120-day sampling event compared to results from the baseline sampling event suggest the occurrence of contaminant mass desorption from site soils, product reinfiltration, and site-specific conditions such as product mixing and groundwater flow. This is supported by the substantial decreases in petroleum constituent concentrations detected by the soil analytical results from the 120-day sampling event.

Isoconcentration maps for BTEX, TPH Diesel and TPH Gasoline results for sampling points AW-1, AW-2, MTMW-1, MTMW-2, MTMW-3, MTMW-4, RW-1 and UGW-3 for baseline, one-week, three-week, and 60-day post-treatment sampling are found in Figures 11, 12 and 13, respectively. These maps illustrate the significant reductions in sorbed concentrations achieved by the CleanOX® Process and the increases in dissolved concentrations temporarily resulting from reduction of free product levels.

3.4 Analytical Data Validation Summary

Prior to CleanOX® treatment at the Site, a round of baseline soil samples were collected on December 16, 1998, and a round of baseline groundwater samples were collected on January 7, 1999. All samples were sent under chain-of-custody to Severn Trent Laboratories (STL) in University Park, Illinois. Analyses and results of baseline sampling are presented in Table 3 and Table 4 for soil and groundwater samples, respectively.

Application of CleanOX® reagents to the pilot test area began on January 11, 1999 and ended on January 29, 1999. Following the application process, three rounds of post-treatment soil samples and four rounds of post-treatment groundwater samples were collected and sent under chain-of-custody to STL. Analyses and results of post-treatment sampling are presented in Table 3 and Table 4 for soil and groundwater samples, respectively.

A third party analytical laboratory, Heartland Environmental Services, Inc. of St. Charles, Missouri (Heartland), provided quality assurance/quality control (QA/QC) data validation for analytical results from the Site. Summaries of those data rejected by QA/QC protocol are presented in the table below. A Data Validation Report provided by Heartland is included as Appendix H.

Sample Location	Matrix	Date Sampled	Analysis	Reasons For Rejection
MTMW-2	Water	4/15/99	Total Lead	Concentrations for sample were 10 times less than concentrations detected for "blank" sample
AW-2	Soil	6/29/99	Total Lead	Matrix spike recovery (210%) greater than 200%
MTMW-4	Soil	6/29/99	Total Lead	Matrix spike recovery (210%) greater than 200%
AW-1	Soil	6/29/99	Total Lead	Matrix spike recovery (210%) greater than 200%

3.5 Mass Destruction Estimates

ManTech used a simplified method to determine a rough estimate of the mass of petroleum constituents that were destroyed within the pilot test treatment area through application of the CleanOX® Process reagents after one-week and after 60 days. We believe the development and presentation of this data is important in the evaluation of the CleanOX® Process at the site because the presence of elevated concentrations of petroleum constituents in free product, residual product, sorbed, and dissolved phases makes the mass removal element of any remedial approach a significant factor in the effectiveness evaluation process. Described below is the simplified calculation method used by ManTech to estimate the TPH Diesel and TPH Gasoline mass removed within the treatment area at the site through application of the CleanOX® Process reagents after one and eight weeks.

The one-week and 60-day sampling events were used for our calculations because both soil and groundwater analytical data were collected. The mass of TPH Diesel and TPH Gasoline present as free product and in saturated soils and groundwater is based on the baseline and the 60-day post-treatment soil and groundwater sampling data. It is important to note the inherent limitations in soil sampling (i.e., heterogeneity of the subsurface) for estimation of the petroleum constituent mass in soil. Further, the limitations inherent in any sampling event (i.e., repeatability of sampling location and procedures, variability of handling and shipping conditions, etc.) are potential sources of error for our calculations. Finally, the mass removal calculations are based on averages of soil

and groundwater sampling data. Note that the application well area is an average of two sampling locations, while the monitoring well area is based on the one soil sampling location of MTMW-4. Depending on how representative these results are, the calculations may either overestimate or underestimate of the efficiency of the CleanOX® Process at the TWFF.

The product thickness data that was collected shows a substantial decrease in product thickness (two feet) in MTMW-4. The data also shows very moderate increases (less than 3 inches) in five other wells. Some of these results are expected and some are unusual. The application of the CleanOX® Process causes turbulence and mixing. To some extent, the differences in product levels between wells detected prior to application will be reduced as a result of the application due to the turbulence and mixing. Therefore, a small thickness of product appearing in a nearby monitoring well that previously had none detected is expected. However, ManTech believes that the baseline product measurements in the newly installed wells is not an adequate representation of the quantity of product that is indeed present within the treatment area. Often, many weeks are required following a well installation within an area containing product for the product to appear and be detected within the well. We believe that subsequent well gauging activities in the area will indicate that a much more substantial quantity of product is and was present in the treatment area, but had not appeared in the newly installed wells. If this is the case, ManTech's calculations provide an even more conservative estimate of product destruction.

For purposes of simplifying the mass reduction calculations, ManTech assumed the following:

- The pilot study area can be divided into three cylinders, as depicted in Figure 14. AW-1 and AW-2 are approximately 15 feet apart. The half-way distance (7.5 feet from each application well) is used to represent the center of the study area. One cylinder is created around each application well, and a larger cylinder is used around the entire study area. The radius of the larger cylinder is 22.5 feet centered at the half-way point between the application wells. Therefore, the 22.5 foot radius represents the expected 15 foot ROI of the application wells plus the half distance between the application wells (22.5=15 + 7.5).

- The analytical data from the application wells, AW-1 and AW-2, are considered representative of the soil and groundwater to a distance of 7.5 feet from each application well. The resulting volume consists of a cylinder with a radius of 7.5 feet and a height of 15 feet (the application well screen lengths);

- The analytical data from the monitoring wells located approximately 12 feet from the application wells (MTMW-1, MTMW-2, MTMW-3, MTMW-4, UGW-3, and RW-1) are considered representative of the soil and groundwater that are outside the 7.5 radius cylinder described above and within the 22.5 foot radius cylinder centered at the half-way distance between the application wells. The resulting volume consists of a hollow cylinder with a radius of 7.5 to 22.5 feet and a height of 15 feet; and

- The saturated soil is assumed to have a porosity of 30%.

Table 6 presents the estimated mass destruction calculations in these two areas after one week and after 60 days. ManTech calculated the total mass of soil in the two areas within the estimated 15-foot ROI of the application wells. As shown in Table 6, the calculations resulted in an estimated total of 8,215 kg (or 2,259 gallons) of petroleum constituent destruction after one week and 12,889 kg (or 3,544 gallons) of petroleum constituent destruction after 60 days. ManTech believes that this degree of destruction for a two-cycle round of chemical application to two application wells demonstrates the effectiveness of the process for source-area mass reduction at the TWFF.

ManTech believes that the results of the mass removal calculations for the "application well area" fully illustrate our contention that the baseline product thickness measurements (no product detected in the application wells) is not a true representation of the quantity of product present in this area. We believe it is valid to assume that the maximum level of treatment occurred in this area due to its proximity to the application wells. However, according to the calculations, 300 kg of petroleum was produced based on the 60-day post-treatment data. The inconsistency lies in the quantity of product that was present prior to application (none). Again, ManTech believes that subsequent monitoring of these wells will demonstrate (once equilibrium conditions have been established) that a substantial quantity of product was present in this area and was treated. At some point, product levels return, via infiltration, to their baseline condition and will be detectable in the application wells. Data and field observations from the 120-day post-treatment monitoring event support this conclusion, based on the 120-day free product thickness measurements of 3 to 5 feet.

4.0 CONCLUSIONS

ManTech has drawn the following conclusions from the results of the CleanOX® field application at the site:

- Technical Feasibility of the CleanOX® Process at the TWFF. The CleanOX® Process is one of the few remediation technologies capable of treating the free product found in the gravel layers and lenses above the confined aquifer in the pilot study area at the TWFF because the CleanOX® reagents can be applied directly to the identified contamination by screening application wells at the depth intervals requiring remediation. ManTech observed that following the well installation, the static water level was measured at approximately 15 feet bgs, or 7 to 8 feet above the depth where wet soils were first encountered. This level also corresponds to the interval where petroleum product is found in permeable gravel layers. By properly installing application wells, the CleanOX® Process can overcome the site condition that so severely limits mechanical recovery methods at the TWFF. The existing product recovery system is designed to remove product that is within the saturated zone/capillary fringe or has accumulated within the wells, while our investigation results indicate that a significant portion of the free product is present within the unsaturated zone.

- Mass Reduction. Significant mass reductions of greater than 12,800 kg of petroleum constituents were produced by applying the CleanOX® Process to two application wells. Field observations verified that substantial oxidation of constituent mass occurred. The hydrocarbon mass represented by the free product and soil concentration reductions is substantial. The product thickness reductions were taken as an average within the monitoring well area. Product thickness increased a marginal amount in six wells, decreased a larger amount in one well, and decreased a substantial amount in one well. Overall, a significant product thickness reduction was achieved if all data are considered equally in terms of the treatment volume they represent. Increases in dissolved concentrations are expected when treating product due to enhanced dissolution of product created by the process. This is the reason dissolved concentration increases were considered in the calculation. ManTech fully expected that the majority of detectable decreases would be in product thickness and the sorbed phase.

- Safe and Efficient Process. The pilot test procedure was performed in a safe, controlled manner at the TWFF. Because of significant reactivity of the aquifer in response to the addition of the reagents, only about 20% of the design volume of oxidizer could be added during the two-cycle pilot study. The resulting application rate was less than desired, but did result in significant mass reduction. Since the process relies on dissolution followed by oxidation of the dissolved mass, ManTech believes that the volume of oxidizer applied likely

resulted in a substantial dissolution effect. Future applications would require the use of more dilute oxidizer to be applied over a longer period of time. In the same way, the use of a more dilute oxidizer would reduce the short-circuiting of CleanOX® reagent reflux to ground surface. This factor was incorporated into the full-scale conceptual approach discussed in Section 5.

- Reagent Infiltration. The pilot test demonstrated sufficient permeability at the TWFF to infiltrate CleanOX® reagents to the surficial, semi-confined or confined aquifer. Field observations and measurements demonstrated that the reagents were distributed to a ROI of approximately 15 feet, as expected. At the TWFF, the gravel lenses are interbedded in a silty clay matrix that reduced the originally estimated rate of infiltration of reagents but did not reduce the estimated 15 foot ROI from each application well.

- Aquifer Response. Field observations and measurements demonstrated the ability of the CleanOX® reagents to adjust the pH and specific conductivity to within optimum ranges for the Fenton Reaction chemistry to take place. Further, observed bubbling, dissolved oxygen, and ORP readings demonstrated oxidation occurred within an estimated 15 foot radius of the application wells.

- Free Product Recovery. Based on our experience at similar sites, ManTech took precautions to contain any product that may have surged up an application well or off-set monitoring well. ManTech had anticipated some degree of product recovery as hot vapors from the interaction of peroxide and product occurred. The reactions observed in the pilot test did not result in any surging of free product to the ground surface and contaminant destruction was accomplished *in-situ*.

The pilot test yielded important site-specific data enabling ManTech to refine the formulation of CleanOX® Process reagents to be used at the TWFF if additional applications of the process are implemented. In summary, the application of the CleanOX® Process at the site demonstrated that the reagents could be added in a safe, controlled manner allowing the groundwater to return to pre-existing conditions fairly rapidly without producing hazardous waste at the ground surface or in the subsurface. Based on post-treatment sampling data, field observations and monitoring, a large mass of organic constituents was oxidized. As observed in the post-treatment sampling events, expected increases of detected contaminant levels in the dissolved phase followed by its oxidation suggest that much of the oxidized mass was desorbed from the soil matrix. If the overall remedial strategy for the TWFF continues to include a source removal element, ManTech believes the CleanOX® Process should be included as an alternative for further consideration.

5.0 FULL-SCALE CLEANOX® PROCESS APPLICATION ESTIMATE

5.1 Conceptual Approach

ManTech is providing a preliminary engineering design and project cost estimate for full-scale free-product remediation at the TWFF site based upon the results of the pilot test conducted in the area by ManTech in January 1999 and free product recovery system monitoring data (April 1999) provided by Baker (Figure 15). Pilot test results were used to determine CleanOX® application well radial influence, number of wells to be installed, personnel needed, reagent quantity and concentrations, application procedures, the duration of each application round, and the number of rounds of application needed for each zone at the TWFF.

In preparing this estimate, ManTech has divided the free-product plume into five zones based upon reported free product thicknesses and geographical locations. Zones are designated as Zones A, B, C, D, and E (Figure 16) and were taken from a map provided to ManTech by Baker and the April 1999 product level data. In the event that migration of free product results in changes to the existing boundaries of any zones, ManTech will adjust the number of application wells accordingly.

For our preliminary design, ManTech has assumed each CleanOX® application well will receive similar volumes and concentrations of reagents during each cycle of treatment. However, based upon the varying apparent free product thickness in each area, the number of cycles required varies from zone to zone. A stabilization period of one to two weeks will be required between each cycle for a specific zone. If more than one zone is to be treated, field crews can work within other zones during these stabilization periods. Zones are discussed in detail below:

Zone A:

Zone A is located approximately 550 feet north-northwest of the intersection of Forrestal Drive and Palau Street in the general vicinity of the pilot test performed by ManTech near monitoring well UGW-3. The area of this zone is approximately 14,400 square feet with current free-product thicknesses ranging from 0.10 to 1.00 foot. Based upon CleanOX® application well radial influence demonstrated during the pilot test, Zone A will require twenty (20) CleanOX® application wells to be installed. Based upon reagent volume and infiltration rates determined to sufficiently oxidize free product during the pilot test, the full-scale application in Zone A will require two application cycles which are estimated to take three weeks per cycle.

Zone B:

Zone B is situated north northwest from the intersection of Forrestal Drive and Palau Street, in the area near monitoring well UGW-4 and just beyond the pump station. This zone is approximately 21,600 square feet in size and the current free-product in the area is less than 0.10 feet in thickness. CleanOX® application well radial influence demonstrated during the pilot test indicates that Zone B will require thirty (30) CleanOX® application wells. Based upon free product reductions during the pilot test and the current apparent product thickness, it is estimated that two cycles would be required to sufficiently reduce the free product in this area. It is estimated that each cycle will take approximately four weeks.

Zone C:

Zone C is at the northern border of Forrestal Drive where it meets Palau Street just to the east of the pump station in the vicinity of monitoring well UGW-5. The area of this zone is comprised of approximately 27,000 square feet and Baker reports that current free-product thickness is generally between 0.01 and 4.00 feet. Based upon pilot test results and current apparent product thickness, thirty-eight (38) CleanOX® application wells will need to be installed in this area and three cycles with a duration of five weeks per cycle will be performed in order to sufficiently oxidize the free product in this area.

Zone D:

Zone D lies along the northeast border of Forrestal Drive, approximately 240 feet to the southeast of the intersection of Forrestal Drive and Palau Street in the general vicinity monitoring well UGW-13. The area of this zone is approximately 11,900 square feet with current free-product thicknesses of 4.00 feet and greater. Zone D will require seventeen (17) CleanOX® application wells be installed based upon CleanOX® application well radial influence demonstrated during the pilot test. The application in this zone will require approximately three weeks to complete each cycle with a total of four cycles to sufficiently reduce the free product in this area based upon free product reductions during the pilot test and the current apparent product thickness in the area.

Zone E:

Zone E lies along the northeastern border of Forrestal Drive just to the southeast of Zone D and approximately 550 feet from the intersection of Forrestal Drive and Palau Street near monitoring well UGW-19. Zone E consists of approximately 8,600 square feet and currently shows between 0.10 and 4.00 feet of free-product thickness. Radial influence determined during ManTech's pilot test indicates that twelve (12) CleanOX® application wells will need to be installed in this area. Based upon pilot test results and current apparent free product thickness in this zone, four cycles

with a duration of three weeks per cycle will be applied to this area in order to effectively oxidize the free product in this area.

All Zones:

In order to perform a full-scale remediation application in all areas with reported free-product, ManTech will install CleanOX® application wells throughout the estimated 83,500 square foot area within the TWFF and points along the northeast border of Forrestal Drive to the southeast of the compound. The application procedure will incorporate all of the above mentioned number of cycles per Zone over the course of fifty (50) weeks. The first cycle which will be applied to the entire area delineated in Figure 16 will require approximately eighteen (18) weeks to complete. The second cycle will encompass the same area and time frame as the first cycle of eighteen (18) weeks. However, the third cycle will only be required for Zones C, D, and E and will therefore require only twelve (12) weeks to complete. The fourth and final cycle will be applied to Zone D alone and require approximately a three (3) week duration to complete.

Permitting and Design

A revised Environmental Protection Plan and a Stormwater Pollution Prevention Plan will be prepared and submitted to Baker and the Navy for review and approval prior to commencing the full-scale application.

The Environmental Protection Plan will follow the format of Naval Facilities Engineering Command Guide Specifications (NFGS) 01575, "Temporary Environmental Controls," and include items such as: contractor organization, address, and phone numbers; identification of hazardous materials to be brought onto the station; an MSDS package; employee training documentation; a hazardous materials/waste storage plan; identification of the hazardous waste that may be generated in the full-scale application; preconstruction survey results; and identification of any permitting requirements for hazardous materials/waste. Potential waste streams that may be generated in the full-scale application include drilling cuttings, well development water, free product from well bail-down tests (to measure true free product levels), and free product that may reflux to the surface during the oxidation process. Empty plastic chemical containers will be labeled and will be picked up for recycling by the supplier. No hazardous waste streams are expected to be generated during the full-scale application of the CleanOX® Process.

The Stormwater Pollution Prevention Plan will follow NFGS 01575 and include: identifying potential sources of pollution that may affect the quality of stormwater at the site; describing the practices and their implementation to reduce the potential impacts to stormwater from the planned activities; and identifying best management practices from USEPA guidance (EPA 832-R-92-005). The focus of this plan will be the precautions to be taken while handling and storing CleanOX® reagents or free product during the full-scale application.

Health and Safety requirements are outlined in NFGS 01525, "Safety Requirements." This specification identifies requirements to submit an Accident Prevention Plan (APP), an Activities Hazard Analysis (AHA), and a Health and Safety Plan (HASP). The APP includes information regarding the site safety officer and other key personnel qualifications and personal information, emergency response plan, hazardous materials use, hazardous energy control plan, and alcohol and drug abuse plan. The AHA defines the activities being performed for each major phase of work, the work sequence, the specific hazards to anticipate, control measures to eliminate or reduce each hazard to acceptable levels, and training requirements. The HASP includes the location, size and details of controlled areas; location and details of decontamination systems; interface of trades involved in the project; sequencing of work; disposal plans; sampling protocols; testing labs; protective equipment; pollution control; evidence of compliance with 29 CFR 1910.120 and 29 CFR 1926.65; and training and certifications of CIH, CSP, or other cognizant persons.

Based on our September 1998 meeting with the Navy, Baker, and EQB, ManTech does not anticipate that an EQB Underground Injection Control (UIC) permit will be required.

In addition, ManTech will prepare a full-scale CleanOX® Process remediation design document for the TWFF. This document will provide the details of full-scale treatment and specify well locations, monitoring points, and procedures to be followed. Preparation of this document will require additional site visits to the TWFF by ManTech to determine the appropriate well layout, establish work area, and define staging areas, among other things.

Application Well Installation and Abandonment

As discussed earlier, the number of application wells required to treat each zone has been determined based on the pilot test's documented ROI of 15 feet. Each CleanOX® application well will be constructed of two-inch diameter, stainless-steel riser with 0.01-inch, slotted stainless-steel screen. Total well depths and the screened intervals will be based on ManTech geologist's field observations during drilling of petroleum stained product and groundwater elevations at each location. ManTech field personnel will survey the top-of-casing elevations of the newly installed application wells.

Free Product Measurements, Groundwater, and Soil Sampling

ManTech will perform baseline apparent and true free product measurements at each of the newly installed application wells and conduct groundwater sampling at existing monitoring and recovery wells in each treatment zone, as follows.

Zone	Approximate Treatment Area (ft^2)	Number of Application Wells	Number of Existing Monitoring and Recovery Wells
A	14,400	20	8
B	21,600	30	6
C	27,000	38	9
D	11,900	17	5
E	8,600	12	3
ALL ZONES	83,500	117	31

Field parameters to be measured onsite during the baseline sampling will include: water levels, product thickness, temperature, pH, ORP, specific conductance, and dissolved oxygen. ManTech has assumed that one trip blank and one duplicate will be required per sampling event and the groundwater samples will be submitted for chemical analyses as listed in Table 8 - Full Scale Sampling Summary.

In each treatment zone, three weeks following the completion of the full-scale application, field measurements will be made in all wells (including application and existing monitoring and recovery wells) and groundwater samples will be collected from the existing wells. Field parameters to be measured onsite during the baseline sampling will include: water levels, product thickness, temperature, pH, ORP, specific conductance, and dissolved oxygen. Groundwater measurements and analysis will be conducted as outlined in Table 8 - Full Scale Sampling Summary.

In the same way, sixty days following the completion of the full scale application in each treatment zone, field measurements will be made in all wells (including application and existing monitoring and recovery wells) and groundwater samples will be collected from the existing wells. Field parameters to be measured onsite during the baseline sampling will include: water levels, product thickness, temperature, pH, ORP, specific conductance, and dissolved oxygen. Groundwater measurements and analysis will be conducted as outlined in Table 8 - Full Scale Sampling Summary. Based on the results of this sampling event, ManTech will recommend to either continue the post-treatment monitoring program, or to petition EQB for approval to discontinue the post-treatment sampling program.

CleanOX® Full-Scale Reagent Application

In each treatment zone, CleanOX® reagents will be added to the application wells to effect free product level reductions in groundwater so that the effectiveness of full-scale treatment using the CleanOX® Process can be evaluated in the existing monitoring and recovery wells.

Since free product is present, the reactions will likely be very exothermic and vigorous and can lead to free product refluxing through the vent lines of the application wells and through nearby monitoring points. Although this did not occur during the pilot test, ManTech will continue to take precautions based on our experience at other sites. In each treatment zone, the existing wells will be fitted with reflux lines and collection drums to containerize any liquids that may be generated during the process. If ManTech observes that there is little or no potential for expecting reflux liquid from these wells, then ManTech may adjust or remove fittings to these off-set wells as needed to facilitate monitoring the application process. Additionally, well heads and collection drums will be surrounded by absorbent material and the application will proceed very slowly to maintain control of the reactions. Collected product will be containerized, sampled, and analyzed for hazardous waste characteristics.

We have assumed that laboratory analyses will document that the collected product will be considered non-hazardous, and it will be transferred by ManTech to the existing free product recovery system holding tank for disposal by the Navy or the Navy's free product recovery contractor.

Prior to reagent application, each application well will be fitted with a well-head seal that includes two valved risers; one riser is attached to the above-ground containers of reagents while the other riser is used as a steam vent. Next, groundwater elevation, pH, ORP, dissolved oxygen, and temperature will be measured in the application wells and existing wells in each treatment zone. Following these measurements, the reagent application will begin. During the application process, groundwater elevation, pH, specific conductance, ORP, temperature, and dissolved oxygen will be monitored in the existing wells.

Off-Site Waste Disposal

ManTech anticipates that the wastes generated during the full-scale application will include well installation drill cuttings, groundwater, and product from well development and purging during groundwater sampling activities, and potentially water and product recovered during application of CleanOX® reagents. Drill cuttings from our well installation activities will be composite sampled for waste disposal analyses.

Well development and purge water from baseline groundwater sampling activities will be containerized and analyzed as required by the disposal contractor. Off-site disposal of this purge

water will be approved by the Navy. Water and product collected as a result of the reagent application will be containerized and then sampled and analyzed for waste disposal characteristics. Off-site disposal of any liquids collected during the full-scale application will be approved by the Navy.

Technical Report

Since the full-scale application is expected to take more than one year to complete, ManTech will prepare quarterly progress reports and one project summary technical report describing the results of the full-scale application after completion of the CleanOX® reagent application and post-treatment monitoring program. The reports will document all field work that was performed, including field equipment specifications and the volumes of reagents applied in each treatment zone. Analytical results from the field sampling program will be presented along with conclusions concerning the effectiveness of the CleanOX® technology in degrading and reducing free product in groundwater within the treatment area of the site. ManTech will prepare draft and final versions of the project summary technical report.

5.2 Cost Estimate

The CleanOX® full-scale application costs have been conservatively estimated using parameters determined during ManTech's pilot test at the TWFF. The following table provides an overview of the full-scale estimate; however, details of estimated costs per cycle are provided in Table 7.

CleanOX® Full-Scale Application Estimated Cost Summary

Zone	Square Feet	Number of Application Wells	Number of Treatment Cycles	Total Cost
A	14,400	20	2	$799,200
B	21,600	30	2	$1,139,000
C	27,000	38	3	$1,977,900
D	11,900	17	4	$1,189,000
E	8,600	12	3	$697,800
ALL ZONES	83,500	117	2-4	$5,802,900

5.3 Assumptions

Key assumptions that were used in the development of this scope of work and cost estimate include:

- Utilities are available at the site including a potable water bib and supply and electrical service (120 V, 60 Hz, 15 amp electrical outlet) within 100 feet of the work areas;

- Adequate facilities are available at the site for the unloading and storage of CleanOX® reagents in or near the proposed treatment area;

- We assume that there are no other sources of contamination in the immediate vicinity of the treatment area since their presence would mask the effectiveness of the CleanOX® Process. Work elements necessary to verify the absence of other sources have not been included in this proposal;

- Weather conditions will permit execution of the full-scale application without work delays. Full-scale application work can be completed under Occupational Safety Health Administration (OSHA) guidelines using Level D personnel protective equipment (PPE);

- ManTech will be responsible for locating underground utilities using Navy documentation, and/or other subsurface features that would delay the full-scale application activities;

- ManTech will provide information and coordinate with the Navy to obtain regulatory approval to perform the CleanOX® application;

- ManTech will mobilize all equipment and personnel required to apply the CleanOX® Process at the property. ManTech will be responsible for arranging the delivery of chemical reagents required to conduct the full-scale program, applying the CleanOX® reagents using the newly installed application wells, and monitoring on-site conditions to ensure that the process is being applied appropriately. During the application of the CleanOX® reagents, parameters such pH, dissolved oxygen, ORP, temperature, and groundwater elevation will be measured periodically in the application and off-set observation wells by ManTech; and

- Characterization, transportation, and disposal of derivative wastes, if any, are not included in ManTech's scope of work. Empty chemical reagent containers will be rinsed and recycled after the full-scale program. Waste materials that may be generated include decontamination water from well sampling and drilling activities, drill cuttings from installing monitoring wells, and PPE.

TABLES

Table 1
Tow Way Fuel Farm
Pilot Test Sampling Summary

Sampling Event	Groundwater Analysis									Soil Analysis						Misc.		Totals
	8260 (BTEX only)	TPH by 8015M (DRO & GRO)	Iron by 236.2/ 6010	Lead by 239.2/ 7421	Hardness by 130.2	Alkalinity by 310.1	Sulfates by 9056	Nitrates/ Nitrites by 9056	TDS by 160.1	pH by 9040/ 9045	TPH by 8015M (DRO/ GRO)	BTEX by 8260	Iron by 6010	Lead by 7421	Sulfates by 9035/9036	Drilling Cuttings*	Purge Water*	
Task 2 - Baseline Soil	1									3	3	3	3	3	3			19
Task 3 - Baseline GW	12	10	10	10	10	10	10	10	10									92
Task 5 - Waste Disposal																1	1	2
Task 6 - 1 week sampling	12	10	10	10	10	10	10	10	10	3	3	3	3	3	3		1	111
Task 7 - 3 week sampling	12	10	10	10	10	10	10	10	10									92
Task 8 - 60 day sampling	12	10	10	10	10	10	10	10	10	3	3	3	3	3	3			110
Task 9 - 120 day sampling	12	10	10	10	10	10	10	10	10	3	3	3	3	3	3			110

*Drill cuttings analyzed for TCLP benzene only. Purge water analyzed for reactivity, corrosivity, ignitability, TCLP benzene & metals, and TOX.

Table 2
Wells Used As Part of the CleanOX® Process Pilot Test
Naval Station Roosevelt Roads Tow Way Fuel Farm

Well ID	Well Diameter (in.)	Well Construction Material	Static Water Level (ft. bgs)	Measured Depth of Well (ft. bgs)	Screened Interval (ft. bgs)	Location Relative to Application Well
AW-1	2	SS	14.15	34.5	20.5-35.5	15ft. NE AW-2
AW-2	2	SS	15.65	30.2	16-31	15ft. SW AW-1
MTMW-1	2	PVC	15.25	37.5	19.5-39.5	11ft. NW AW-1
MTMW-2	2	PVC	15.46	36.6	18-38	13ft. SE AW-1
MTMW-3	2	PVC	14.09	35.1	15-35	14ft. NW AW-2
MTMW-4	2	PVC	15.99	33.9	15.5-36	11ft. SE AW-2
RW-1*	6	PVC	13.49	30.2	10-30	10ft. SW AW-2
UGW-3*	2	PVC	15.01	33.5	25.44-35.44	11ft. NE AW-1

* Installed by others.

Table 3
CleanOX® Pilot Test Project
Naval Station Roosevelt Roads Tow Way Fuel Farm
Soil Analytical Results

Well	AW-1 (30 to 32 feet bgs)								AW-2 (24 to 26 feet bgs)								MTMW-4 (18 to 20 bgs)							
Date	12/16/98		2/8/99		4/27/99		6/29/99		12/16/98		2/8/99		4/15/99		6/29/99		12/16/98		2/8/99		4/15/99		6/29/99	
Distance from application well (ft)	0		0		0		0		0		0		0		0		12		12		12		12	
8260 BTEX																								
Benzene (ug/kg)	30	UJ	ND(<6)	U	ND(<130)	U	6	UJ	ND(32)	U	ND(<33)	U	ND(<6)	U	32	UJ	36	J	170	J	ND(<59)	U	80	J
Toluene (ug/kg)	30	UJ	ND(<6)	U	ND(<130)	U	6	UJ	ND(32)	U	ND(<33)	U	ND(<6)	U	32	UJ	120	J	270	J	ND(<59)	U	460	J
Ethylbenzene (ug/kg)	30	UJ	ND(<6)	U	ND(<130)	U	6	UJ	280	J	64		ND(<6)	U	15	J	4,100	J	4,200	J	160		9,000	J
Xylene (Total) (ug/kg)	30	UJ	ND(<6)	U	ND(<130)	U	6	UJ	220	J	61		ND(<6)	U	12	J	6,800	J	6,500	J	250		13,000	J
Total BTEX (ug/kg)	120	UJ	ND	U	ND	U	24	UJ	500		125		ND		91	UJ	11,056	J	11,140	J	410		22,540	J
8015M Gasoline Range Organics (ug/kg)	32,000	Y	390	Y	290,000		77	Y	350,000	Y	61,000	Y	ND(<55)	U	150,000	Y	5,600,000	Y	5,100,000	Y	320,000	Y	5,100,000	Y
8015M Diesel Range Organics (mg/kg)	ND(19)	U	ND(<7)	U	790	Y	7.9	U	580	J	140	Y	ND(<6.8)	U	1,400	Y	8,800	Y	3,400	Y	2,000	Y	110,000	Y
Iron, Total (mg/kg)	31,000		32,800		29,000		29,100		24,400		41,500		36,100		39,800		47,900		42,600		34,500		67,600	
Lead, Total (mg/kg)	0.56		0.7		0.41	B	2.2	R	0.51		0.7		1.8		0.47	R	1.8		3.1		2.2	B	1.9	R
Sulfate (mg/kg)	16.4	J	35.2		5.5		32.1		10.6	J	47.9		5.5		8.5		8.8		55.0		22.4		31.2	
pH (s.u.)	8.2		4.4		7.4		8		9.3		5.4		8.5		31.8		8.9		7.5		8.1		7.2	

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U= Not Detected.

J= Estimated Value.

R= Result is Rejected and unusable.

B= Result is less than the CRDL, but greater than or equal to the instrument detection limit.

Table 4
CleanOX® Pilot Test Project
Naval Station Roosevelt Roads Tow Way Fuel Farm
Groundwater Analytical Results

Well	AW-1										AW-2									
Sample Collection Date	1/7/99		2/8/99		2/22/99		4/15/99		6/29/99		1/7/99		2/8/99		2/22/99		4/15/99		6/29/99	
Distance from application well (ft)	0		0		0		0		0		0		0		0		0		0	
8260 BTEX																				
Benzene (ug/L)	2		50		37		62		51		9		14		29		37		43	
Toluene (ug/L)	ND(1)	U	28		16		ND(<50)	J	25		4		9		ND(<25)	U	18		18	
Ethylbenzene (ug/L)	1		180		120		160		150		37		68		59		120		110	
Xylene (Total) (ug/L)	6		250		170		230		200		45		91		94		170		158	
Total BTEX (ug/L)	9		508		343		552		426		95		182		182		345		329	
8015M Gasoline Range Organics (ug/L)	640	Y	36,000	Y	22,000	Y	160,000	Y	60,000	Y	1,700	Y	6,300	Y	5,700	Y	77,000	Y	15,000	Y
8015M Diesel Range Organics (mg/L)	0.96	Y	6,500	Y	1,600	Y	1,500	Y	420,000	Y	3.6	Y	190	Y	1,000	Y	420	Y	200,000	Y
Iron, Total (ug/L)	5,030		596,000		577,000		377,000		216,000	J	23,900		416,000		550,000		473,000		425,000	J
Lead, Total (ug/L)	ND(<1.3)	U	16.1		10.3		12	UJ	18.5	J	2.9		13.5		13.8		12	UJ	36.5	J
Alkalinity (mg/L)	783		ND(10)	U	ND(10)	U	ND(<10)	U	10		609		ND(<10)	U	ND(<10)	U	ND(<10)	U	ND(<10)	U
Hardness by EDTA (mg/L)	1,590		6,620		4,700		1,020		5,480		342		6,470		7,000		7,450		6,660	
Nitrate, as N (mg/L)	3.3		2.6		0.16		0.18		0.17		ND(0.1)	U	5.3		2.7		ND(<0.1)	U	0.13	
Sulfate (mg/L)	238		2,220		3,060		1,130		1,110		43		1,860		2,440		1,730		2,310	
Total Dissolved Solids (mg/L)	4,800		16,000		15,000		17,000		12,000		1,600		11,000		15,000		17,000		15,000	
Field Parameters																				
Depth to water (ft)	14.15		14.42		14.8		16.16		16.71		13.87		15.29		15.62		16.54		19.79	
Product Thickness (ft)	ND(<0.01)		ND(<0.01)		ND(<0.01)		0.05		5.15		ND(<0.01)		0.09		0.01		0.16		5.35	
pH (s.u.)	7.06		6.41		6.3		4.39		7		7.04		6.56		5.87		5.2		7.01	
Temperature (oC)	29.05		28.8		26.1		29.5		26.1		29.03		31.2		28.1		33.8		26.1	
Dissolved Oxygen (ppm)	3.73		23.2*		3.37		3.54		2.48		5.41		51.2*		3.2		2.75		2.21	
ORP (mV)	-31.8		222.7		205.3		197.5		189		-65		233.7		205.8		168.7		141	
Specific Conductance (us/cm)	7,491		ND(>20,000)		ND(>20,000)		1,070		17,200		3,411		157,600		18,340		21,000		16,300	

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*= Measured in percent.

Table 4
CleanOX® Pilot Test Project
Naval Station Roosevelt Roads Tow Way Fuel Farm
Groundwater Analytical Results

Well	MTMW-1										MTMW-2									
Sample Collection Date	1/7/99		2/8/99		2/22/99		4/15/99		6/29/99		1/7/99		2/8/99		2/22/99		4/15/99		6/29/99	
Distance from application well (ft)	12		12		12		12		12		15		15		15		15		15	
8260 BTEX																				
Benzene (ug/L)	3		11		14		22		41		40		30		22		13		6	
Toluene (ug/L)	2		3		ND(<12)	U	8		15		10		6		11		3		4	
Ethylbenzene (ug/L)	20		33		68		59		96		57		92		160		3		37	
Xylene (Total) (ug/L)	34		42		88		92		160		50		68		150		66		37	
Total BTEX (ug/L)	59		89		170		181		312		157		196		343		85		84	
8015M Gasoline Range Organics (ug/L)	1,400	Y	5,000	Y	12,000	Y	11,000	Y	2,400	Y	1,900	Y	15,000	Y	9,600	Y	4,600		1,800	Y
8015M Diesel Range Organics (mg/L)	2.0	Y	19	Y	270	Y	6,200	Y	110	Y	3.1	Y	290	Y	450	Y	8,800		7.7	Y
Iron, Total (ug/L)	7,140		23,900		80,900		10,200		7,950	J	12,700		56,900		208,000		5,250		3,240	J
Lead, Total (ug/L)	ND(<1.3)	U	ND(<1.3)	U	ND(<1.3)	U	ND(<1.7)	U	2.9	J	ND(<1.3)	U	2.3		5.8		ND(<5)	R	4.6	J
Alkalinity (mg/L)	767		839		764		911		694		700		795		863		458		923	
Hardness by EDTA (mg/L)	1,920		4,880		2,000		1,800		1,740		1,820		2,090		1,350		877		884	
Nitrate, as N (mg/L)	6.5		0.37		1.4		1		ND(0.02)	U	ND(0.1)	U	ND(0.1)	U	ND(<0.01)		ND(<0.1)	U	ND(0.1)	U
Sulfate (mg/L)	320		187		105		181		14.3		152		14.5		145		52		37.3	
Total Dissolved Solids (mg/L)	5,600		5,400		5,800		5,500		4,900		5,300		3,500		3,400		3,600		3400	
Field Parameters																				
Depth to water (ft)	15.12		15.26		15.66		17.87		17.9		15.01		16.07		16.77		18.45		18.75	
Product Thickness (ft)	ND(<0.01)		0.01		ND(<0.01)		ND(<0.01)		16.36		ND(<0.01)		0.01		ND(<0.01)		0.14		3.8	
pH (s.u.)	7.08		6.71		6.74		6.6		6.97		6.77		6.86		6.67		7.19		7	
Temperature (oC)	29.04		27.3		27.2		30.2		26.1		29.12		30		27.5		31.4		26.1	
Dissolved Oxygen (ppm)	1.35		2.5*		0.46		1.17		0.99		1.85		8.2*		0.01		0.54		0.5	
ORP (mV)	-28.2		-70.2		4.2		18.1		16.7		-105.8		53.8		21.7		34.9		29.95	
Specific Conductance (us/cm)	7,990		17,680		17,280		19,130		16,680		10,482		17,920		13,880		12,170		17,380	

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Table 4
CleanOX® Pilot Test Project
Naval Station Roosevelt Roads Tow Way Fuel Farm
Groundwater Analytical Results

Well	MTMW-3										MTMW-4									
Sample Collection Date	1/7/99		2/8/99		2/22/99		4/15/99		6/29/99		1/7/99		2/8/99		2/22/99		4/15/99		6/29/99	
Distance from application well (ft)	12		12		12		12		12		12		12		12		12		12	
8260 BTEX																				
Benzene (ug/L)	ND(1)	U	30		32		23		13		44		42		19		42		36	
Toluene (ug/L)	ND(1)	U	12		14		12		ND(12)	U	16		24		14		17		22	
Ethylbenzene (ug/L)	1		76		120		140		30		69		110		120		71		130	
Xylene (Total) (ug/L)	5		140		230		240		54		95		200		210		100		160	
Total BTEX (ug/L)	6		258		396		415		97	Y	224	Y	376		363		230		348	
8015M Gasoline Range Organics (ug/L)	760	Y	24,000	Y	18,000	Y	200,000		44000	Y	2,600	Y	6,800	J	42,000	Y	2,600	Y	8,600	Y
8015M Diesel Range Organics (mg/L)	2.3	Y	1,300	Y	3,200	Y	300		350	J	3.7		500	J	1,300	Y	18,000	Y	420,000	Y
Iron, Total (ug/L)	90,000		32,400		91,300		79,100		12400	J	8,140		61,100		82,000		15,300		21,700	J
Lead, Total (ug/L)	7.1		9.2		2.4		2.6		4.9		1.4		7.4		2.2		ND(<6)	UJ	141	J
Alkalinity (mg/L)	716		765		751		872		864		767		839		809		793		885	
Hardness by EDTA (mg/L)	1,650		2,340		1,500		1,640		1500		1,430		1,990		1,370		898		1360	
Nitrate, as N (mg/L)	12.2		7.9		5.9		8.4		6.3		ND(0.1)	U	ND(0.1)	U	ND(0.1)	U	0.48		ND(0.1)	U
Sulfate (mg/L)	287		281		317		276		190		77.2		24.6		69.4		32.4		132	
Total Dissolved Solids (mg/L)	4,200		4,900		4,100		5,100		4200		4,300		4,300		4,100		4,800		4000	
Field Parameters																				
Depth to water (ft)	14		13.56		13.85		15.67		16.9		16.12		15.28		16.1		17.9		17.88	
Product Thickness (ft)	ND(<0.01)		0.01		0.01		0.16		4.55		2.22		0.01		ND(<0.01)		0.22		4.3	
pH (s.u.)	7.11		7.64		6.28		5.15		7.08		7.02		6.78		6.14		6.02		6.98	
Temperature (oC)	28.97		30		27		33.7		26.1		28.92		28.2		26.4		30.4		26.1	
Dissolved Oxygen (ppm)	0.72		24.5*		1.67		1.54		1.56		1.08		20.5*		1.53		1.18		1.41	
ORP (mV)	-70.7		99.3		93.4		84		62		-116.5		-3.1		18		26.1		3.2	
Specific Conductance (us/cm)	7,027		13,400		13,250		15,340		17,000		8,266		14,470		12,790		16,020		16,900	

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*= Measured in percent.

Table 4
CleanOX® Pilot Test Project
Naval Station Roosevelt Roads Tow Way Fuel Farm
Groundwater Analytical Results

Well	RW-1										UGW-3									
Sample Collection Date	1/7/99		2/8/99		2/22/99		4/15/99		6/29/99		1/7/99		2/8/99		2/22/99		4/15/99		6/29/99	
Distance from application well (ft)	10		10		10		10		10		12		12		12		12		12	
8260 BTEX																				
Benzene (ug/L)	ND(2)	U	ND(<50)	U	10	J	ND(<50)	U	29	J	7		ND(<12)	U	2	UJ	7		3	
Toluene (ug/L)	ND(2)	U	ND(<50)	U	4	J	ND(<50)	U	ND(25)	U	ND(<2)	U	ND(<12)	U	2	UJ	ND(<2)	U	2	
Ethylbenzene (ug/L)	7		130		36	J	80		180	J	17		42		11		14		15	
Xylene (Total) (ug/L)	9		240		52	J	130		240	J	12		58		2	UJ	18		19	
Total BTEX (ug/L)	16		370		102	J	210		449	J	36		100		17	UJ	39		39	
8015M Gasoline Range Organics (ug/L)	2,900	Y	240,000	Y	3,400	Y	35,000		17,000	Y	550	Y	19,000	Y	4,300	Y	1,300		1,200	J
8015M Diesel Range Organics (mg/L)	4.7	J	1,300	Y	250	J	520		50	Y	3.8	J	170	Y	33	Y	28		1.2	Y
Iron, Total (ug/L)	1,910		499,000		371,000		293,000		251,000	J	12,900		14,900	J	86,700		3,180		2,260	J
Lead, Total (ug/L)	ND(<1.3)	U	34.3		18.0		ND(<6)	U	9.4	J	ND(<1.3)	U	ND(<1.3)	U	2.2	B	1.2	UJ	50.2	J
Alkalinity (mg/L)	674		1,280		ND(10)	U	513		2040		783		842		805		909		865	
Hardness by EDTA (mg/L)	384		6,470		5,050		1,640		3170		1,870		2,240		1,800		1,600		2,120	
Nitrate, as N (mg/L)	ND(0.1)	U	ND(0.1)	U	ND(0.1)	U	0.11		ND(0.1)	U	0.95		0.35		0.34		ND(<0.1)	U	0.023	
Sulfate (mg/L)	21.5		1,600		1,520		933		615		275		180		239		69.6		215	
Total Dissolved Solids (mg/L)	1,500		12,000		13,000		9,800		8300		5,600		5,700		5,100		5,200		5,800	
Field Parameters																				
Depth to water (ft)	13.49		14.8		14.46		16.7		16		15.02		17.33		17.6		17		20.41	
Product Thickness (ft)	ND(<0.01)		0.20		ND(<0.01)		ND(<0.01)		3.1		0.35		0.15		ND(<0.01)		ND(<0.01)		ND(<0.01)	
pH (s.u.)	7.41		5.26		5.51		4.3		7		6.98		7.08		6.49		5.45		6.95	
Temperature (oC)	28.7		29		28.3		28.8		28.3		29		27.6		27.9		29.3		28.3	
Dissolved Oxygen (ppm)	0.39		8.2*		0.25		0.17		0.93		1.78		1.8*		0.5		0.67		0.47	
ORP (mV)	-230		134.7		133.5		117.4		2.4		-163.5		-122.3		2.3		-54.2		6.21	
Specific Conductance (us/cm)	2,570		ND(>20,000)		ND(>20,000)		16,360		17,600		8,365		18,320		17,880		4,140		17,400	

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Table 4
CleanOX® Pilot Test Project
Naval Station Roosevelt Roads Tow Way Fuel Farm
Groundwater Analytical Results

Well	UGW-14										UGW-25									
Sample Collection Date	1/7/99		2/8/99		2/22/99		4/15/99		6/29/99		1/7/99		2/8/99		2/22/99		4/15/99		6/29/99	
Distance from application well (ft)	100		100		100		100		100		110		110		110		110		110	
8260 BTEX																				
Benzene (ug/L)	ND(<2)	U	ND(<2)	U	ND(<2)	U	ND(<2)	U	ND(<1)	U	10		14		7		8		5	
Toluene (ug/L)	ND(<2)	U	ND(<2)	U	ND(<2)	U	ND(<2)	U	ND(<1)	U	ND(<2)	U	1		0.6		ND(<2)	U	ND(<2)	U
Ethylbenzene (ug/L)	ND(<2)	U	9		5		5		ND(<1)	U	10		7		3		3		4	
Xylene (Total) (ug/L)	ND(<2)	U	ND(<2)	U	ND(<2)	U	7		ND(<1)	U	56		39		20		28		27	
Total BTEX (ug/L)	ND	U	9		5		12		ND	U	76		61		30.6		41		36	
8015M Gasoline Range Organics (ug/L)	1,300	Y	24,000	Y	5,400	Y	870		1,100	Y	220,000	Y	4,000	Y	5,100	Y	30,000	Y	2,000	J
8015M Diesel Range Organics (mg/L)	5.8	J	98	Y	34	Y	5		2.6	Y	360	Y	280	Y	740	Y	7,400	Y	780	Y
Iron, Total (ug/L)	37,100		90,700		28,200		2,180		4,090	J	2,320		3,780		3,150		4,030		2,440	
Lead, Total (ug/L)	4.8		6.7		ND(1.3)	U	ND(<1.7)	U	2.9		1.5		1.3		ND(1.3)	U	ND(<1.7)	U	7.4	
Alkalinity (mg/L)	990		1,030		1,060		1,050		1,180		998		992		943		1,060		986	
Hardness by EDTA (mg/L)	1,270		2,490		1,250		1,230		1,250		310		1,590		320		271		315	
Nitrate, as N (mg/L)	0.14		ND(0.1)	U	ND(0.1)	U	ND(0.1)	U	ND(0.1)	U	ND(0.1)	U	ND(0.1)	U	ND(0.1)	U	ND(0.1)	U	ND(0.1)	U
Sulfate (mg/L)	23.2		25.1		37.6		19.6		5.1		54		9.6		73.8		15.7		34.8	
Total Dissolved Solids (mg/L)	3,900		3,600		4,300		4,100		3,900		2,200		1,800		2,000		2,500		2,300	
Field Parameters																				
Depth to water (ft)	12.09		13.71		14.3		14.2		16.15		45.4		47.2		47.64		47.55		49	
Product Thickness (ft)	ND(<0.01)		ND(<0.01)		ND(<0.01)		ND(<0.01)		ND(<0.01)		1.34		1.34		1.39		ND(<0.01)		1.41	
pH (s.u.)	7.3		6.95		6.67		5.75		7.01		7.2		7.28		6.79		5.1		7.1	
Temperature (oC)	27.8		27.4		26.3		28.2		26.1		28.3		27.7		26.8		27.9		28.3	
Dissolved Oxygen (ppm)	NM		0*		0.54		0.45		0.36		NM		21.4*		2.08		1.77		1.72	
ORP (mV)	NM		-159.9		16.9		-29.4		2.3		NM		55.3		16.6		66.9		43.5	
Specific Conductance (us/cm)	13,200		13,450		12,630		13,130		17,400		13,100		6,980		7,160		6,120		16,680	

UJ= Reported Quantitation limit is qualified as estimated.

Y=The chromatographic response resembles a typical fuel pattern.

U= Not Detected.

J= Estimated Value.

R= Result is Rejected and unusable.

B= Result is less than the CRDL, but greater than or equal to the instrument detection limit.

*= Measured in percent.

Table 5
CleanOX® Pilot Test Project
Naval Station Roosevelt Roads Tow Way Fuel Farm
Pilot Test Field Measurements

Well	AW-1			AW-2			MTMW-1			MTMW-2		
Condition	Baseline	Max/End	Change	Baseline	Max/End	Change	Baseline	Max/End	Change	Baseline	Max/End	Change
Parameter												
Temperature (°C)	29.05	38.63	9.58	29.03	43.64	14.61	29.04	29.19	0.15	29.12	29.20	0.08
Sp. Cond (uS/cm)	7,491	13,273	5,782	3,411	8,104	4,693	7,990	8,147	157	10,482	10,454	-28
pH	7.06	2.12	-4.94	7.04	2.02	-5.02	7.08	6.80	-0.28	6.77	6.81	0.04
DO (ppm)	3.73	19.66	15.93	5.41	48.85	43.44	1.35	66.88	65.53	1.85	51.05	49.20
ORP (mV)	-31.8	462.7	494.5	-65.0	447.7	512.7	-28.2	-41.2	-13.0	-105.8	-72.0	33.8
Depth to product (ft.bgs)	14.15*	ND(<0.01)	0.00	15.64	ND(<0.01)	0.00	15.20	15.38	0.18	15.20	16.12	0.92
Depth to water (ft. bgs)	14.15	13.85	-0.30	15.65	15.30	-0.35	15.25	15.53	0.28	15.48	16.34	0.86
Product thickness (ft.)	0.00	0.00	0.00	0.01	0.00	-0.01	0.05	0.15	0.10	0.28	0.22	-0.06

Well	MTMW-3			MTMW-4			RW-1			UGW-3		
Condition	Baseline	Max/End	Change	Baseline	Max/End	Change	Baseline	Max/End	Change	Baseline	Max/End	Change
Parameter												
Temperature (°C)	28.97	29.30	0.33	28.92	29.14	0.22	28.70	29.04	0.34	29.00	29.04	0.04
Sp. Cond (uS/cm)	7,027	6,765	-262	8,366	7,977	-389	2,570	15,609	13,039	8,365	8,672	307
pH	7.11	6.61	-0.50	7.02	6.69	-0.33	7.41	3.72	-3.69	6.98	6.84	-0.14
DO (ppm)	0.72	16.93	16.21	1.08	55.83	54.75	0.39	58.39	58.00	1.78	56.50	54.72
ORP (mV)	-70.7	73.3	144.0	-116.5	-40.8	75.7	-230.0	120.1	350.1	-163.5	-145.8	17.7
Depth to product (ft.bgs)	14.04	13.82	-0.22	13.90	15.18	1.28	13.49*	14.57	1.08	14.67	14.92	0.25
Depth to water (ft. bgs)	14.09	16.46	2.37	16.18	16.40	0.22	13.49	14.58	1.09	15.04	15.14	0.10
Product thickness (ft.)	0.05	2.64	2.59	2.28	1.22	-1.06	0.00	0.01	0.01	0.37	0.22	-0.15

ND(<0.01)=Free product not detected less than 0.01 s.u.
*=Depth to water value used for Depth of Product baseline value.
Max/End data = data collected during pilot test.

Table 6
Mass Removal Calculations

Mass Removal Calculations (2/8/99)

	Application Well Area	Monitoring Well Area	Total
Volume of Soil Treated (cu.ft.)	5,301.45	18,555.08	23,856.53
Mass of Soil Treated (kg)	267,750.00	937,125.00	1,204,875.00
Soil Porosity	0.30	0.30	0.60
Volume of Groundwater Treated (gal)	11,896.45	41,637.59	53,534.04
Soil DRO Concentration Change (mg/kg)	-226	-5,400	-5,626.00
Soil GRO Concentration Change (mg/kg)	-160	-500	-660.31
Groundwater DRO Conc. Increase (mg/L)	3,343	111	3,453.40
Groundwater GRO Conc. Increase (mg/L)	20	50	70.41
PSH Thickness Change (ft)	0.0	-0.36	-0.32
Mass of PSH Change (kg)	101	-2,861	-2,759.60
Mass of DRO/GRO Change in Soil (kg)	-103	-5,529	-5,632.47
Mass of DRO/GRO Desorbed (kg)	152	25	177.04
Total Mass of DRO/GRO/PSH Change (kg)	150	-8,365	-8,215.03

Mass Removal Calculations (4/15/99)

	Application Well Area	Monitoring Well Area	Total
Volume of Soil Treated (cu.ft.)	5,301.45	18,555.08	23,856.53
Mass of Soil Treated (kg)	267,750.00	937,125.00	1,204,875.00
Soil Porosity	0.30	0.30	0.60
Volume of Groundwater Treated (gal)	11,896.45	41,637.59	53,534.04
Soil DRO Concentration Change (mg/kg)	99	-6,800	-6,701.10
Soil GRO Concentration Change (mg/kg)	-46	-5,280	-5,325.97
Groundwater DRO Conc. Increase (mg/L)	958	5,156	6,113.24
Groundwater GRO Conc. Increase (mg/L)	117	41	158.54
PSH Thickness Change (ft)	0.1	-0.34	-0.24
Mass of PSH Change (kg)	236	-2,688	-2,451.10
Mass of DRO/GRO Change in Soil (kg)	14	-11,320	-11,306.30
Mass of DRO/GRO Desorbed (kg)	48	820	868.55
Total Mass of DRO/GRO/PSH Change (kg)	299	-13,188	-12,888.85

Table 7
CleanOX® Process Full-Scale Application Cost Estimate

Task		ZONE A	ZONE B	ZONE C	ZONE D	ZONE E	ALL ZONES
	Treatment Area (sq. ft.)	14,400	21,600	27,000	11,900	8,600	83,500
Task 1	Permitting / Design	$2,500	$2,500	$2,500	$2,500	$2,500	$12,500
Task 2	Well Installation						
	and Abandonment[1]						
	No. Wells	20	30	38	17	12	117
	Cost	$100,000	$150,000	$190,000	$85,000	$60,000	$585,000
Task 3	Sampling (baseline, 3week, 60day)	$56,300	$53,000	$58,100	$51,500	$48,200	$267,100
Task 4	Reagent Application	$238,300	$350,000	$440,300	$201,400	$148,000	$1,377,800
	Number of Cycles	2	2	3	4	3	14
	Total Application Costs	$476,600	$700,000	$1,320,900	$805,600	$444,000	$3,747,100
Task 5	Waste disposal						
	Purge,Reflux, Drill Cuttings, etc.	$6,700	$8,600	$10,600	$5,900	$4,600	$36,400
Task 6	Project Management	$23,900	$35,000	$66,100	$40,300	$22,200	$187,500
	and Reporting						
	Subtotal Cost	$666,000	$949,100	$1,648,200	$990,800	$581,500	$4,835,600
	Estimated Contingency (20%)	$133,200	$189,900	$329,700	$198,200	$116,300	$967,300
	Total Cost	**$799,200**	**$1,139,000**	**$1,977,900**	**$1,189,000**	**$697,800**	**$5,802,900**

[1] Includes ManTech labor, ODCs, travel, etc.

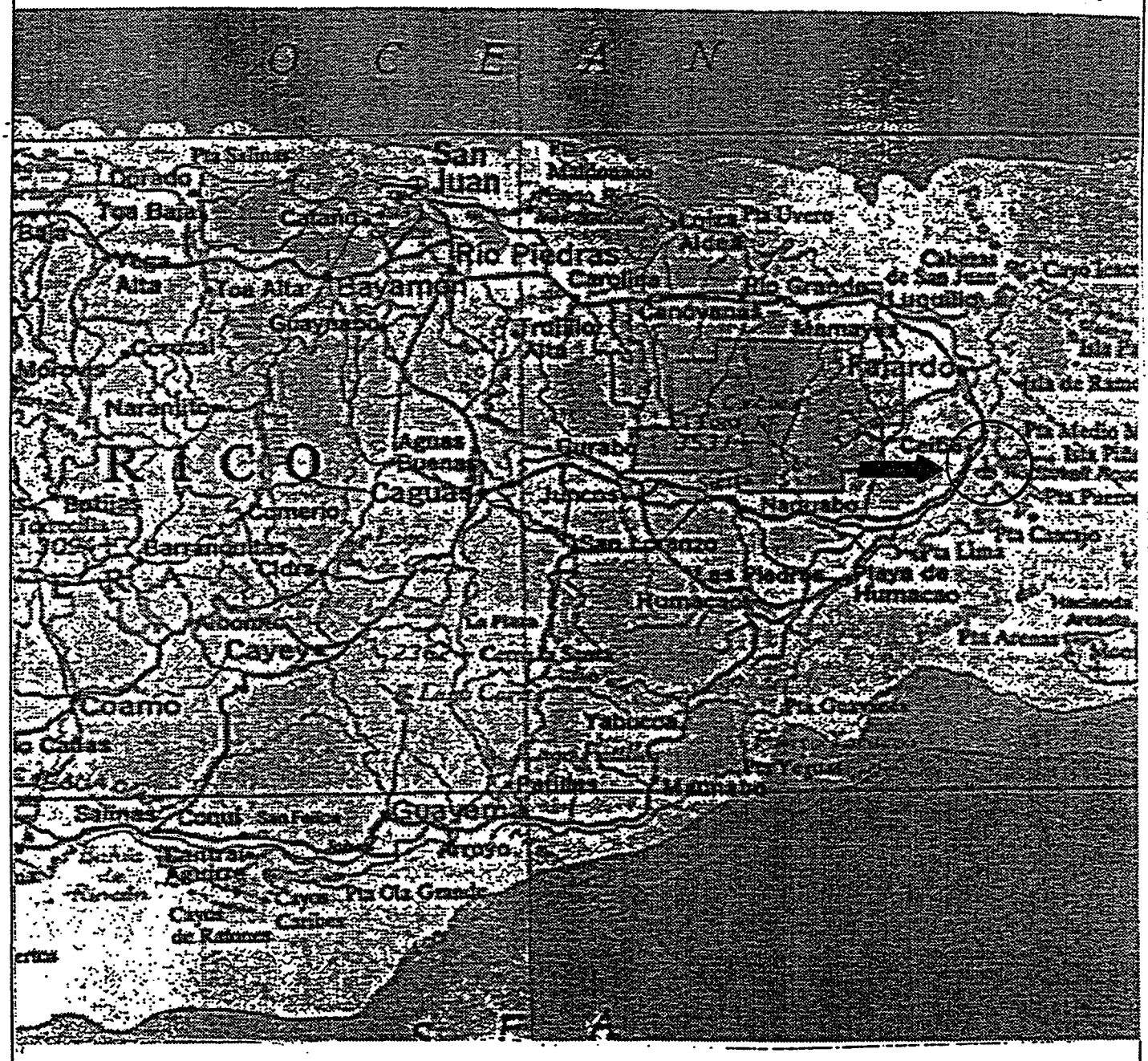
Table 8
Tow Way Fuel Farm
Full Scale Sampling Summary

Sampling Event		Groundwater Analysis									Waste Disposal		Totals
	Zone	8260 (BTEX only)	TPH by 8015M (DRO & GRO)	Iron by 236.2/ 6010	Lead by 239.2/74 21	Hardness by 130.2	Alkalinity by 310.1	Sulfates by 9056	Nitrates /Nitrites by 9056	TDS by 160.1	Purge Water*	Drill Cuttings**	
Baseline GW	A	8	8	8	8	8	8	8	8	8	1	1	74
	B	6	6	6	6	6	6	6	6	6	1	1	56
	C	9	9	9	9	9	9	9	9	9	1	1	83
	D	5	5	5	5	5	5	5	5	5	1	1	47
	E	3	3	3	3	3	3	3	3	3	1	1	29
3-Week Sampling	A	8	8	8	8	8	8	8	8	8	1	1	74
	B	6	6	6	6	6	6	6	6	6	1	1	56
	C	9	9	9	9	9	9	9	9	9	1	1	83
	D	5	5	5	5	5	5	5	5	5	1	1	47
	E	3	3	3	3	3	3	3	3	3	1	1	29
60-Day Sampling	A	8	8	8	8	8	8	8	8	8	1	1	74
	B	6	6	6	6	6	6	6	6	6	1	1	56
	C	9	9	9	9	9	9	9	9	9	1	1	83
	D	5	5	5	5	5	5	5	5	5	1	1	47
	E	3	3	3	3	3	3	3	3	3	1	1	29

*Composite of purge water analyzed after each sampling event for reactivity, corrosivity, ignitability, TCLP benzene & metals, and TOX.

**Composite of drill cuttings generated from well installation analyzed for TCLP benzene only.

FIGURES



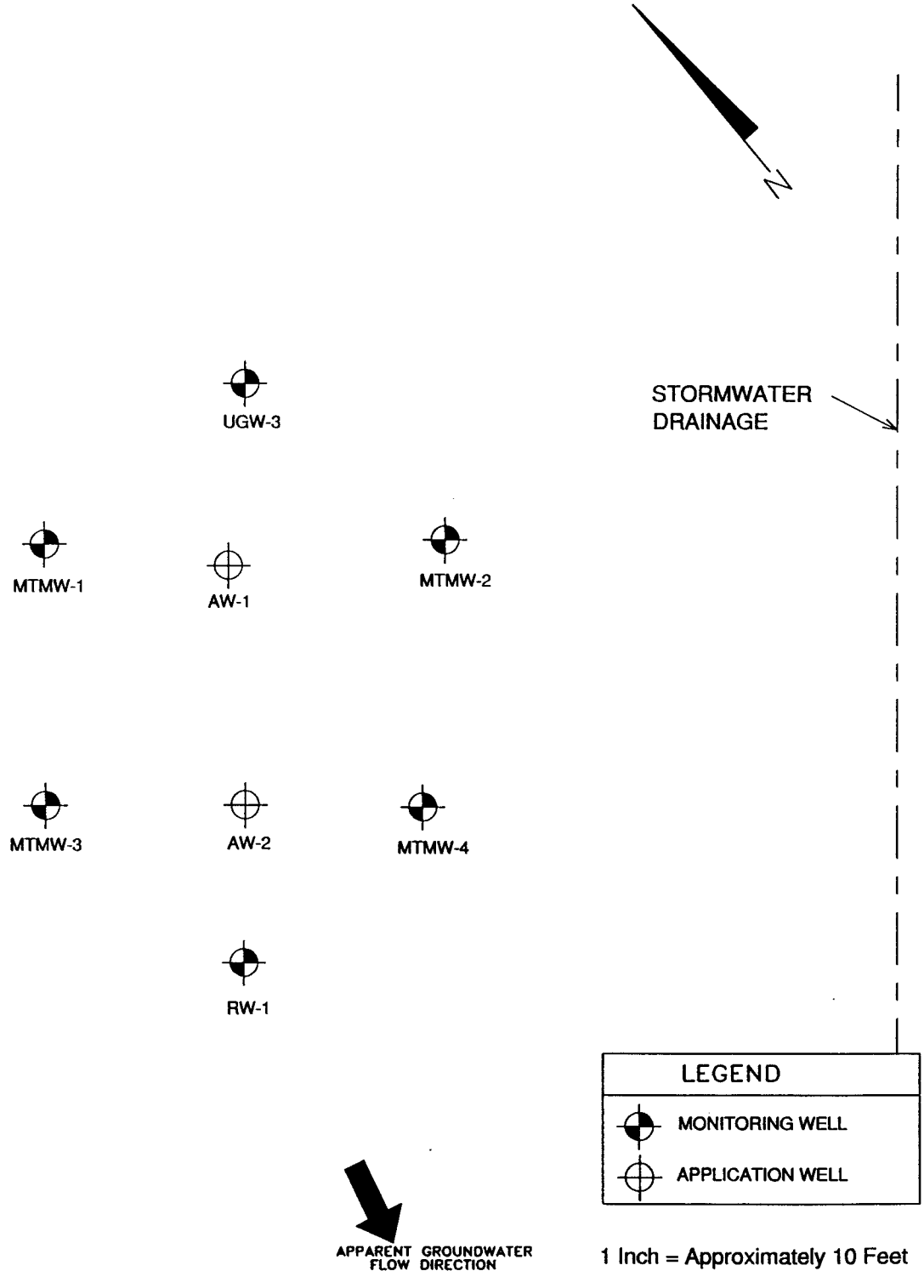
N

MANTECH ENVIRONMENTAL CORPORATION

NAVAL STATION ROOSEVELT ROADS

SITE LOCATION MAP
TOW WAY FUEL FARM
CEIBA, PUERTO RICO

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/5/99	FIGURE1.DWG	CT	CC	1

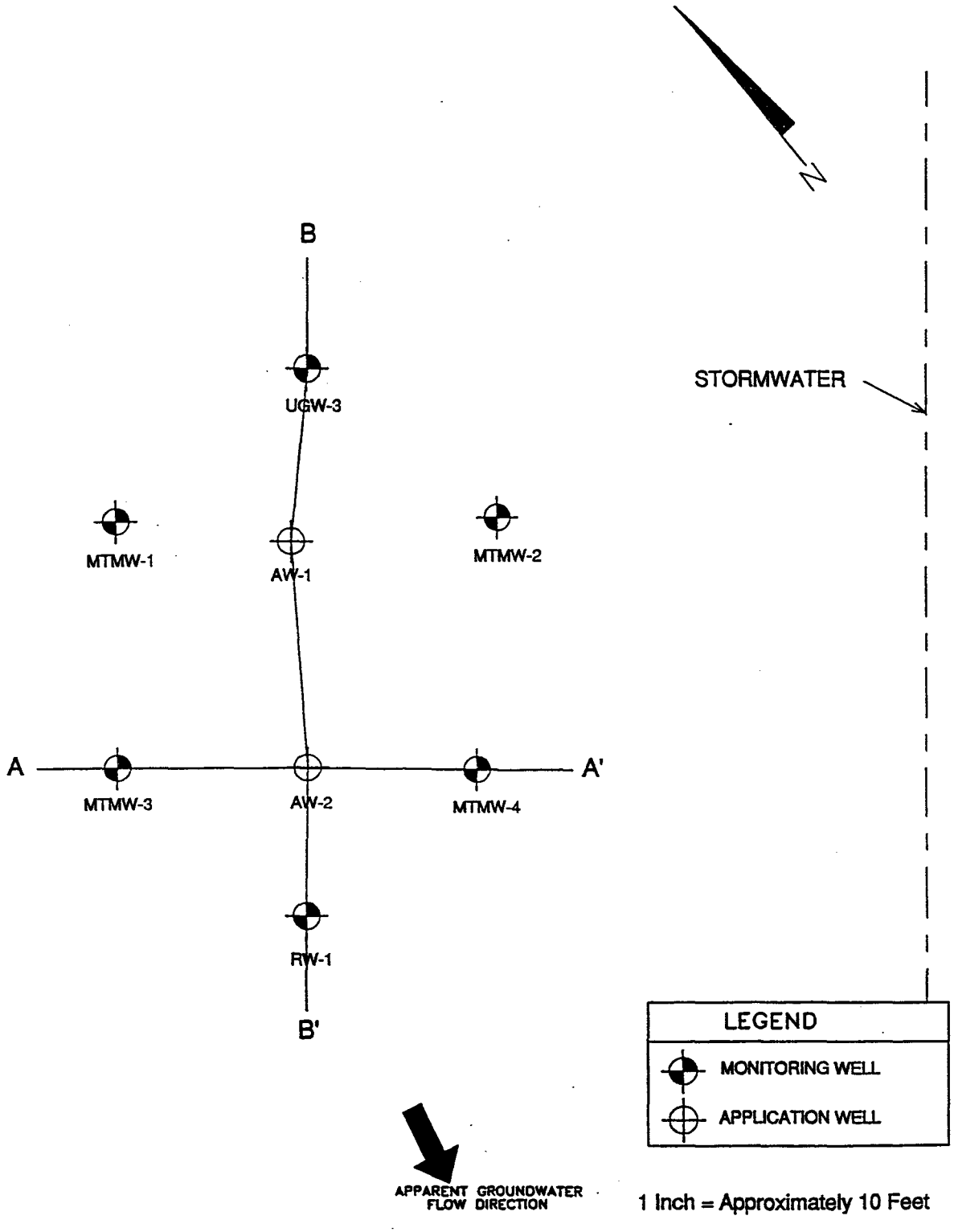


MANTECH ENVIRONMENTAL CORPORATION
14280 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

SITE MAP
TOW WAY FUEL FARM
CEIBA, PUERTO RICO

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	12/16/99	FIGURE2.DWG	CT	CC	2

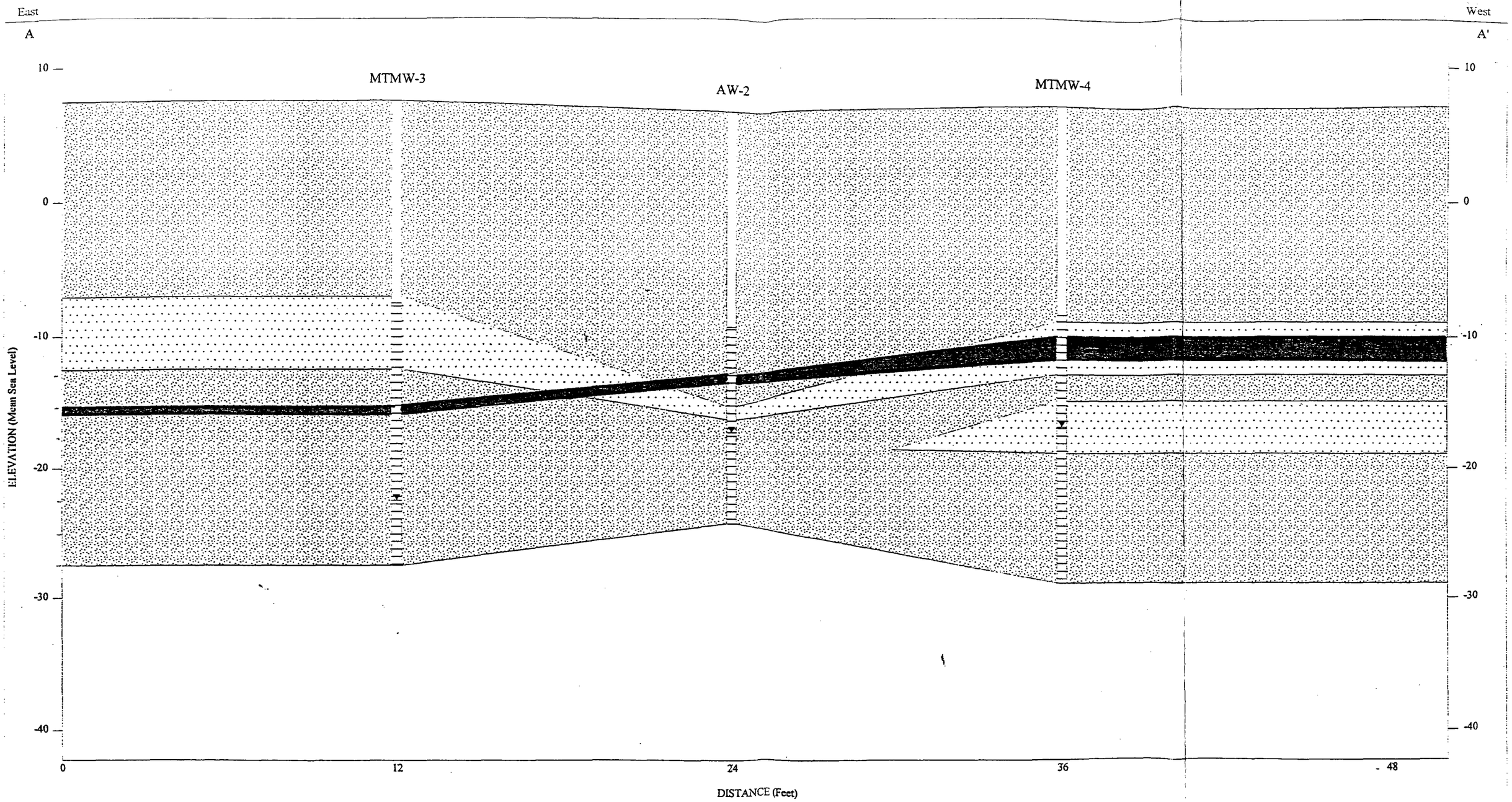


MANTECH ENVIRONMENTAL CORPORATION
14280 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

CROSS SECTION REFERENCE
TOW WAY FUEL FARM
CEIBA, PUERTO RICO

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	12/16/99	FIGURE3.DWG	CT	CC	3



Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

MANTECH ENVIRONMENTAL
14290 Sullyfield Circle, Suite 100
Chantilly, Virginia 20151

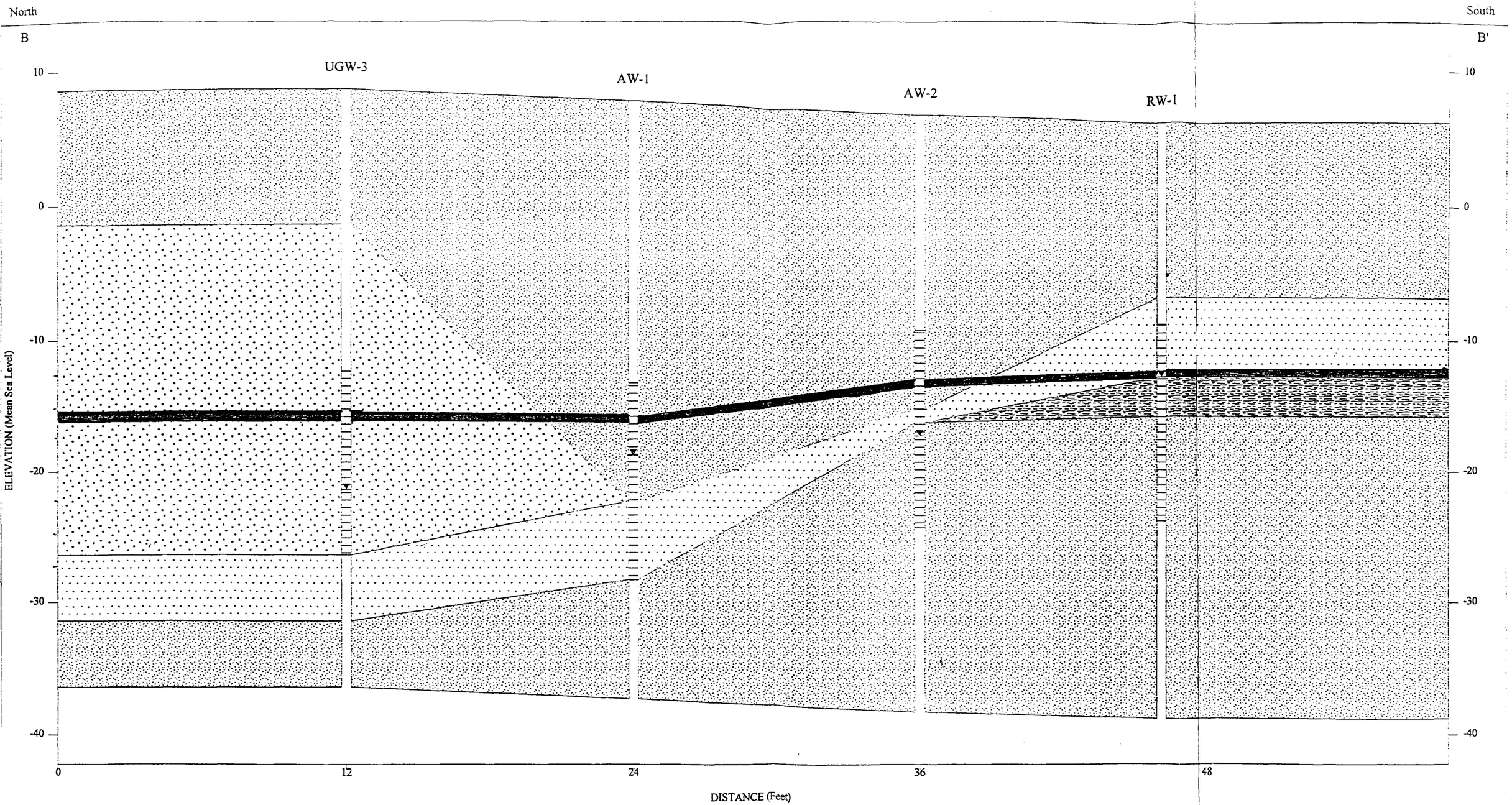
Figure 4

GEOLOGIC CROSS SECTION
Section A-A'
East-West
Scale 1 inch = Approximately 3.5 Feet

LEGEND

- Silty clay with angular gabbro lenses.
- Gravel, angular gabbro cobbles.
- Wet With Petroleum Product.

06-02-1999 L:\Projects\8207\Borlog\simcros.cro



Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

MANTECH ENVIRONMENTAL
14290 Sullyfield Circle, Suite 100
Chantilly, Virginia 20151

Figure 5

GEOLOGIC CROSS SECTION
Section B-B'
North-South
Scale 1 inch = Approximately 3.5 Feet

LEGEND

- Silty clay with angular gabbro lenses.
- Wet With Petroleum Product
- Fine to coarse dense brown sand, well sorted.
- Gravel, angular gabbro cobbles.
- Rock fragments, subangular, grey to green gabbro.

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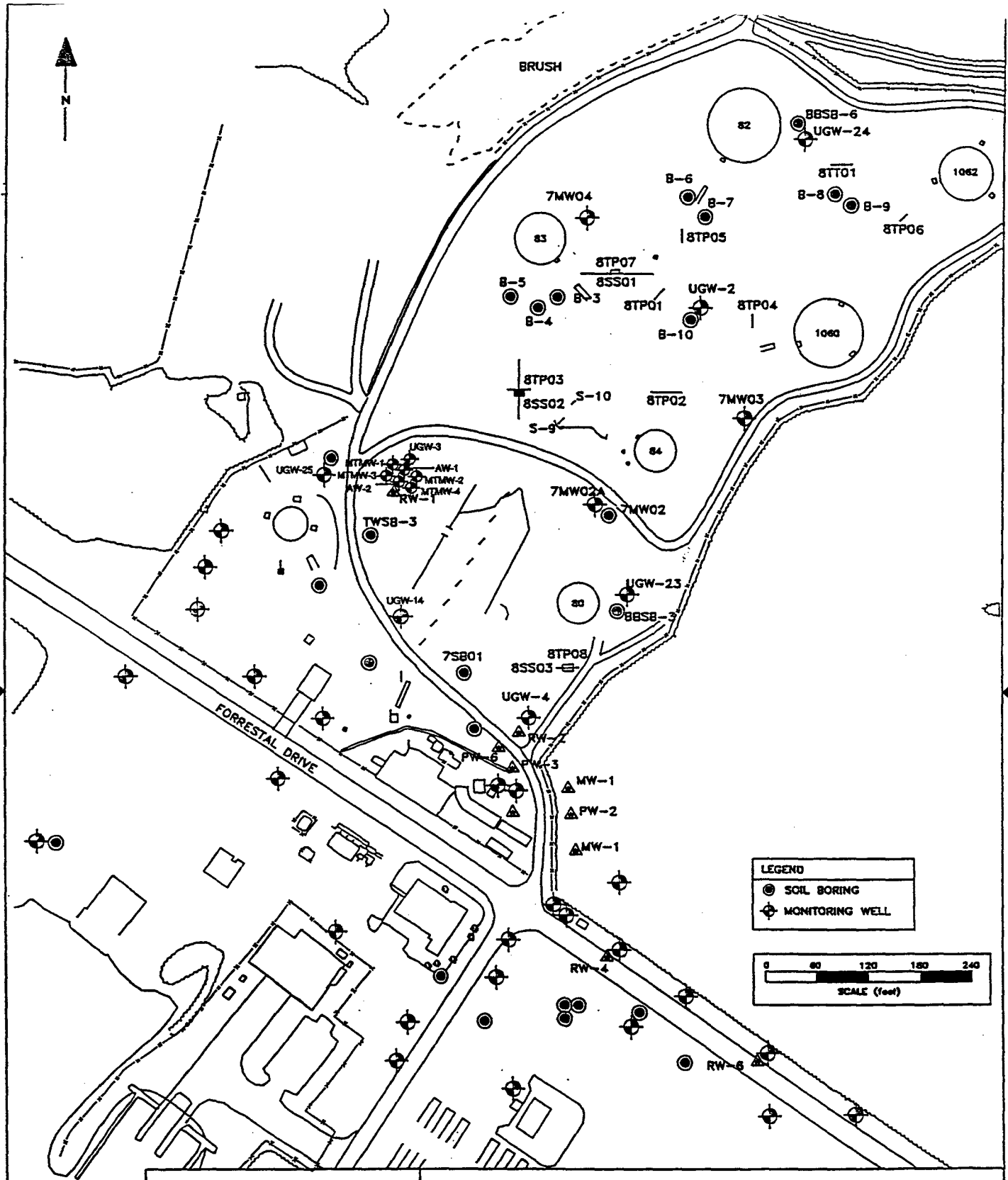
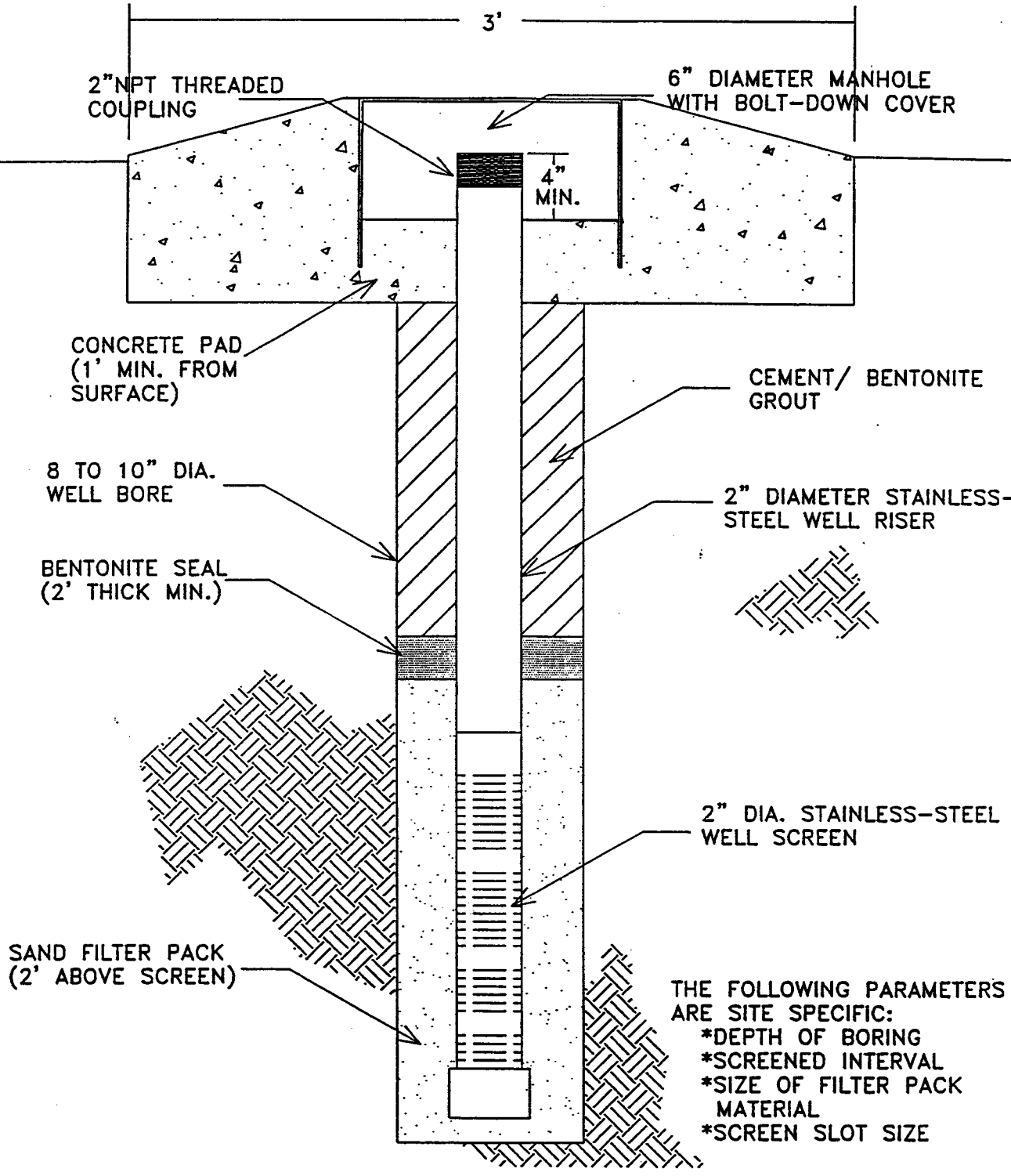


MANTECH ENVIRONMENTAL CORPORATION
14295 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

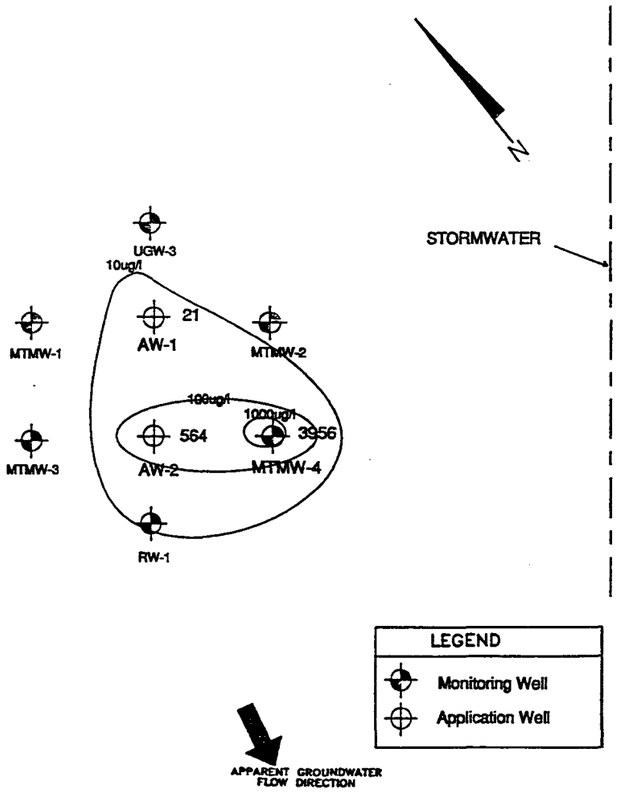
MONITORING AND APPLICATION WELL LOCATION TOW WAY FUEL FARM CEIBA, PUERTO RICO

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/12/99	FIGURE6.DWG	CT	CC	6



DRAWING NOT TO SCALE

MANTECH ENVIRONMENTAL CORPORATION 14290 SULLYFIELD CIRCLE, SUITE 100 CHANTILLY, VIRGINIA 20151	CleanOX® APPLICATION WELL (TYPICAL) CONSTRUCTION DIAGRAM MANTECH ENVIRONMENTAL CORPORATION				
CLIENT: BAKER ENVIRONMENTAL, INC.	DATE: 4/14/99	DWG. FILE: PLTFIG7.DWG	DRWN BY: CT	REV'D BY: CC	FIG. NO.: 7

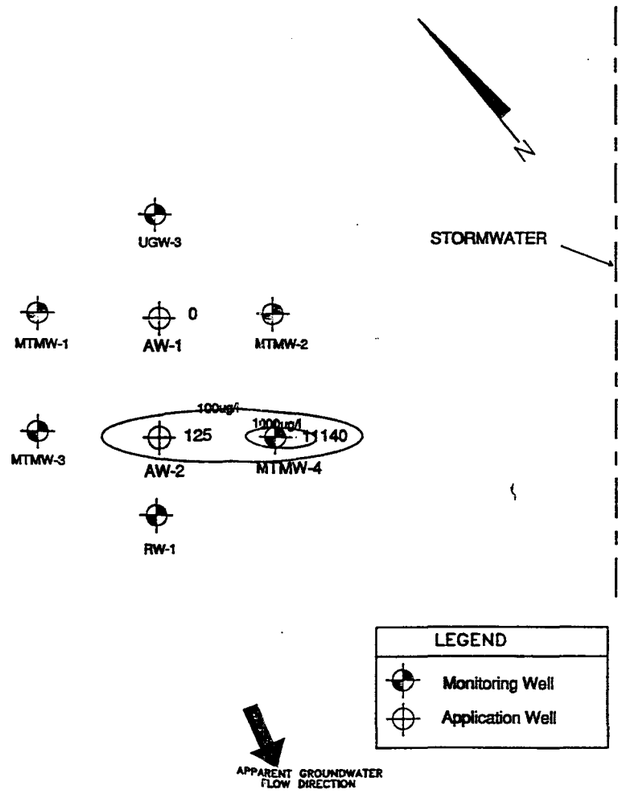


MANTECH ENVIRONMENTAL CORPORATION
14200 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

BTEX CONCENTRATIONS IN SOIL (DEPTH)
TOW WAY FUEL FARM
BASELINE 12/16/99

CLIENT:	DATE:	DWG. FILE:	DRAWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE8.DWG	CT	CC	8a

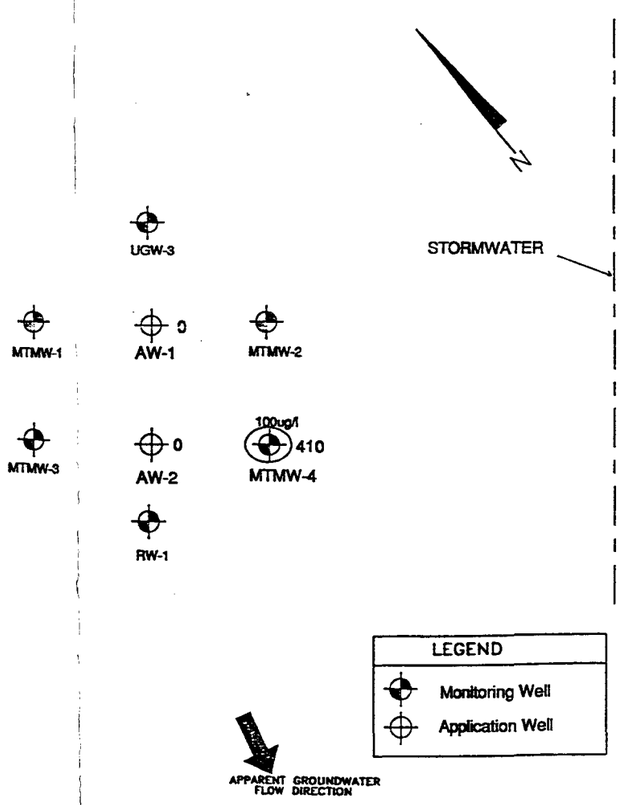


MANTECH ENVIRONMENTAL CORPORATION
14200 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

BTEX CONCENTRATIONS IN SOIL (DEPTH)
TOW WAY FUEL FARM
1 WEEK POST TREATMENT 2/8/99

CLIENT:	DATE:	DWG. FILE:	DRAWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE8.DWG	CT	CC	8b

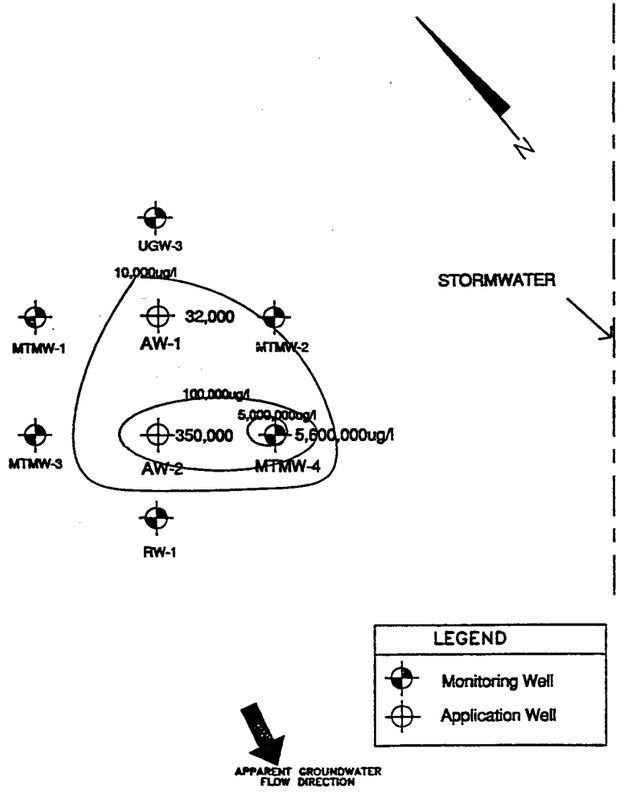


MANTECH ENVIRONMENTAL CORPORATION
14200 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

BTEX CONCENTRATIONS IN SOIL (DEPTH)
TOW WAY FUEL FARM
8-WEEK POST TREATMENT 4/15/99

CLIENT:	DATE:	DWG. FILE:	DRAWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE8.DWG	CT	CC	8c

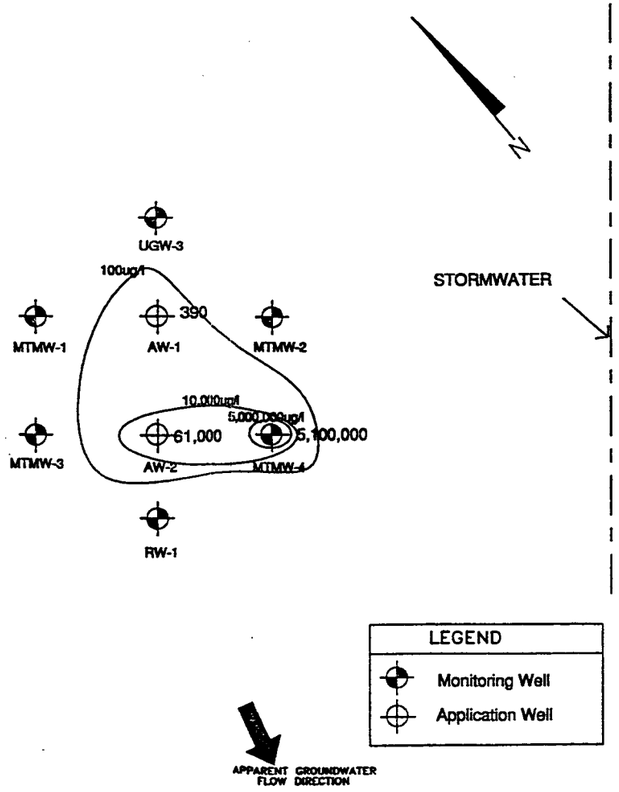


MANTECH ENVIRONMENTAL CORPORATION
14150 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

GRO CONCENTRATIONS IN SOIL (DEPTH)
TOW WAY FUEL FARM
BASELINE 12/16/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE9.DWG	CT	CC	9a

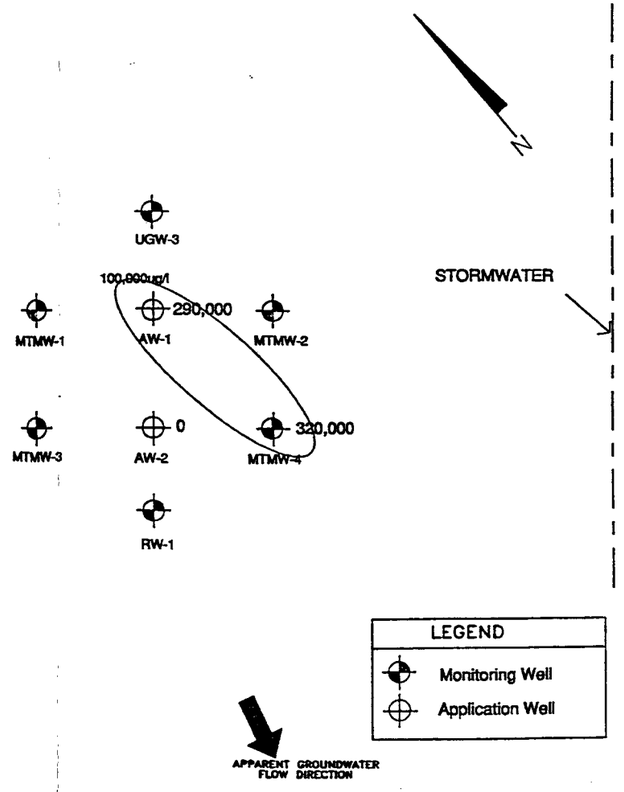


MANTECH ENVIRONMENTAL CORPORATION
14150 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

GRO CONCENTRATIONS IN SOIL (DEPTH)
TOW WAY FUEL FARM
1 WEEK POST TREATMENT 2/8/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE9.DWG	CT	CC	9b

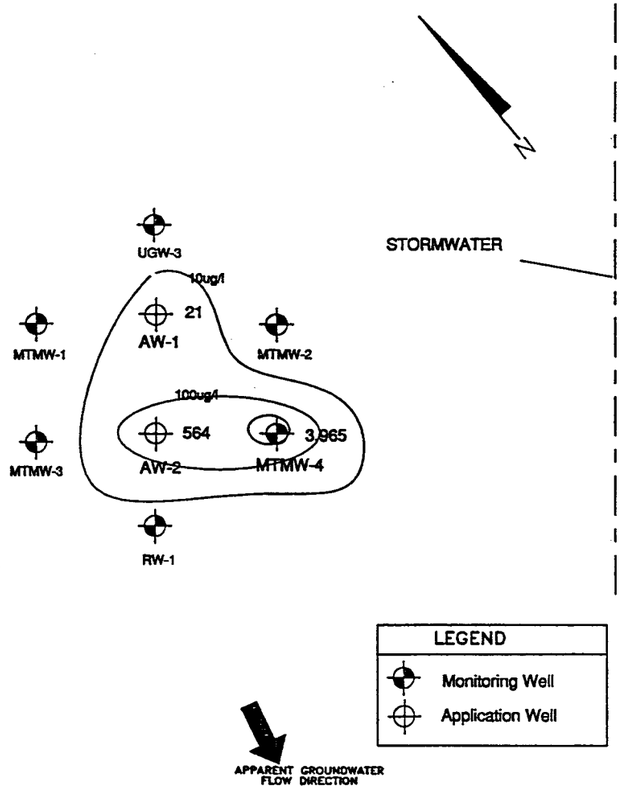


MANTECH ENVIRONMENTAL CORPORATION
14150 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

GRO CONCENTRATIONS IN SOIL (DEPTH)
TOW WAY FUEL FARM
8-WEEK POST TREATMENT 4/15/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE9.DWG	CT	CC	9c

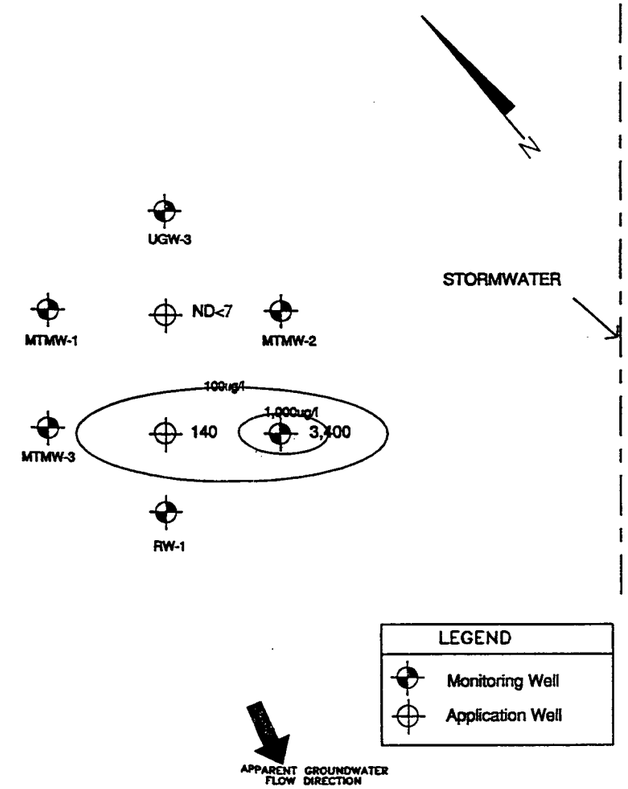


MANTECH ENVIRONMENTAL CORPORATION

NAVAL STATION ROOSEVELT ROADS

DRO CONCENTRATIONS IN SOIL (DEPTH)
TOW WAY FUEL FARM
BASELINE 12/16/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE10.DWG	CT	CC	10a

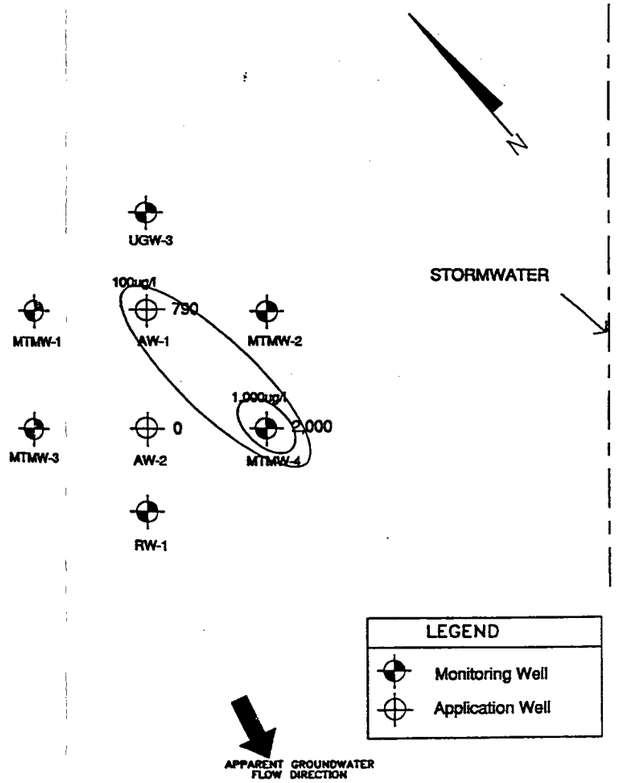


MANTECH ENVIRONMENTAL CORPORATION

NAVAL STATION ROOSEVELT ROADS

DRO CONCENTRATIONS IN SOIL (DEPTH)
TOW WAY FUEL FARM
1 WEEK POST TREATMENT 2/8/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE10.DWG	CT	CC	10b

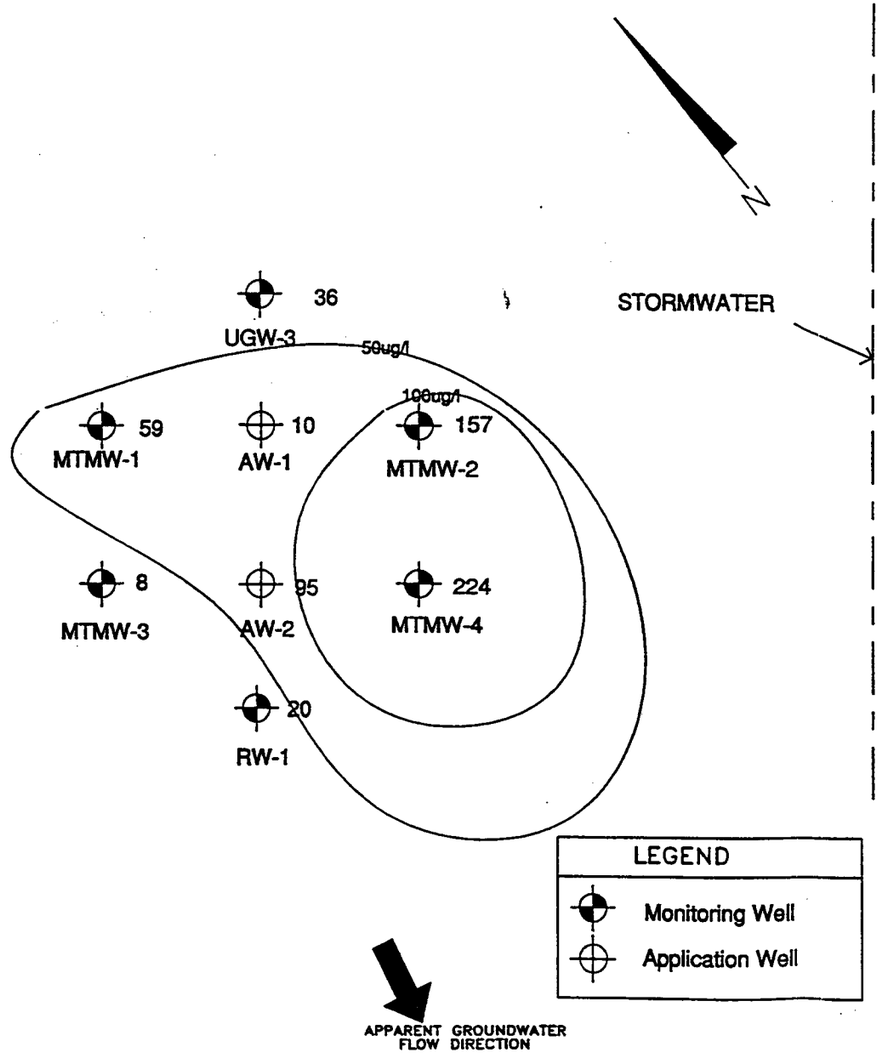


MANTECH ENVIRONMENTAL CORPORATION

NAVAL STATION ROOSEVELT ROADS

DRO CONCENTRATIONS IN SOIL (DEPTH)
TOW WAY FUEL FARM
8-WEEK POST TREATMENT 4/15/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE9.DWG	CT	CC	10c

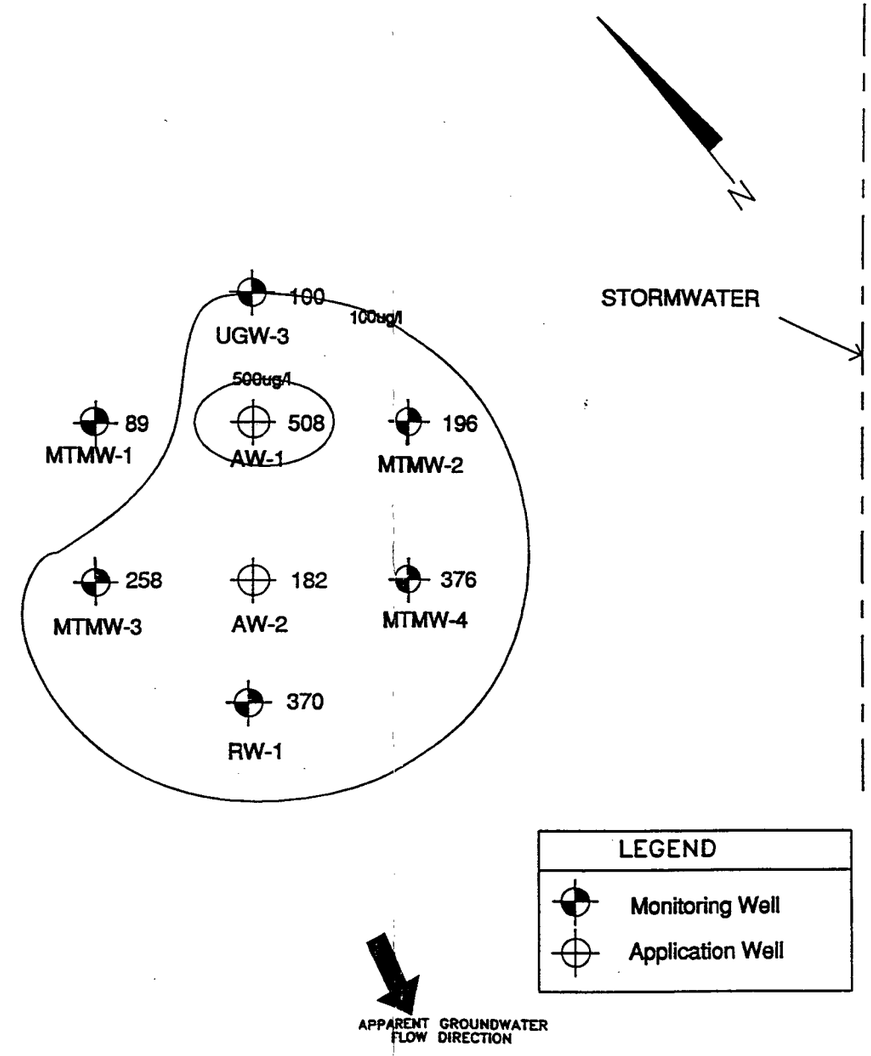


MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

BTEX CONCENTATIONS IN GROUNDWATER
TOW WAY FUEL FARM
BASELINE 1/7/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE11.DWG	CT	CC	11a

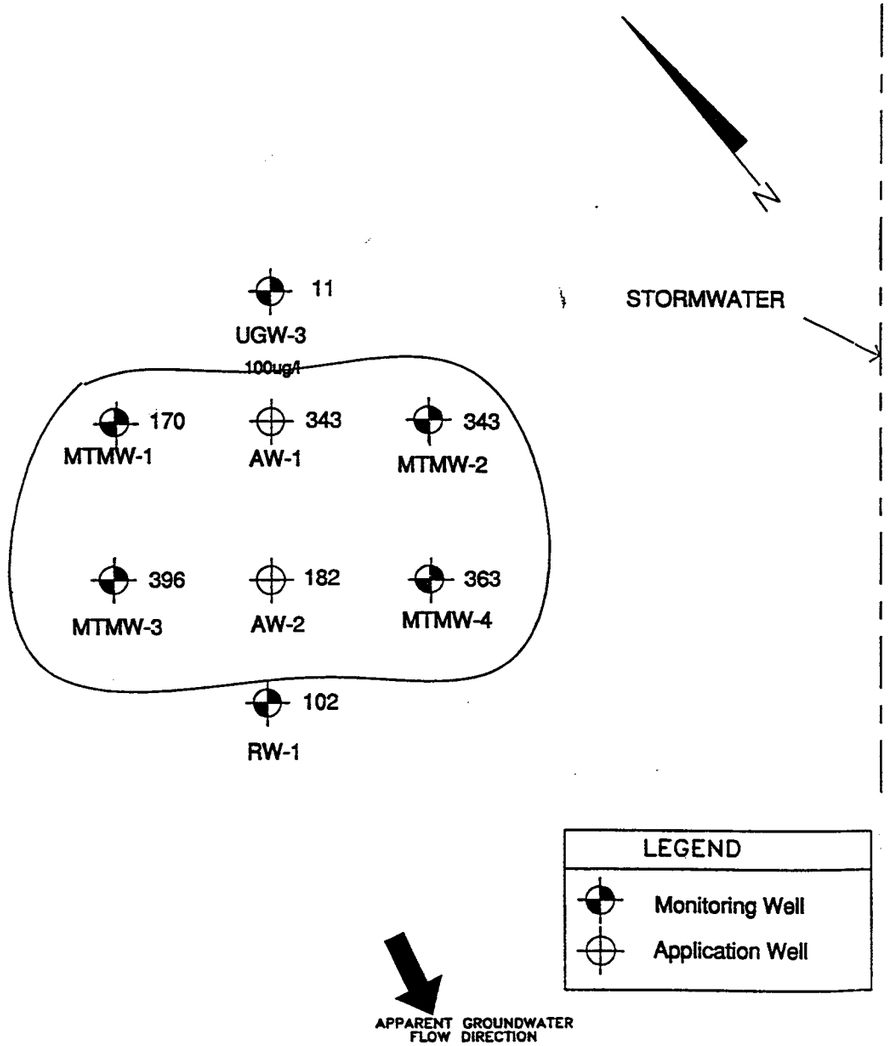


MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

BTEX CONCENTATIONS IN GROUNDWATER
TOW WAY FUEL FARM
1 WEEK POST TREATMENT 2/8/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE11.DWG	CT	CC	11b

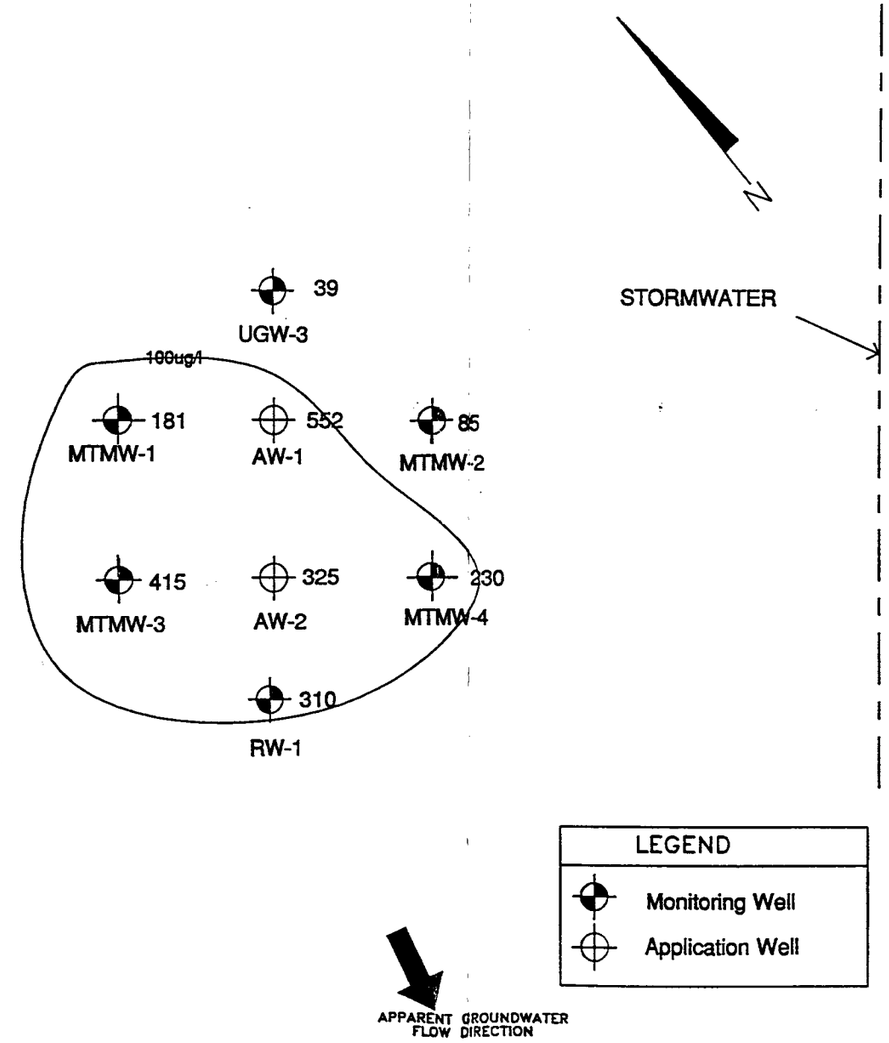


MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

BTEX CONCENTATIONS IN GROUNDWATER
TOW WAY FUEL FARM
3 WEEK POST TREATMENT 2/22/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE11.DWG	CT	CC	11c

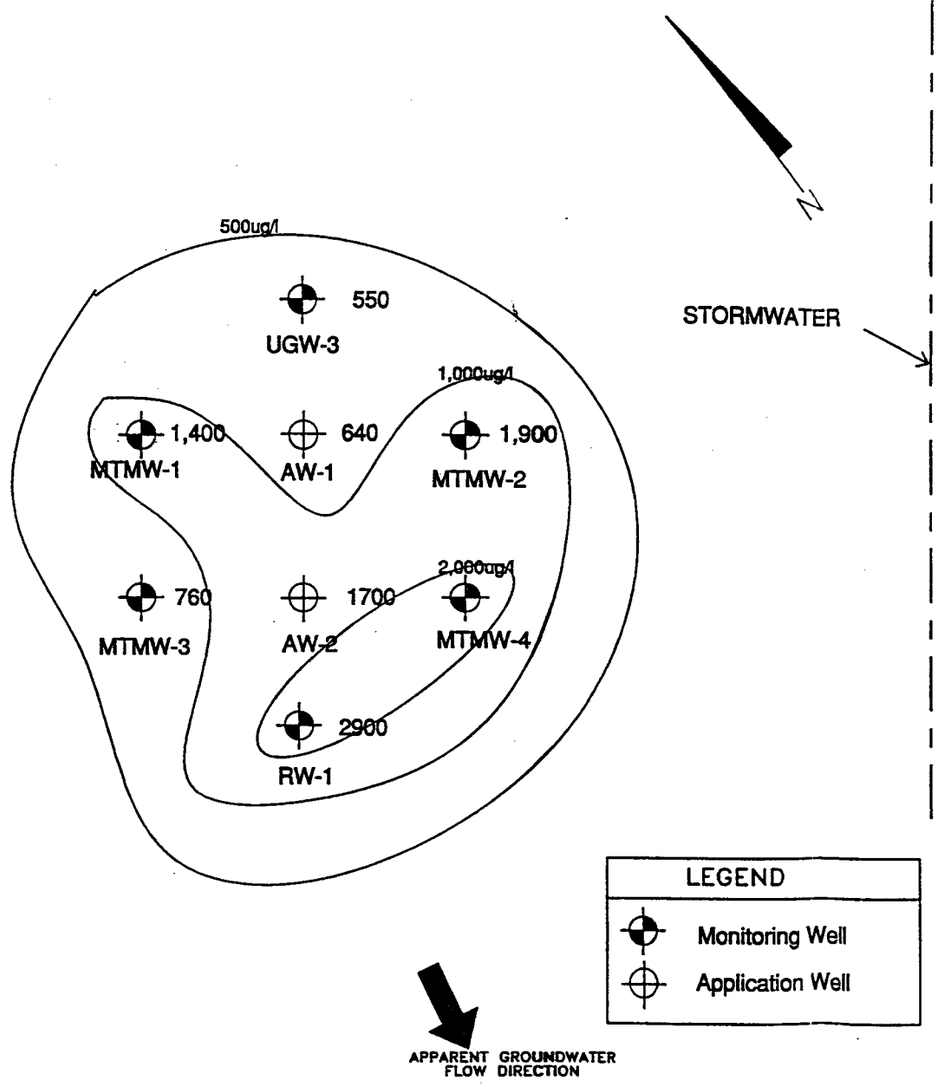


MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

BTEX CONCENTATIONS IN GROUNDWATER
TOW WAY FUEL FARM
8-WEEK POST TREATMENT 4/15/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE11.DWG	CT	CC	11d

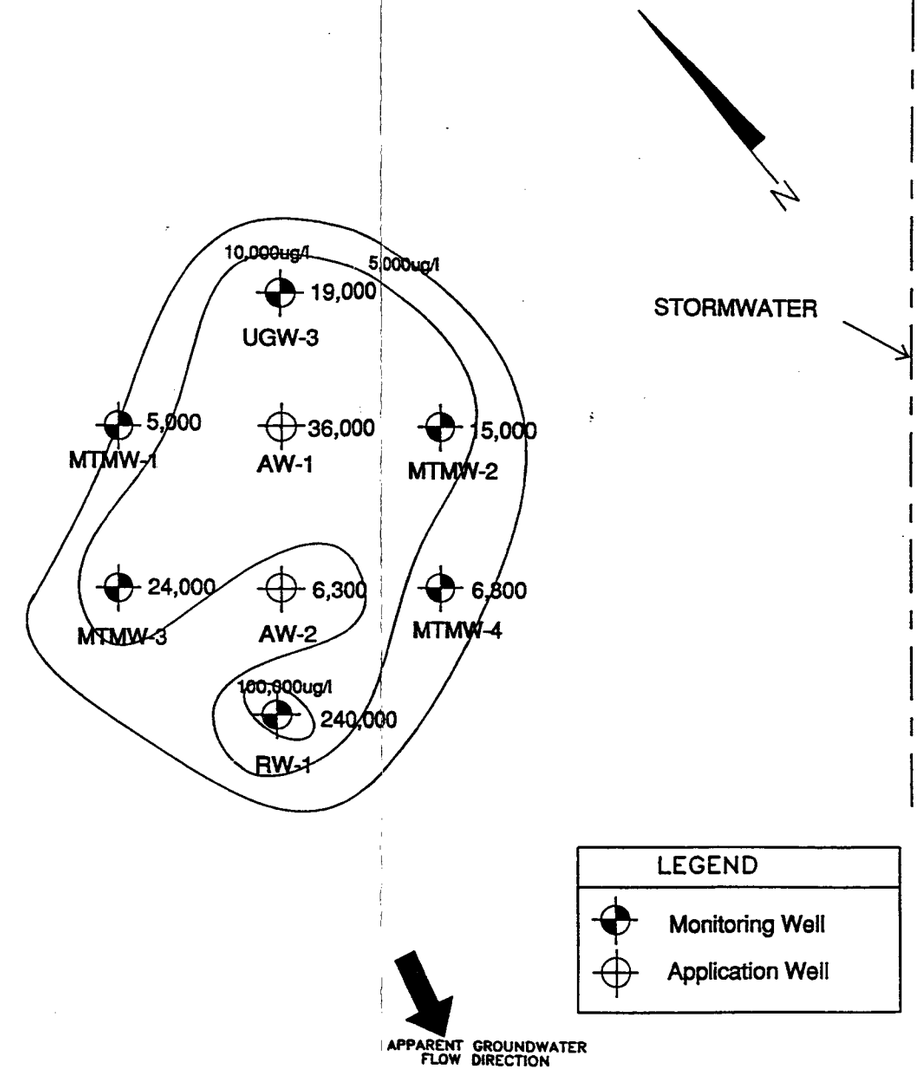


MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

GRO CONCENTRATIONS IN GROUNDWATER
TOW WAY FUEL FARM
BASELINE 1/7/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE12.DWG	CT	CC	12a

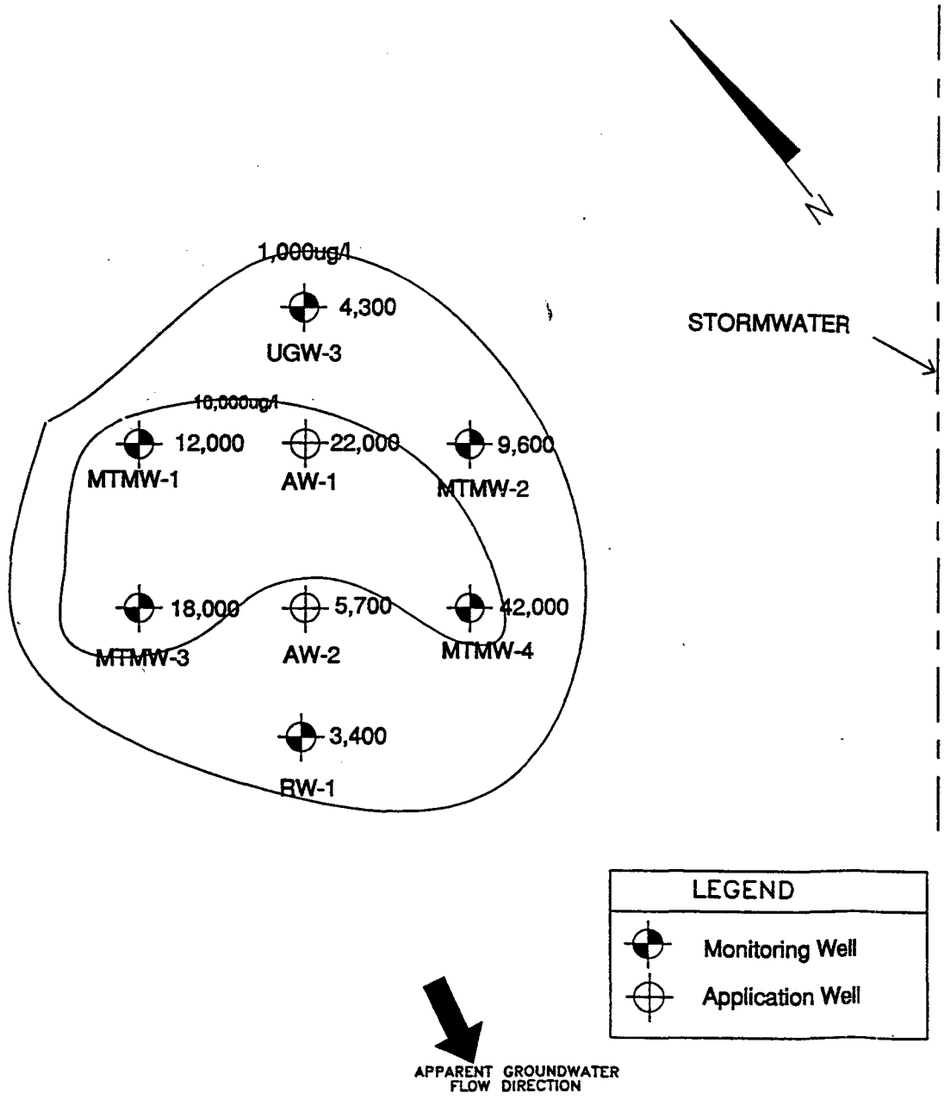


MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

GRO CONCENTRATIONS IN GROUNDWATER
TOW WAY FUEL FARM
1 WEEK POST TREATMENT 2/8/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE12.DWG	CT	CC	12b

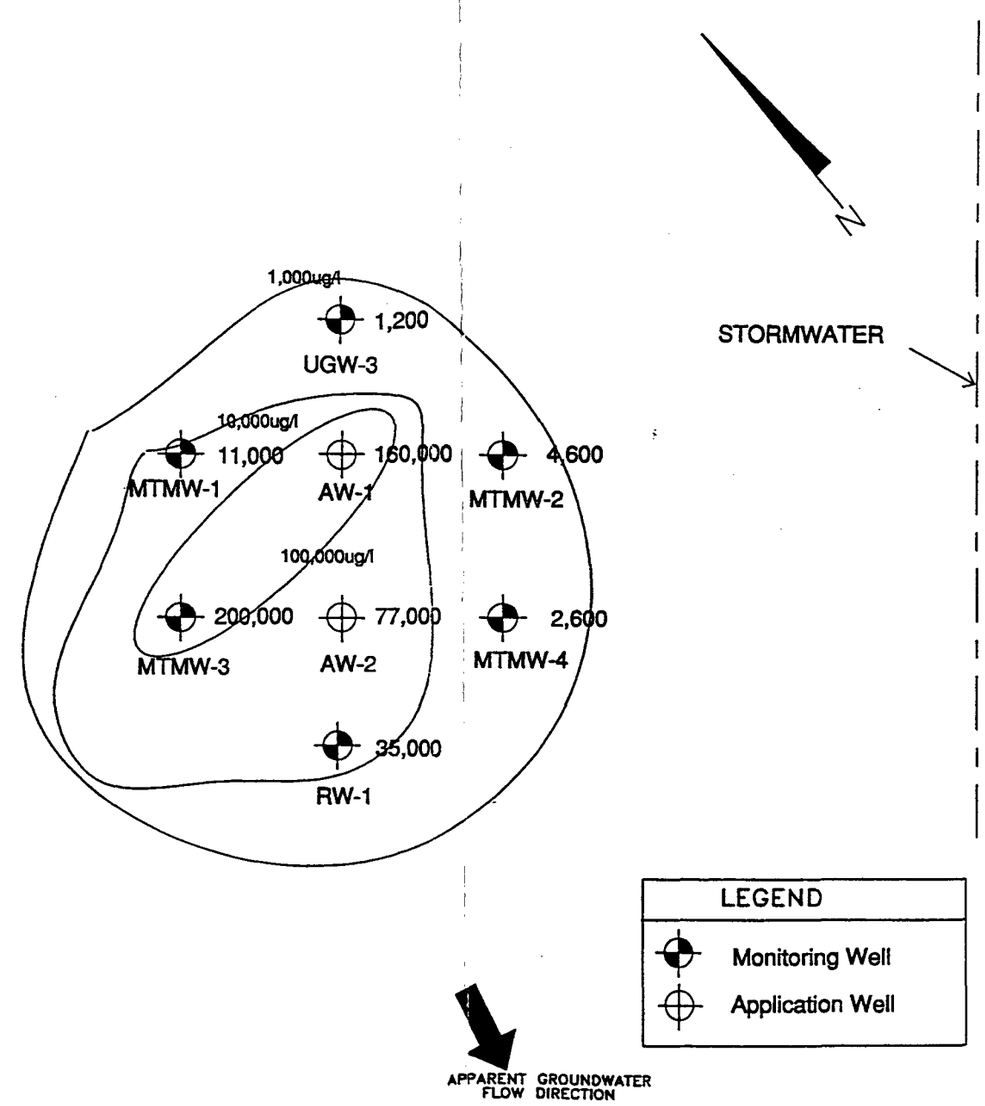


MANTECH ENVIRONMENTAL CORPORATION
14280 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

GRO CONCENTRATIONS IN GROUNDWATER
TOW WAY FUEL FARM
3 WEEK POST TREATMENT 2/22/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE12.DWG	CT	CC	12c

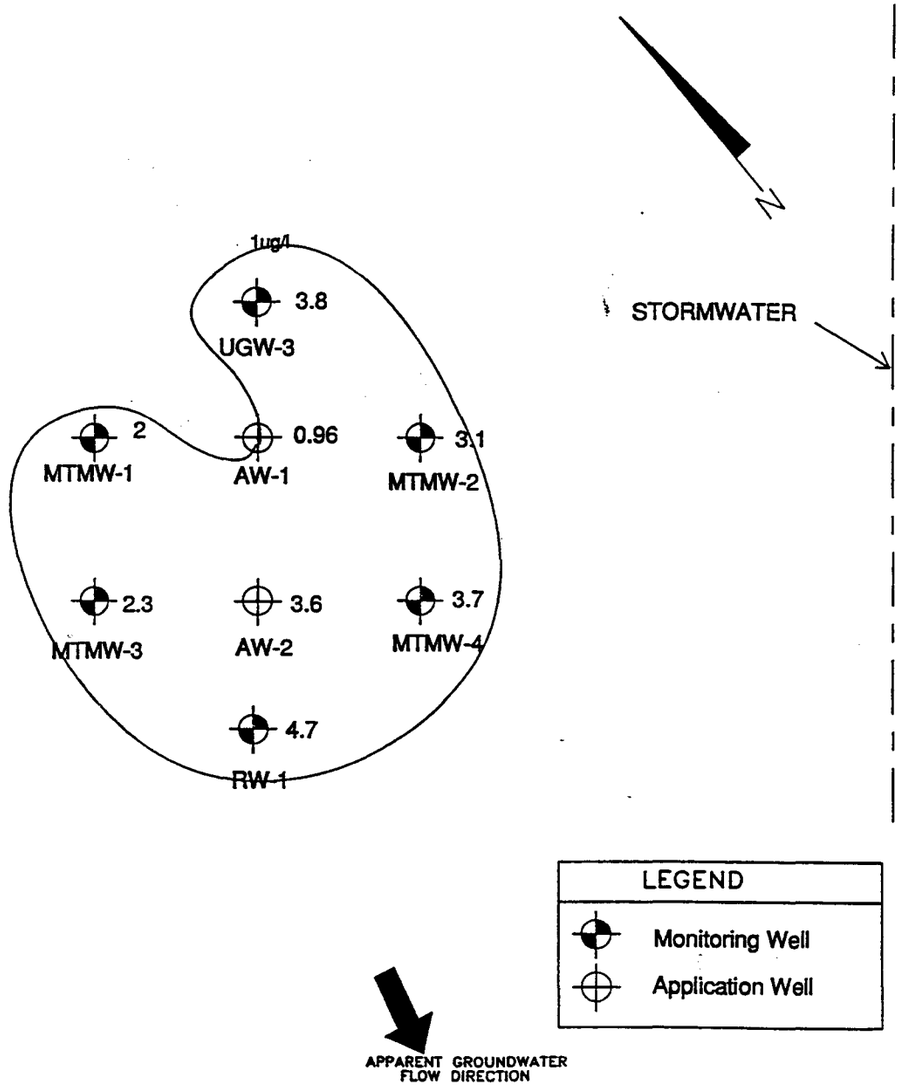


MANTECH ENVIRONMENTAL CORPORATION
14280 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

GRO CONCENTRATIONS IN GROUNDWATER
TOW WAY FUEL FARM
8-WEEK POST TREATMENT 4/15/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE12.DWG	CT	CC	12d

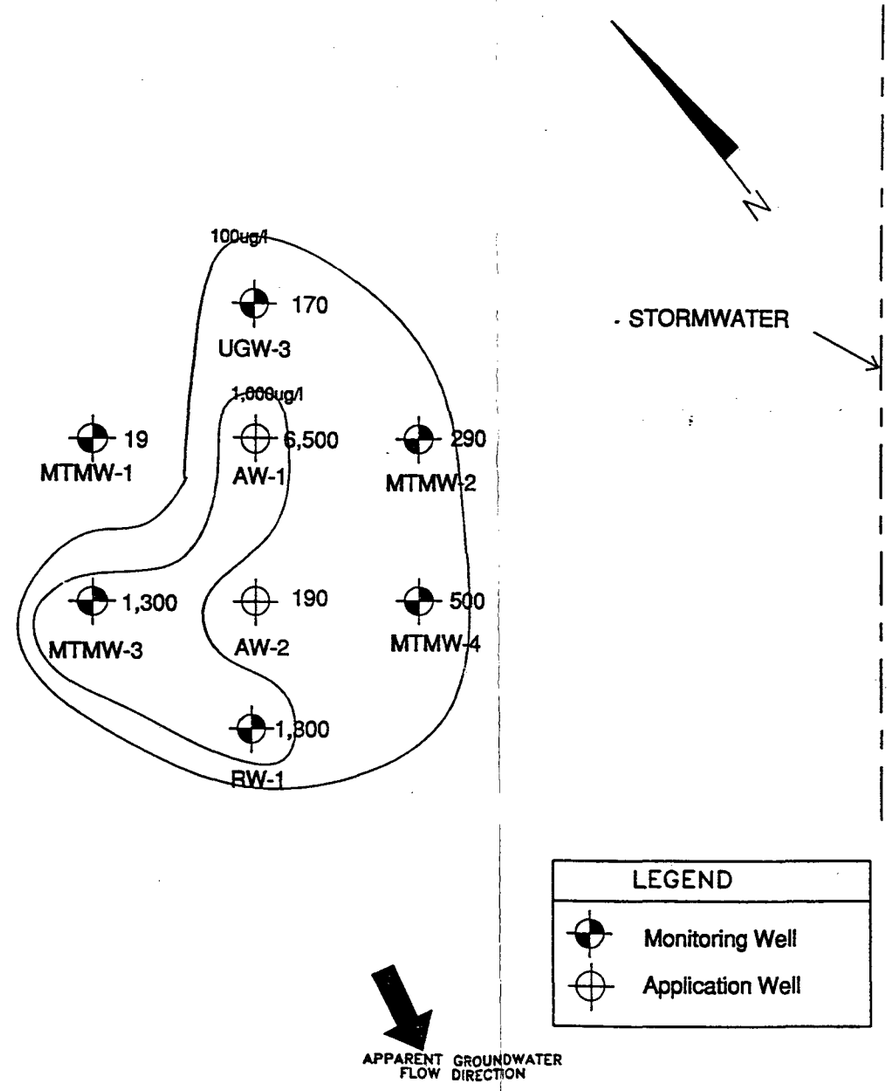


MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

DRO CONCENTRATIONS IN GROUNDWATER
TOW WAY FUEL FARM
BASELINE 1/7/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE13.DWG	CT	CC	13a

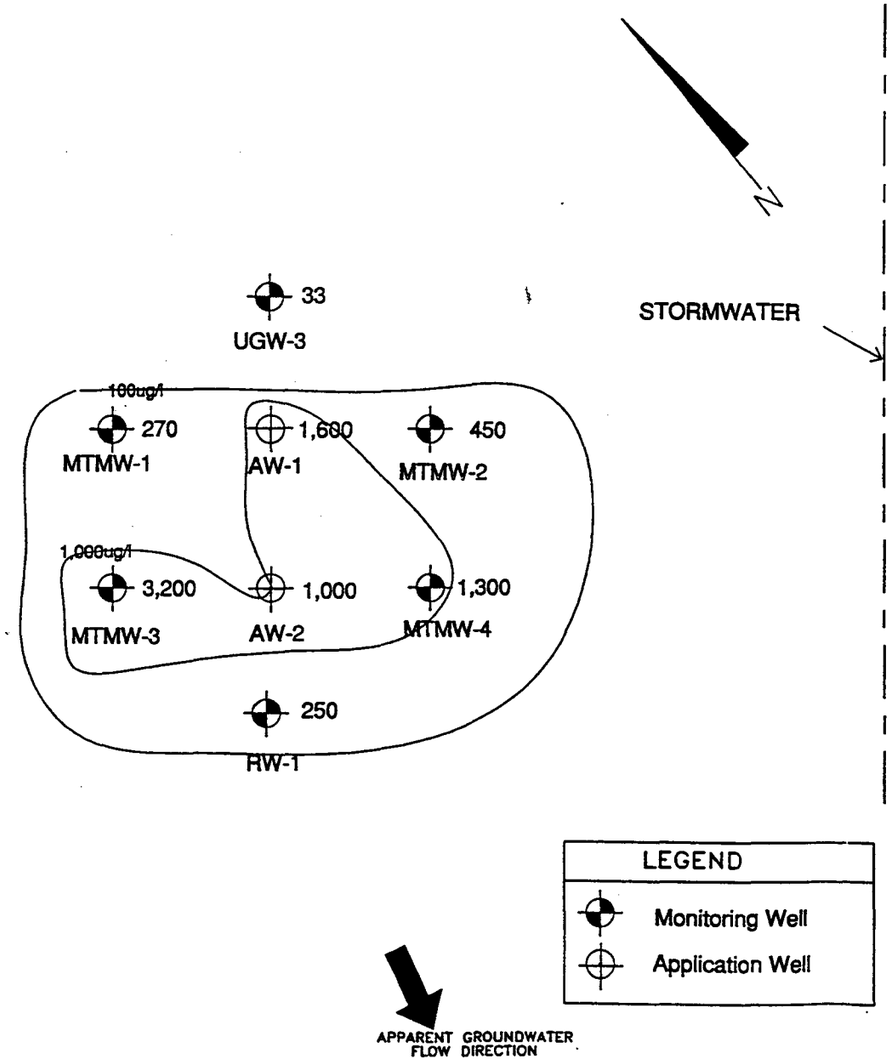


MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

DRO CONCENTRATIONS IN GROUNDWATER
TOW WAY FUEL FARM
1 WEEK POST TREATMENT

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE13.DWG	CT	CC	13b

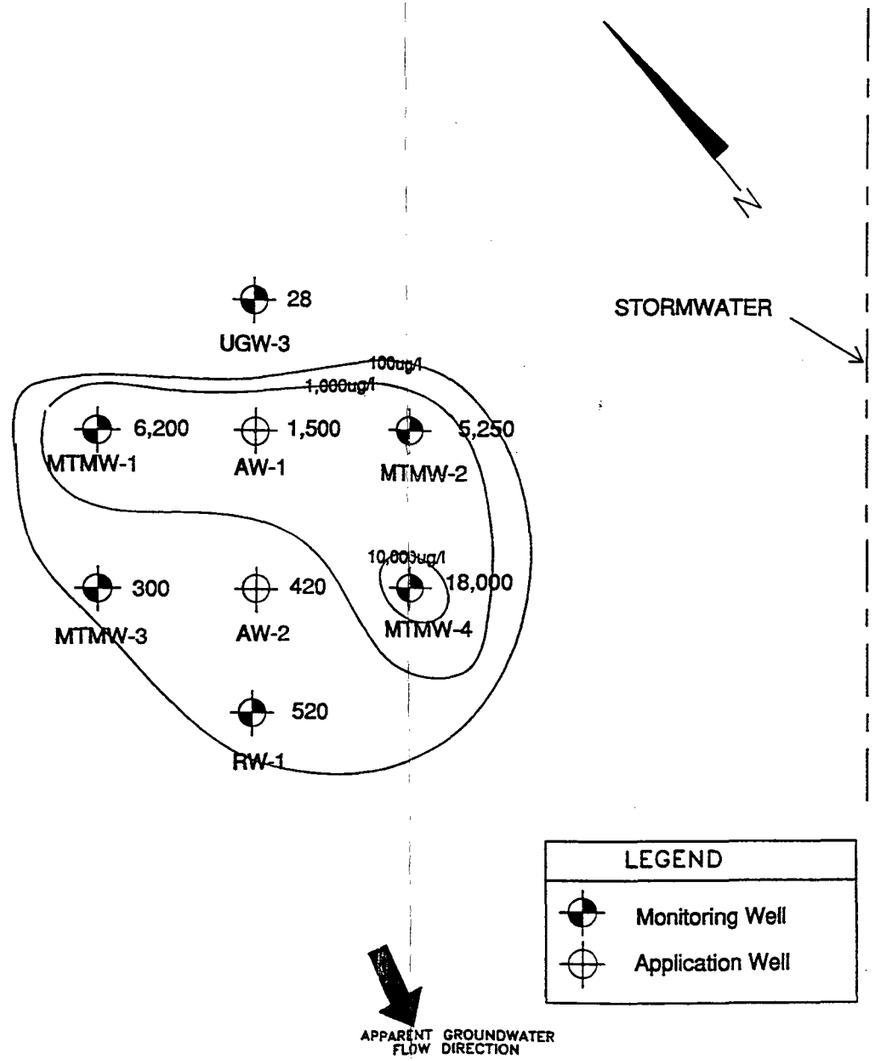


MANTECH ENVIRONMENTAL CORPORATION
14280 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

DRO CONCENTRATIONS IN GROUNDWATER
TOW WAY FUEL FARM
3 WEEK POST TREATMENT 2/22/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE13.DWG	CT	CC	13c

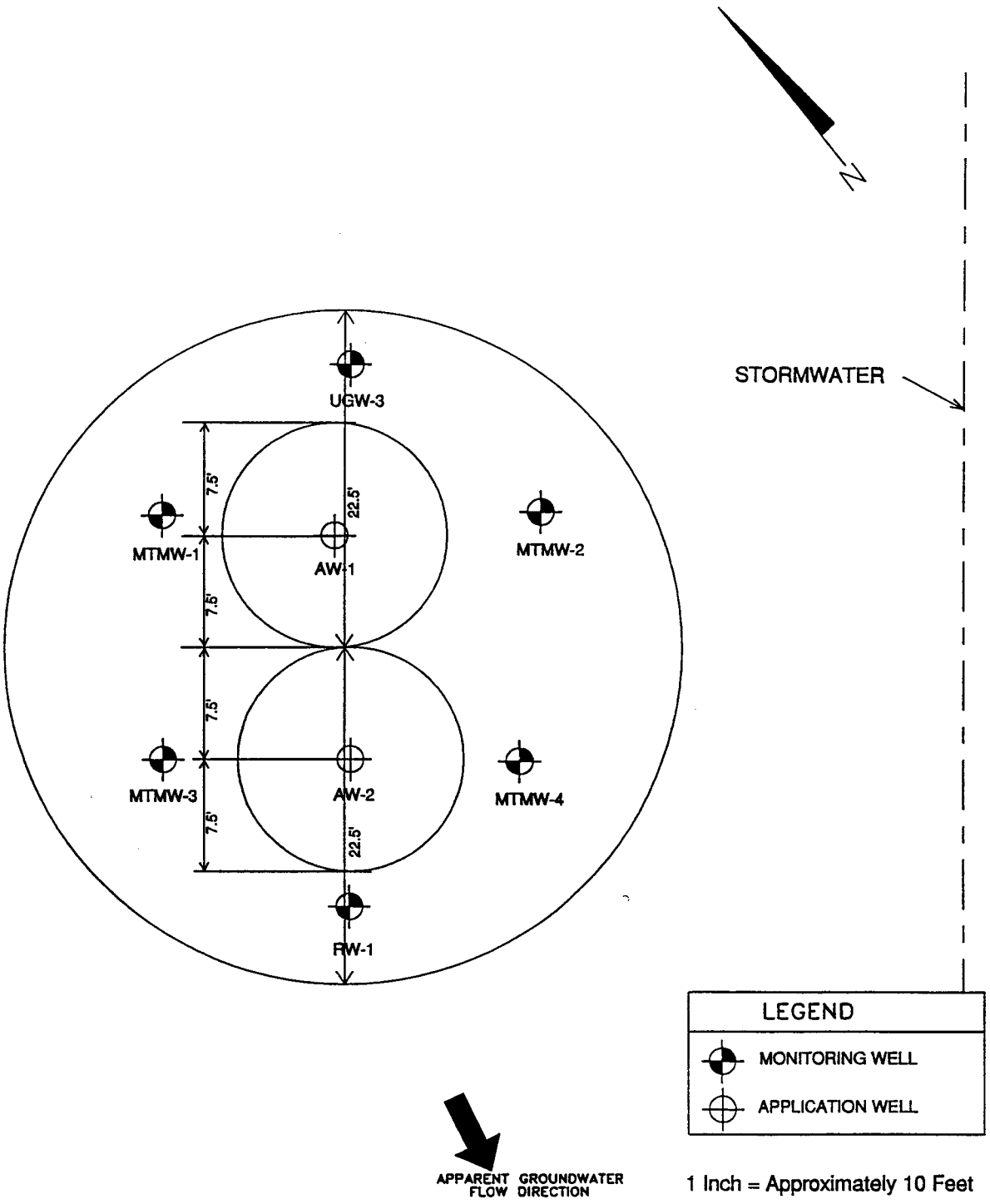


MANTECH ENVIRONMENTAL CORPORATION
14280 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

DRO CONCENTRATIONS IN GROUNDWATER
TOW WAY FUEL FARM
8-WEEK POST TREATMENT 4/15/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE13.DWG	CT	CC	13d

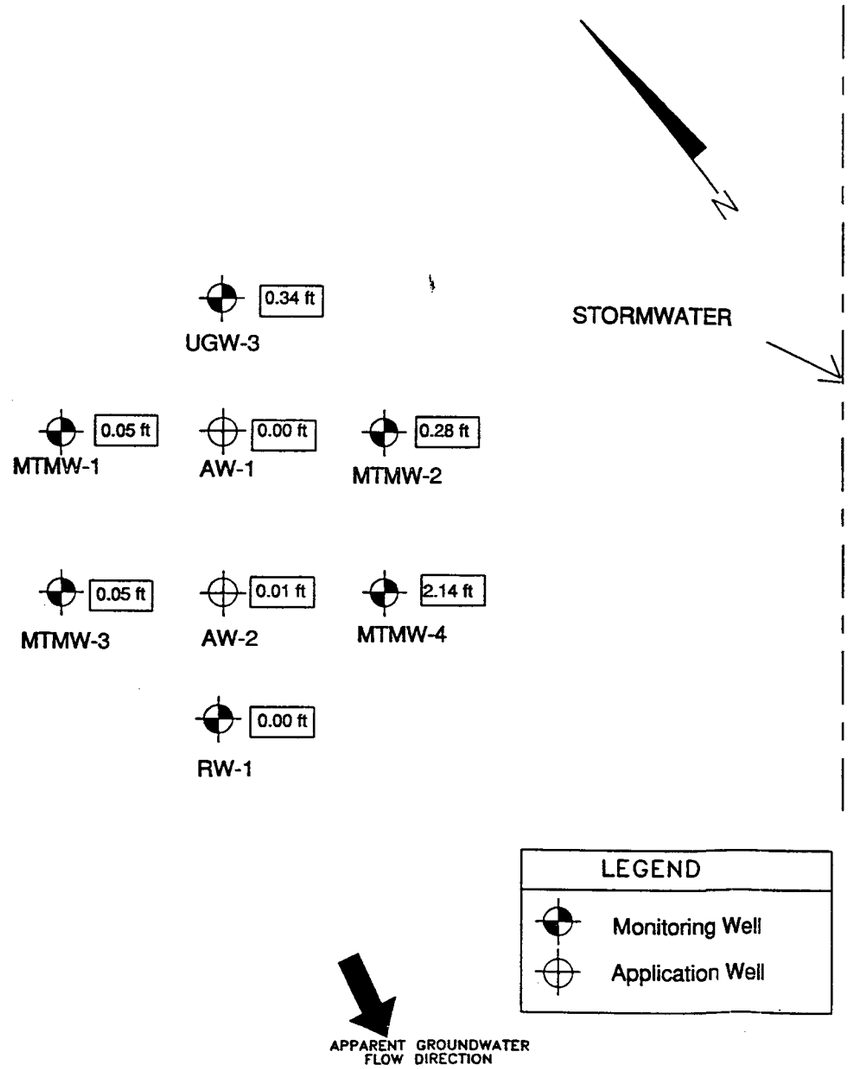


MANTECH ENVIRONMENTAL CORPORATION
14250 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

BASIS OF MASS DESTRUCTION CALCULATIONS
TOW WAY FUEL FARM
CEIBA, PUERTO RICO

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	12/16/99	FIGURE14.DWG	CT	CC	14

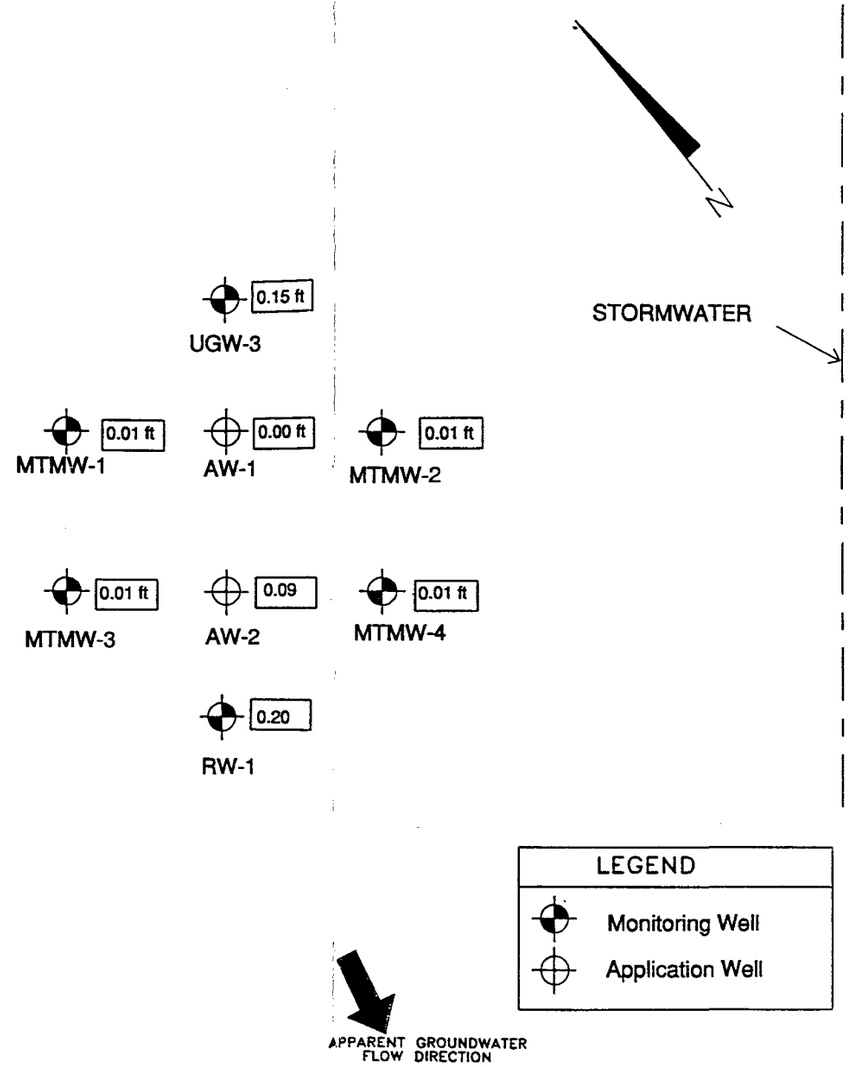


MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

FREE PRODUCT MEASUREMENTS
TOW WAY FUEL FARM
BASELINE 1/7/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE15.DWG	CT	CC	15a

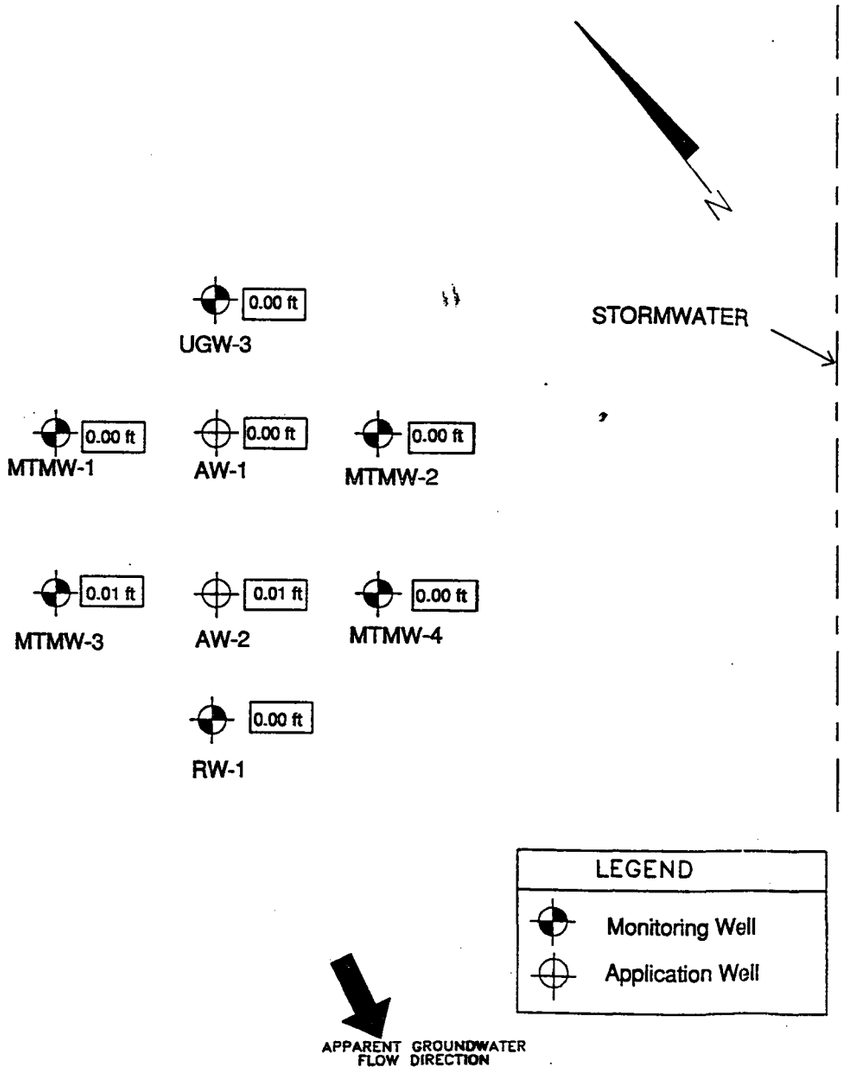


MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

FREE PRODUCT MEASUREMENTS
TOW WAY FUEL FARM
1 WEEK POST TREATMENT

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE15.DWG	CT	CC	15b

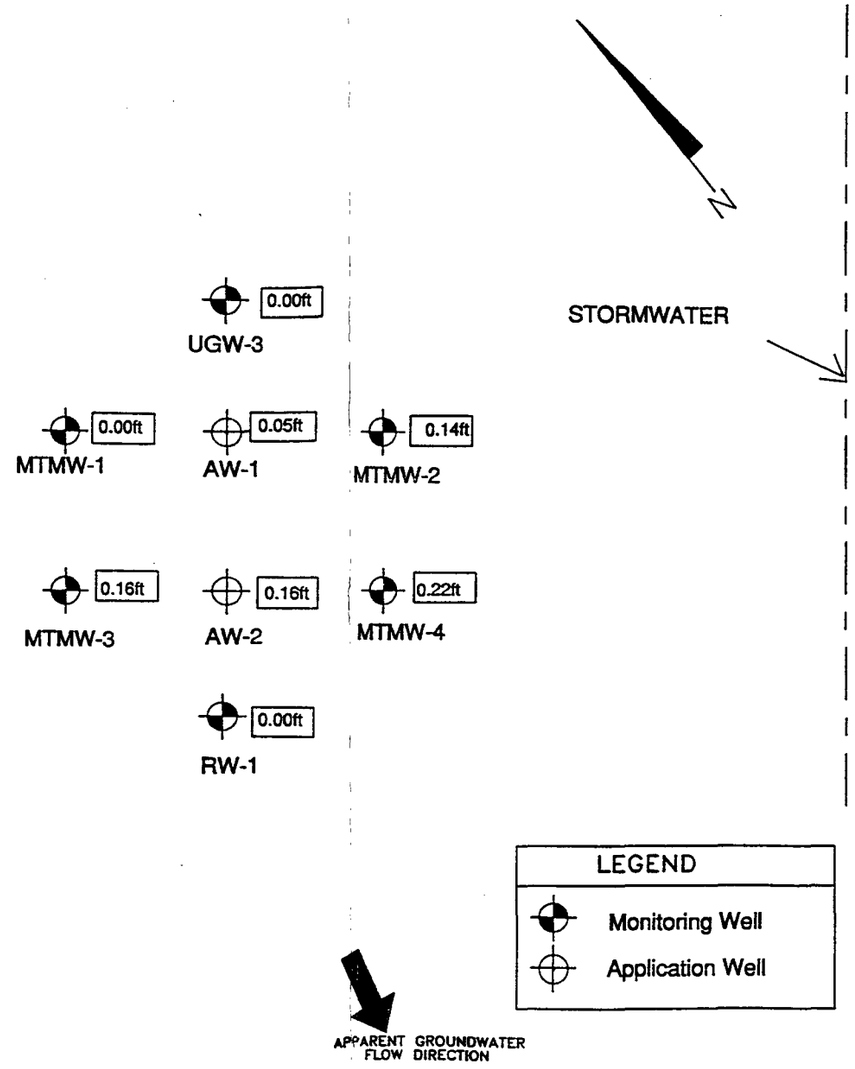


MANTECH ENVIRONMENTAL CORPORATION
14250 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

FREE PRODUCT MEASUREMENTS
TOW WAY FUEL FARM
3 WEEK POST TREATMENT

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE15.DWG	CT	CC	15c

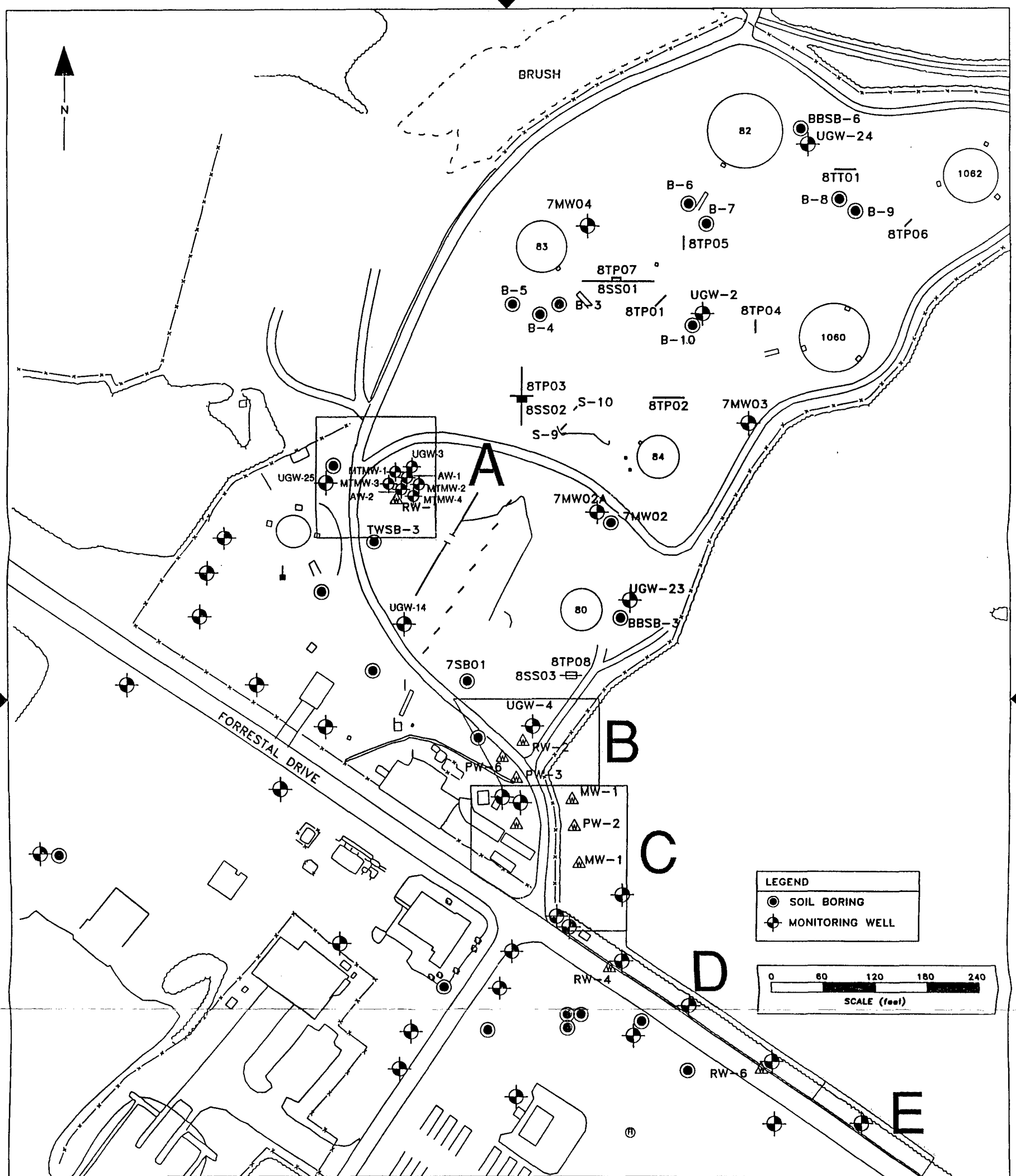


MANTECH ENVIRONMENTAL CORPORATION
14250 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

FREE PRODUCT MEASUREMENTS
TOW WAY FUEL FARM
8-WEEK POST TREATMENT 4/15/99

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/13/99	FIGURE15.DWG	CT	CC	15d



MANTECH ENVIRONMENTAL CORPORATION
14290 SULLYFIELD CIRCLE SUITE 100
CHANTILLY, VIRGINIA 20151

NAVAL STATION ROOSEVELT ROADS

CLEANOX® REMEDIATION ZONES
TOW WAY FUEL FARM
CEIBA, PUERTO RICO

CLIENT:	DATE:	DWG. FILE:	DRWN BY:	REV'D BY:	FIG. NO.:
BAKER ENVIRONMENTAL, INC.	4/12/99	FIGURE16.DWG	CT	CC	16

APPENDIX A

SITE BORING LOGS

MANTECH ENVIRONMENTAL
14290 Sullyfield Circle, Suite 100
Chantilly, Virginia 20151

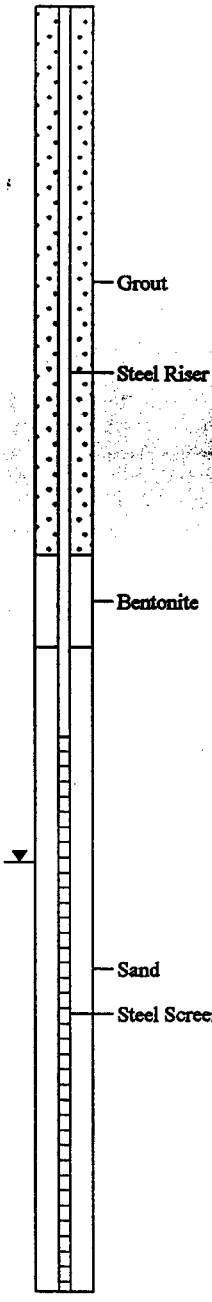
LOG OF BORING AW-1

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 24 feet bgs
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callaghan	Well Inner Diameter	: 2 inch
Sample Type	: Split Spoon, Grab	Well Construction	: PVC Screen/Riser
Hole Diameter	: 8 inches	Well Depth	: 36 Feet

Well1: AW-1
Elev.: 7.7 Feet Above Mean Sea Level

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Depth in Feet	Samples	Blow Count
0	Brown silty clay	CH		0		
16	Dense grey clay with gravel and cobbles, Petroleum odor, Dry	CH		16		
18	Dense brown clay with angular cobbles and boulders, slight petroleum odor, Dry	CH		18		
24	Dense red-brown clay slight petroleum odor, Dry	CH		24		
26	Rock-angular cobbles and boulders, WET WITH PETROLEUM PRODUCT	PD		26		
28	Brown clay with gravel, Wet	CH		28		
30	Brown silty gravel, Wet	GW		30		
36				36		



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MANTECH ENVIRONMENTAL
14290 Sullyfield Circle, Suite 100
Chantilly, Virginia 20151

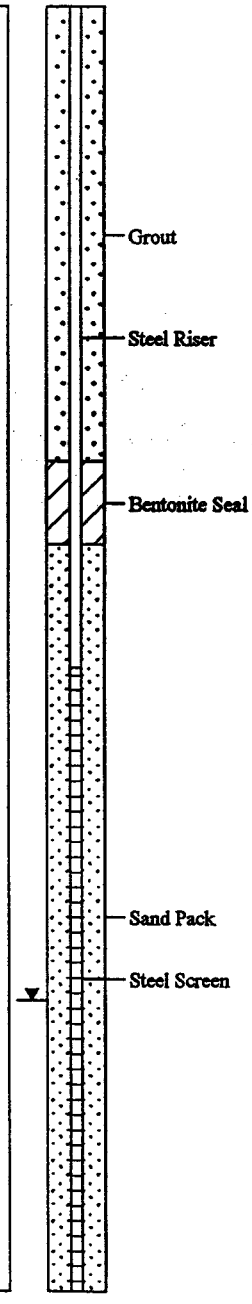
LOG OF BORING AW-2

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 24 Feet bgs
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callaghan	Well Inner Diameter	: 2 inches
Sample Type	: Split Spoon, Grab	Well Construction	: Steel Screen/Riser
Hole Diameter	: 8 Inches	Well Depth	: 31

Depth in feet	DESCRIPTION	USCS	GRAPHIC	Depth in feet	Blow Count
0–7	Cuttings brown silty clay, then light brown - red clay	CH		0–7	
8–9	Red brown silty clay, Dry	CH		8–9	
10	Brown and grey mottled clay, Dry	CH		10	
11	Dense brown clay, Dry	CH		11	
12–15	Dense brown clay with cobbles, Dry	CH		12–15	
16–19	Grey silty clay with cobbles, petroleum odor, Dry	CH		16–19	
20	Dense grey clay with cobbles WET WITH PETROLEUM PRODUCT	PD		20	
21	Dense grey clay with cobbles, Dry	CH		21	
22	Angular cobbles of gabbro petroleum stained, Wet	GW		22	
23	Red Clay, Dry	CH		23	
24–31	Silty clay with cobbles, petroleum stained, Wet	CH		24–31	

Well1: AW-2
Elev.: 6.7 Feet Above Mean Sea Level



MANTECH ENVIRONMENTAL
14290 Sullyfield Circle, Suite 100
Chantilly, Virginia 20151

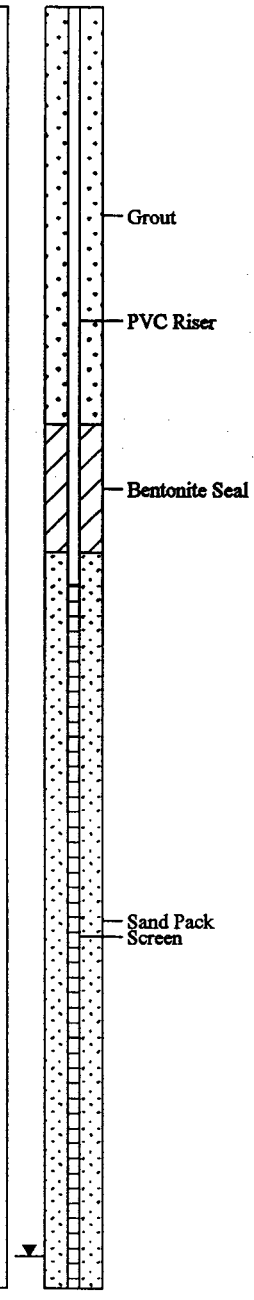
LOG OF BORING MTMW-1

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 39 Feet bgs
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callaghan	Well Inner Diameter	: 2 inches
Sample Type	: Split Spoon, Grab	Well Construction	: PVC Screen/Riser
Hole Diameter	: 8 Inches	Well Depth	: 40

Well1: MTMW-1
Elev.: 8.6 Feet Above Mean Sea Level

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Depth in Feet	Samples	Blow Count
0	Brown sity clay, Dry.			0		
2				2		
4				4		
6				6		
8				8		
10				10		
12				12		
14		CH		14		
16				16		
18				18		
20				20		
22				22		
24				24		
26				26		
28				28		
29	WET WITH PETROLEUM PRODUCT.	PD				
30	Brown silty clay, Wet at 39 feet bgs.			30		
32				32		
34		CH		34		
36				36		
38				38		
40				40		



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MANTECH ENVIRONMENTAL
14290 Sullyfield Circle, Suite 100
Chantilly, Virginia 20151

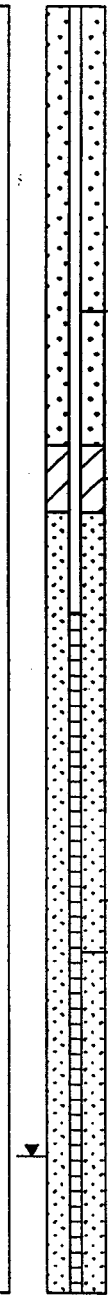
LOG OF BORING MTMW-2

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 34 Feet bgs
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callaghan	Well Inner Diameter	: 2 inches
Sample Type	: Split Spoon, Grab	Well Construction	: PVC Screen/Riser
Hole Diameter	: 8 Inches	Well Depth	: 38

Well1: MTMW-2
Elev.: 8.0 Feet Above Mean Sea Level

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Depth in Feet	Samples	Blow Count
0	Grey clay and gravel with petroleum odor. Water at 34 feet bgs.	CH		0		
2				2		
4				4		
6				6		
8				8		
10				10		
12				12		
14				14		
16				16		
18				18		
20				20		
22				22		
24				24		
26				26		
28				28		
30				30		
32				32		
34				34		
36				36		
38				38		



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MANTECH ENVIRONMENTAL
14290 Sullyfield Circle, Suite 100
Chantilly, Virginia 20151

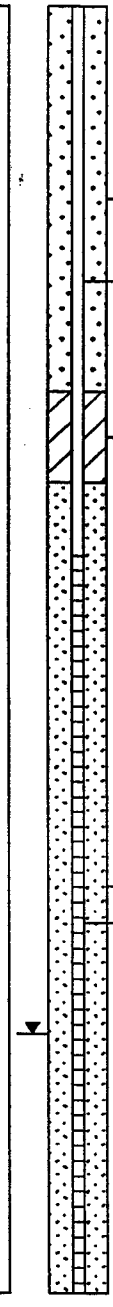
LOG OF BORING MTMW-3

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 28 feet bgs
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callaghan	Well Inner Diameter	: 2 inch
Sample Type	: Split Spoon, Grab	Well Construction	: PVC Screen/Riser
Hole Diameter	: 8 inches	Well Depth	: 35 Feet

Well1: MTMW-3
Elev.: 7.5 Feet Above Mean Sea Level

Depth in Feet	DESCRIPTION	USCS
0–10	Silty clay	CH
10–14	Dense red brown to olive silty clay with cobbles, Dry	CH
14–15	Dense red and grey mottled clay, Dry	CH
15–18	Gravel and cobbles, Dry	GW
18–20	Dense greyish gabbro saprolite, strong petroleum odor, dry	GW
20–22	Dense petroleum stained brown silty clay with cobbles, dry	CH
22–24	Dense petroleum stained grey silty clay with cobbles, Dry	CH
24–25	Dense petroleum stained grey silty clay with cobbles, WET WITH PETROLEUM PRODUCT	PD / CH
25–26	Silty sand with cobbles, Dry	CH
26–27	Red brown silty clay with cobbles	CH
27–30	Silty sand with cobbles, Wet at 30 Feet	CH
30–35	Silty clay	CH



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06-01-1999

MANTECH ENVIRONMENTAL
14290 Sullyfield Circle, Suite 100
Chantilly, Virginia 20151

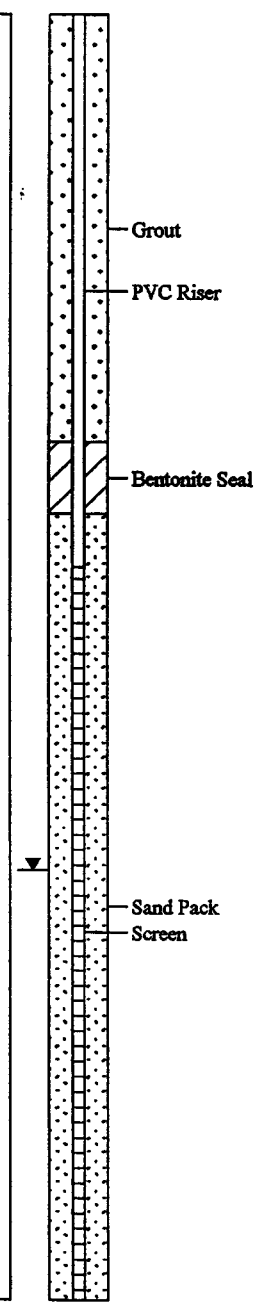
LOG OF BORING MTMW-4

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 22
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callaghan	Well Inner Diameter	: 2 inch
Sample Type	: Split Spoon, Grab	Well Construction	: PVC Screen/Riser
Hole Diameter	: 8 in.	Well Depth	: 36 Feet

Well1: MTMW-4
Elev.: 7.1 Feet Above Mean Sea Level

Depth in Feet	DESCRIPTION	USCS
0–8	Brown silty clay	CH
8–9	Dense brown and grey mottled clay, dry	CH
9–10	Gravel, dry	GW
10–12	Red clay, dry	CH
12–13	Grey clay, strong petroleum odor, dry	CH
13–14	Grey clay some angular gravel, strong petroleum odor, dry	CH
14–16	Green silty clay with angular gabbro gravel, petroleum odor,dry	CH
16–18	Angular gabbro gravel, dry	GW
18–20	Angular gabbro gravel, WET WITH PETROLEUM PRODUCT	PD
20–22	Silty clay with gravel, strong petroleum odor, dry	CH
22–26	Gabbro gravel, wet	GW
26–36	Olive silty clay, wet	CH

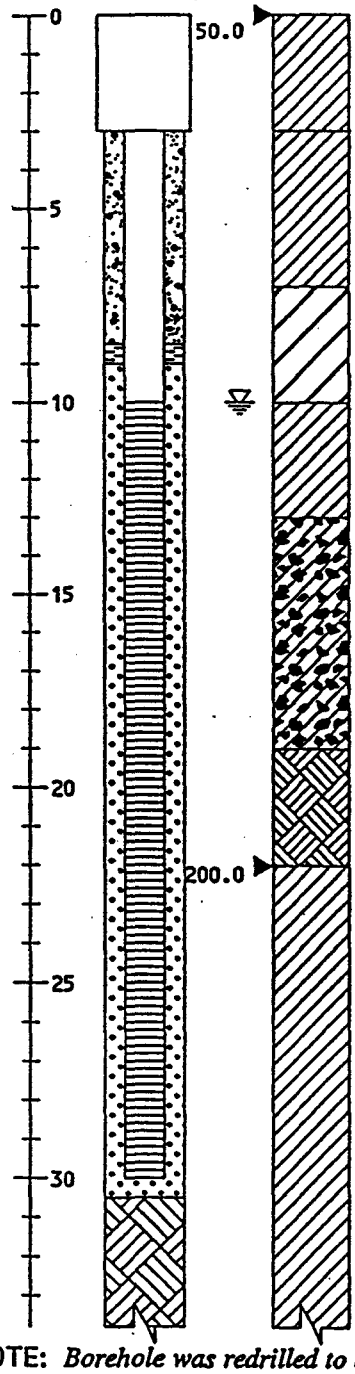


BORING / WELL LOG

BORING NO.: RW-1

PROJECT: Free Product Recovery
PROJECT NO.: 945809
CLIENT/OWNER: U.S. Navy
BORING LOCATION: Upper Tow-Way Fuel Facility
DRILLING CO.: Soil Tech
DRILLER: Jorge Diaz
DRILLING METHOD: 8 1/4" HSA
DRILL RIG: Mobile B-90

DATE DRILLED: 10/17/96
TOC ELEVATION:
GS ELEVATION:
DTW AT COMPLETION: 10'9
DTW AFTER 24 HOURS:
LOGGED BY: D. Drozd



ELEVATION/ DEPTH (feet)	WELL DETAIL	PID READINGS, SOIL SYMBOLS, SAMPLERS, AND TEST DATA	USCS	DESCRIPTION	SAMPLE No.	SAMPLE Rec.	STANDARD PENETRATION TES DEPTH	N	CURVE 10 30 5
			cl	SILT and CLAY, little gravel, brown, moist, fill					
			cl	CLAY, some silt, some gravel, gray-green, strong odor, moist, compacted					
			ch	CLAY, light brown, strong odor, moist, compacted					
			cl	CLAY, some silt, little gravel, angular to subangular, light brown, slight odor, compacted					
			gc	GRAVEL, little clay, light brown, medium odor, moist, uncompacted					
			rock	ROCK, subangular, gray-green, hard, little clay, medium brown, wet, medium odor					
			cl	CLAY, little sand, medium to coarse grained, trace gravel, wet, strong odor, compacted					

NOTE: *Borehole was redrilled to a depth of 35 feet because well originally collapsed and to allow room for installation of the well if the borehole collapsed.*

CHECKED BY

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

ICHOR Services, Inc.

BORING / WELL LOG

PROJECT: Free Product Recovery
PROJECT NO.: 945809
CLIENT/OWNER: U.S. Navy
BORING LOCATION: Upper Tow-Way Fuel Facility
DRILLING CO.: Soil Tech
DRILLER: Jorge Diaz
DRILLING METHOD: 8 1/4" HSA
DRILL RIG: Mobile B-90

DATE DRILLED: 10/17/96
TOC ELEVATION:
GS ELEVATION:
DTW AT COMPLETION:
DTW AFTER 24 HOURS:
LOGGED BY: D. Drozd

ELEVATION/ DEPTH (feet)	WELL DETAIL	PID READINGS, SOIL SYMBOLS, SAMPLERS, AND TEST DATA	USCS	DESCRIPTION	SAMPLE No.	SAMPLE Rec.	STANDARD PENETRATION TEST DEPTH	STANDARD PENETRATION TEST N	CURVE 10 30 5
35			35.0	Bottom of Boring					
40									
45									
50									
55									
60									
65									

NOTE: *Borehole was redrilled to a depth of 35 feet because well originally collapsed and to allow room for installation of the well if the borehole collapsed.*

CHECKED

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

ICHOR Services, Inc.

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No. UGW-3 Sheet 1 of 1
Project Location: U.S. Naval Station Roosevelt Rd. Puerto Rico Client: Naval Engineering Command	SAMPLER Type: Split Spoon Hammer: 140 lbs. Fall: 30"	Ground Water Depth Date Depth Date File No.: 3543.020.130

Boring Co.: JACA & Sierra Testing Laboratories
Foreman: Angel Ferrer
OBG Geologist: Tim Eddy

Boring Location:
Ground Elevation:
Dates: Started: 3/5/91 Ended: 3/6/91

Depth	Sample No	Sample Depth	Blows /6"	Penetr/ Recovry	"N" Valve	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Sp Cond	HNU	Rmks
0	1	0-2'	3-4-5-8	2'/1'	9	Moist, brown/green/black, medium stiff SILT little fine to medium gravel, trace clay					30	*
	2	2-4'	3-4-8-7	2'/2'	12	Moist, brown and gray mottled, stiff CLAY, some silt, trace fine to medium sand					40	
	3	4-6'	5-5-8-2	2'/1.8'	13	Same as above					40	
5												
10	4	10-12'	27-38-18-21	2'/1.6'	56	Damp, brown/orange/green, fine to medium SAND, some silt, trace fine to medium gravel					1	
15	5	15-17'	10-50/0.5	1'/1'	—	Damp, very dense, brown-gray, silty, fine to coarse SAND, trace fine to medium gravel					6	
20	6	20-22'	25-50/0.3	0.8/0.8'	—	Very dense, brown slight green, fine to coarse SAND, some silt, trace fine to medium gravel					100	
25	7	25-27'	47-50/0.3	0.8/0.8'	—	Very dense, brown, fine to coarse SAND, little silt and fine to medium gravel 25-25.3 Wet with petroleum product					7	
30	8	30-32'	84/0.5'	0.5/0.5'	—	Wet, brown, very dense, silty, fine to coarse SAND, little fine to medium gravel					140	

* - HNU readings reported in ppm.

Bottom of boring 33.0 ft

MW3.KJF

FINAL

APPENDIX B

SLUG TEST DATA AND HYDRAULIC CONDUCTIVITY CALCULATIONS

Slug Test Results

Title: Naval Sation Roosevelt Roads - Tow Way Fuel Farm
Client:
Job Number: 8207-000
Well Number: AW-1

Hydraulic Conductivity

Bouwer-Rice: 1.21E-5 (ft/sec), 3.19E-1 (m/day)

Well Geometry (ft)
H: 30.0
Le: 15.0
Lw: 21.18
rc: .167
rw: .333

drainable filter pack porosity: 0.0
effective radius: 1.67E-1 (ft)

Bouwer Rice Coefficients
Le/rw: 45.045
A: 2.819
B: 0.425
C: 2.473
ln(Re/rw): 2.79

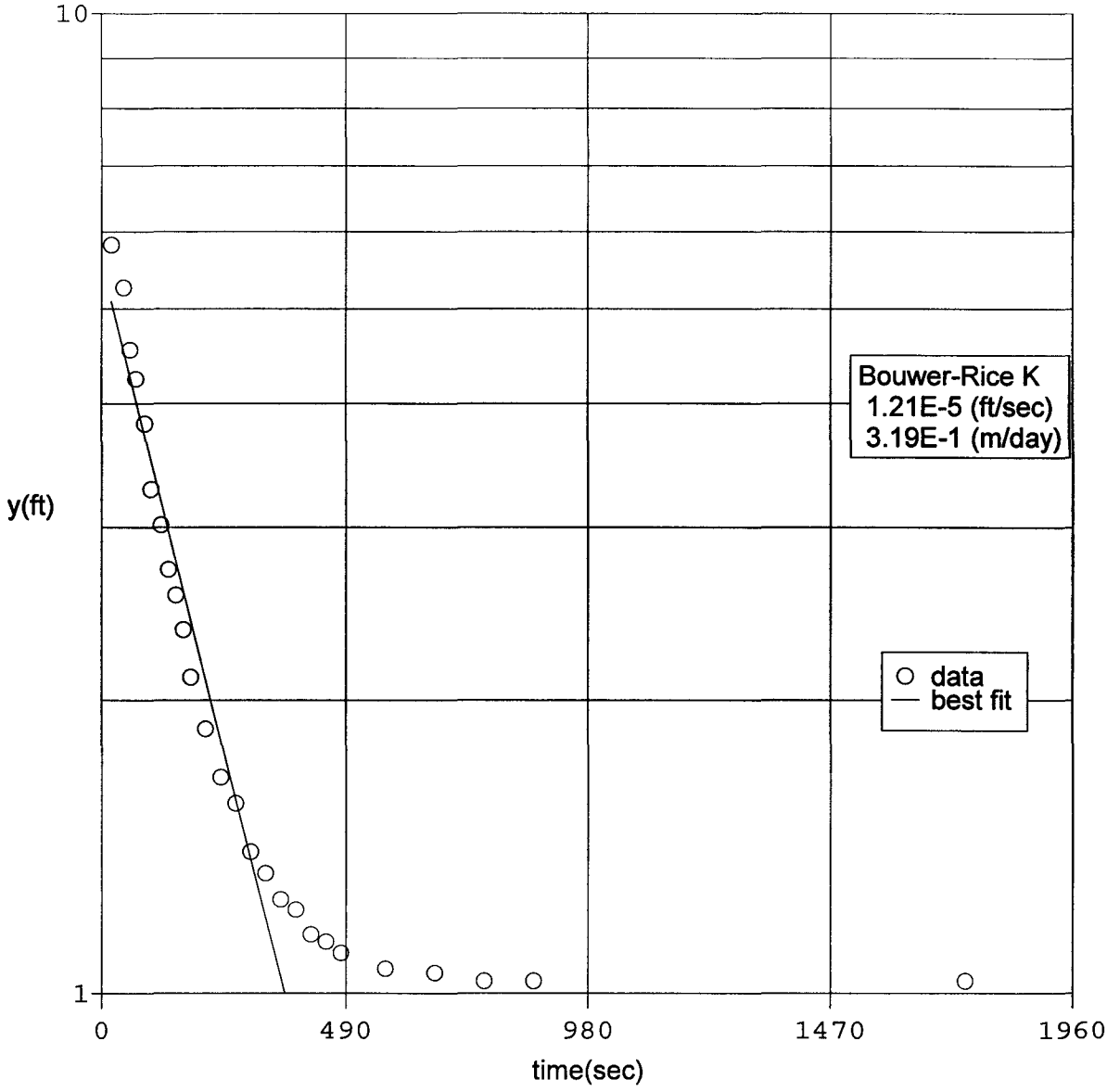
Least Squares Fit
slope: -4.67E-3
intercept: 1.72E+0

Recovery Data and Fit

time(sec)	y(ft)	weight	fit(ft)
20.0	5.820	1.0	5.092
45.0	5.260	1.0	4.531
58.0	4.540	1.0	4.264
70.0	4.240	1.0	4.032
88.0	3.820	1.0	3.707
100.0	3.280	1.0	3.505
120.0	3.020	1.0	3.192
135.0	2.720	1.0	2.976
150.0	2.560	1.0	2.775
165.0	2.360	1.0	2.587
180.0	2.110	1.0	2.412
210.0	1.870	1.0	2.097
240.0	1.670	1.0	1.823
270.0	1.570	1.0	1.585
300.0	1.400	1.0	1.378

330.0	1.330	1.0	1.198
360.0	1.250	1.0	1.041
390.0	1.220	0.0	0.905
420.0	1.150	0.0	0.787
450.0	1.130	0.0	0.684
480.0	1.100	0.0	0.595
570.0	1.060	0.0	0.391
670.0	1.050	0.0	0.245
770.0	1.030	0.0	0.154
870.0	1.030	0.0	0.096
1740.0	1.030	0.0	0.002

Well AW-1 / Naval Station Roosevelt Roads - Tow Way Fuel Farm



Slug Test Results

Title: Naval Station Roosevelt Roads - Tow Way Fuel Farm
Client:
Job Number: 8207-000
Well Number: AW-2

Hydraulic Conductivity

Bouwer-Rice: 1.55E-5 (ft/sec), 4.08E-1 (m/day)

Well Geometry (ft)

H:	30.0
Le:	15.0
Lw:	17.11
rc:	.167
rw:	.333

drainable filter pack porosity: 0.0
effective radius: 1.67E-1 (ft)

Bouwer Rice Coefficients

Le/rw:	45.045
A:	2.819
B:	0.425
C:	2.473
ln(Re/rw):	2.657

Least Squares Fit

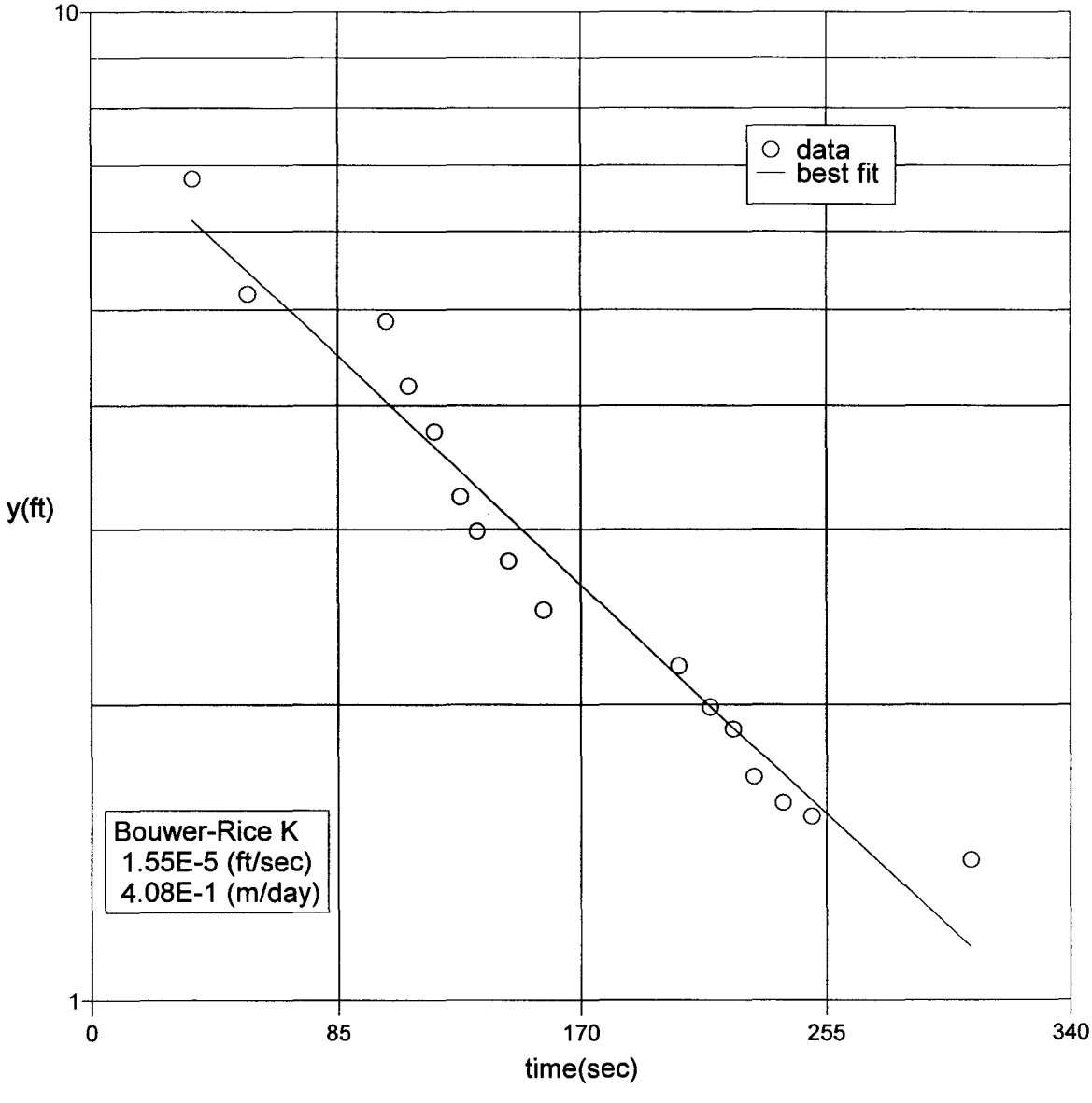
slope:	-6.27E-3
intercept:	2.04E+0

Recovery Data and Fit

time(sec)	y(ft)	weight	fit(ft)
35.0	6.790	1.0	6.157
54.0	5.190	1.0	5.466
102.0	4.870	1.0	4.045
110.0	4.190	1.0	3.847
119.0	3.770	1.0	3.636
128.0	3.240	1.0	3.437
134.0	2.990	1.0	3.310
145.0	2.790	1.0	3.089
157.0	2.490	1.0	2.865
204.0	2.190	1.0	2.134
215.0	1.990	1.0	1.992
223.0	1.890	1.0	1.894
230.0	1.690	1.0	1.813
240.0	1.590	1.0	1.703
250.0	1.540	1.0	1.599

305.0	1.390	1.0	1.133

Well AW-2 / Naval Station Roosevelt Roads - Tow Way Fuel Farm



FINAL

APPENDIX C

SOIL CUTTINGS ANALYTICAL RESULTS

teg

The World Leader In On-Site Sampling and Analysis

MANTECH ENVIRONMENTAL CORP. PROJECT NO. 8207.000.00
PILOT STUDY ROOSEVELT ROADS
CEIBA, PR

TEG Project #98I1221MAN

BTEX (Mod. EPA Method 8020) ANALYSES OF WATER WITH TCLP EXTRACTION

SAMPLE NUMBER	DATE ANALYZED	BENZENE (ug/L)	TOLUENE (ug/L)	ETHYL-BENZENE (ug/L)	TOTAL XYLENES (ug/L)
METHOD BLANK	1/4/99	ND	ND	ND	ND
DRUMS	1/4/99	ND	ND	ND	16
DETECTION LIMIT (ug/L)		5.0	5.0	5.0	15

SAMPLING PERFORMED BY MANTECH PERSONNEL
"ND" INDICATES NOT DETECTED AT LISTED DETECTION LIMIT
ug/L = MICROGRAMS PER LITER

ANALYSES PERFORMED BY: JOSE MIGUEL PEREZ
DATA REVIEWED BY: KEVIN SHELBURNE

Marco A. Pedraza
Laboratory Manager

Kevin Shelburne
Principal

MARCO A. PEDRAZA RUIZ
Químico Licenciado
Estado Libre Asociado de Puerto Rico
LICENCIA NÚM. 3303
LIA 560351

TEG-PUERTO RICO • PMB 627, HC-01 Box 29030, Caguas, PR 00725 • Phone (787) 720-0329 • Fax (787) 789-3858 • Pager 759-1255 Unit 217-4053

teg

QA/QC REPORT - CALIBRATION DATA

TEG Project #98I1221MAN
DAILY CALIBRATION DATE : 1/4/99

MANTECH ENVIRONMENTAL CORP. 8207.000.00

			INITIAL		OPENING			CLOSING		
COMPOUND	DETECTOR	CALIB RANGE	RF	%RSD	AREA	RF	%DIFF	AREA	RF	%DIFF
BENZENE	PID - GC3	1 - 200	183.90	4.2%	3832.55	153.30	16.6%	4015.16	160.61	12.7%
TOLUENE	PID - GC3	1 - 200	169.60	6.9%	3709.88	148.40	12.5%	3846.04	153.84	9.3%
ETHYLBENZENE	PID - GC3	1 - 200	138.70	9.1%	3125.36	125.01	9.9%	3366.01	134.64	2.9%
m&p-XYLENES	PID - GC3	1 - 200	158.74	17.5%	8772.10	175.44	10.5%	9327.19	186.54	17.5%
o-XYLENES	PID - GC3	1 - 200	145.66	13.7%	3311.12	132.44	9.1%	3376.45	135.06	7.3%

CALIB RANGE - RANGE OF CALIBRATION CURVE IN ppb
INITIAL RF - AVERAGE RESPONSE FACTOR FROM MULTIPOINT CALIBRATION CURVE
% RSD - LINEARITY OF MULTIPOINT CALIBRATION CURVE (+/- 20% ACCEPTABLE LIMITS)
AREA - AREA COUNTS FROM DAILY CALIBRATION STANDARD
RF - DETECTOR RESPONSE FACTOR FROM MID-POINT CALIBRATION STANDARD
% DIFF - DIFFERENCE, IN PERCENT, BETWEEN THE AVERAGE RF AND THE OPENING OR CLOSING RF (+/- 25% ACCEPTABLE LIMITS)
OPENING - MID-POINT CALIBRATION STANDARD ANALYZED BEFORE SAMPLE ANALYSES BEGIN
CLOSING - MID-POINT CALIBRATION STANDARD ANALYZED AFTER SAMPLES ANALYSES ARE COMPLETE

ANALYSES PERFORMED BY: JOSE MIGUEL PEREZ
DATA REVIEWED BY: KEVIN SHELBURNE

TRANSGLOBAL ENVIRONMENTAL GEOCHEMISTRY
PMB 627, HC-01 BOX 29030, CAGUAS, P.R. 00725
TELEPHONE (787) 720-0329 FAX 789-3858

teg

MATRIX SPIKE (MS)/MATRIX SPIKE DUPLICATE (MSD)

TEG Project #98I1221MAN
DATE: 1/4/99

MANTECH ENVIRONMENTAL CORP. 8207.000.00

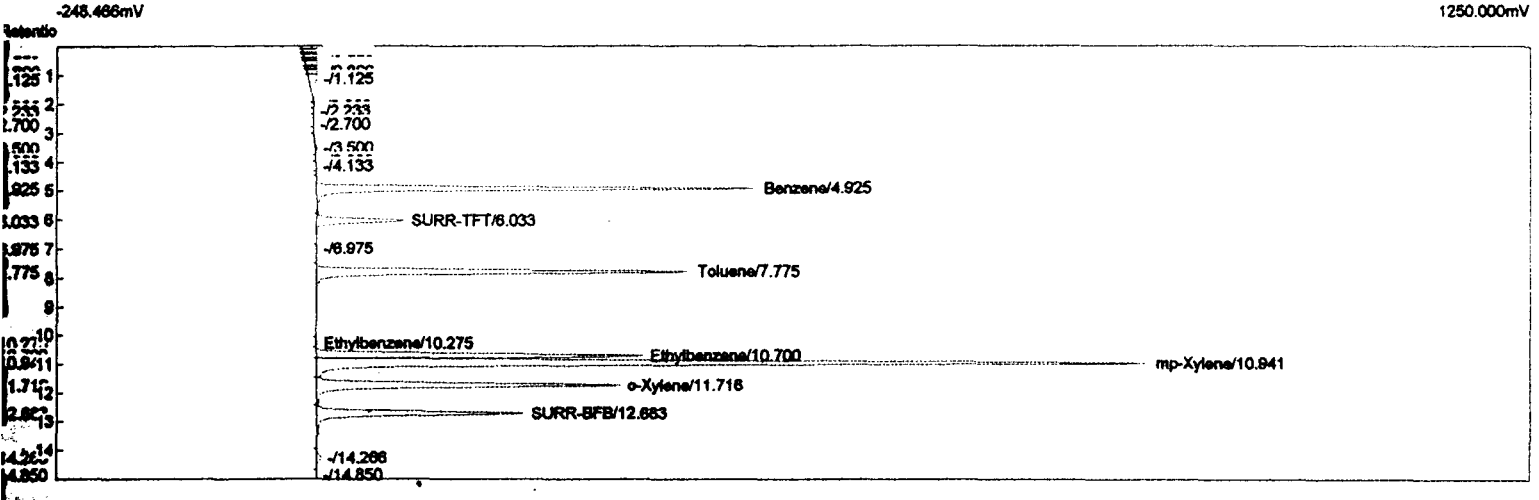
COMPOUND	SPK CONC (ppb)	MS CONC (ppb)	%REC MS	MSD CONC (ppb)	%REC MSD	RPD	ACCEPTABLE RPD	ACCEPTABLE RECOVERY
BENZENE	50	52	104%	53	106%	2%	20%	65%-125%
TOLUENE	50	53	106%	54	108%	2%	20%	65%-125%
ETHYLBENZENE	50	52	104%	53	106%	2%	20%	65%-125%
TOTAL XYLENES	150	175	117%	174	116%	1%	20%	65%-125%

ppb = PARTS PER BILLION
SPK CONC - CONCENTRATION SPIKED INTO MATRIX
MS CONC - ANALYZED CONCENTRATION OF SPIKED SAMPLE
% REC - PERCENT RECOVERY OF SPIKE FROM MATRIX
RPD - RELATIVE PERCENT DIFFERENCE BETWEEN MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RECOVERIES

ANALYSES PERFORMED BY: JOSE MIGUEL PEREZ
DATA REVIEWED BY: KEVIN SHELBURNE

TRANSGLOBAL ENVIRONMENTAL GEOCHEMISTRY
PMB 627, HC-01 BOX 29030, CAGUAS, P.R. 00725
TELEPHONE (787) 720-0329 FAX 789-3858

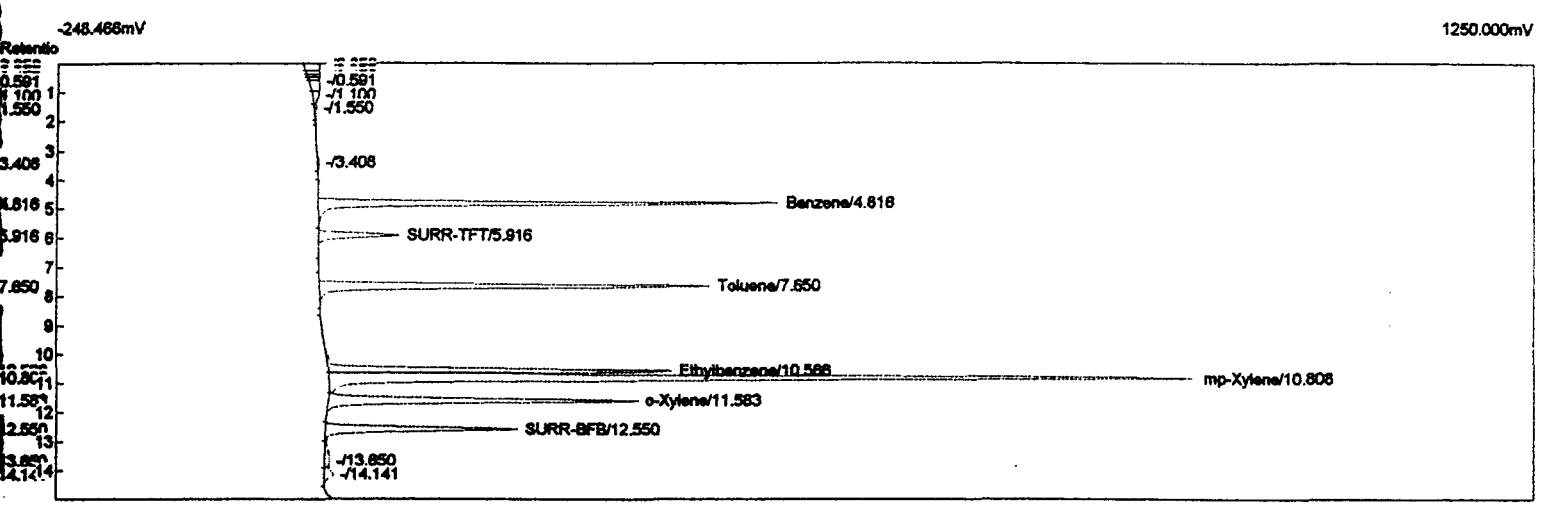
Lab name: TEG Puerto Rico
Analysis date: 01/04/1999 12:57:43
Method: EPA 8021 Mod.
Lab ID: GC-3
Description: PID, GC-3, P&T
Column: RTX-5 (30x.53x5)
Carrier: N2, 15mL/min
Data file: 0104p6.CHR ()
Sample: 50 ppb BTEX Opening
Operator: JMP



Retention	Component	Number	Area	External	Internal	Units
4.925	Benzene	1	3832.552	47.81	47.8113	ppb
6.033	SURR-TFT	2	903.899	10.49	10.4946	ppb
7.775	Toluene	3	3709.879	48.37	48.3687	ppb
~~10.275~~	~~Ethylbenzene~~	~~4~~	~~7.335~~	~~0.11~~	~~0.1149~~	~~ppb~~
10.700	Ethylbenzene	4	3125.361	48.96	48.9562	ppb
10.941	mp-Xylene	5	8772.099	110.15	110.1469	ppb
11.716	o-Xylene	6	3311.115	50.91	50.9089	ppb
12.683	SURR-BFB	7	2279.995	12.22	12.2219	ppb
		8	25942.236	329.02	329.0233	

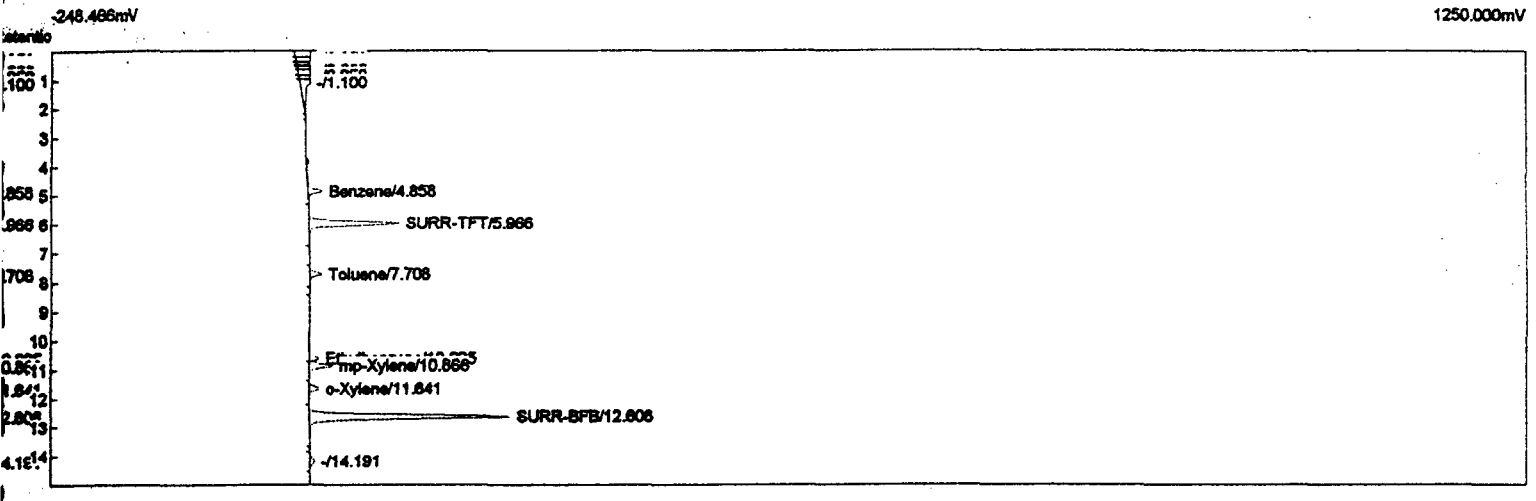
mp

Analysis date: 01/04/1999 19:14:03
Method: EPA 8021 Mod.
Lab ID: GC-3
Description: PID, GC-3, P&T
Column: RTX-5 (30x.53x5)
Carrier: N2, 15mL/min
Data file: 0104p19.CHR ()
Sample: 50 ppb BTEX Closing
Operator: JMP



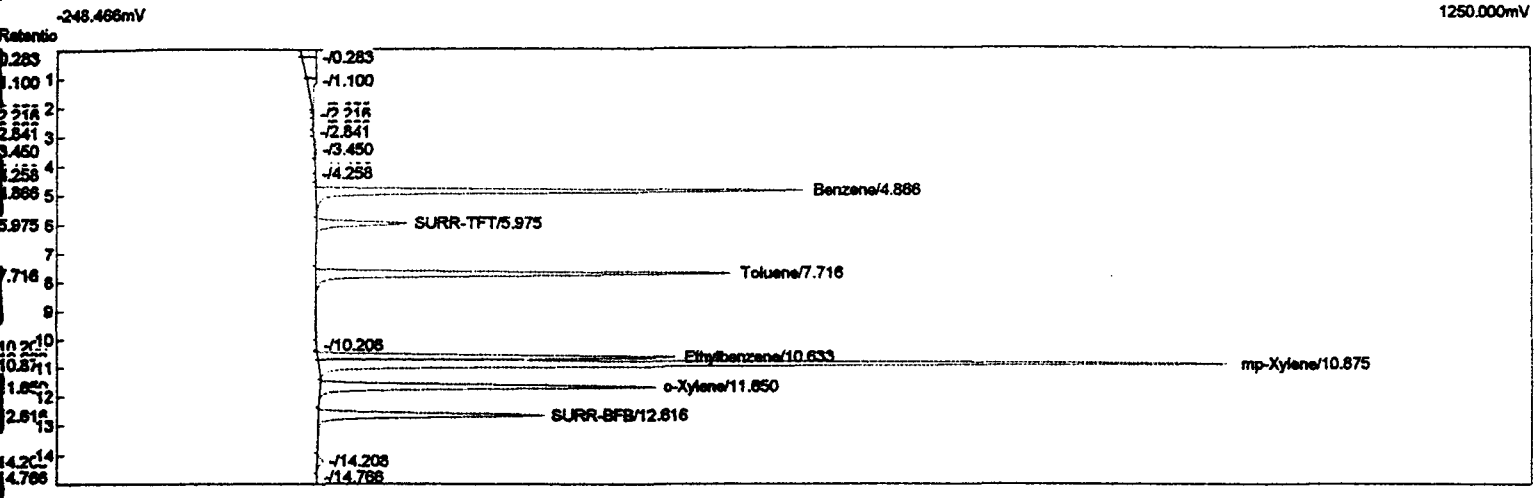
Retention	Component	Number	Area	External	Internal	Units
4.816	Benzene	1	4015.160	50.09	50.0893	ppb
5.916	SURR-TFT	2	841.153	9.77	9.7661	ppb
7.650	Toluene	3	3846.044	50.14	50.1440	ppb
10.566	Ethylbenzene	4	3366.009	52.73	52.7257	ppb
10.808	mp-Xylene	5	9327.188	117.12	117.1169	ppb
11.583	o-Xylene	6	3376.448	51.91	51.9134	ppb
12.550	SURR-BFB	7	2044.081	10.96	10.9573	ppb
		7	26816.082	342.71	342.7127	

Lab name: TEG Puerto Rico
Analysis date: 01/04/1999 15:41:05
Method: EPA 8021 Mod.
Lab ID: GC-3
Description: PID, GC-3, P&T
Column: RTX-5 (30x.53x5)
Carrier: N2, 15mL/min
Data file: 0104p11.CHR ()
Sample: METHOD BLANK
Operator: JMP



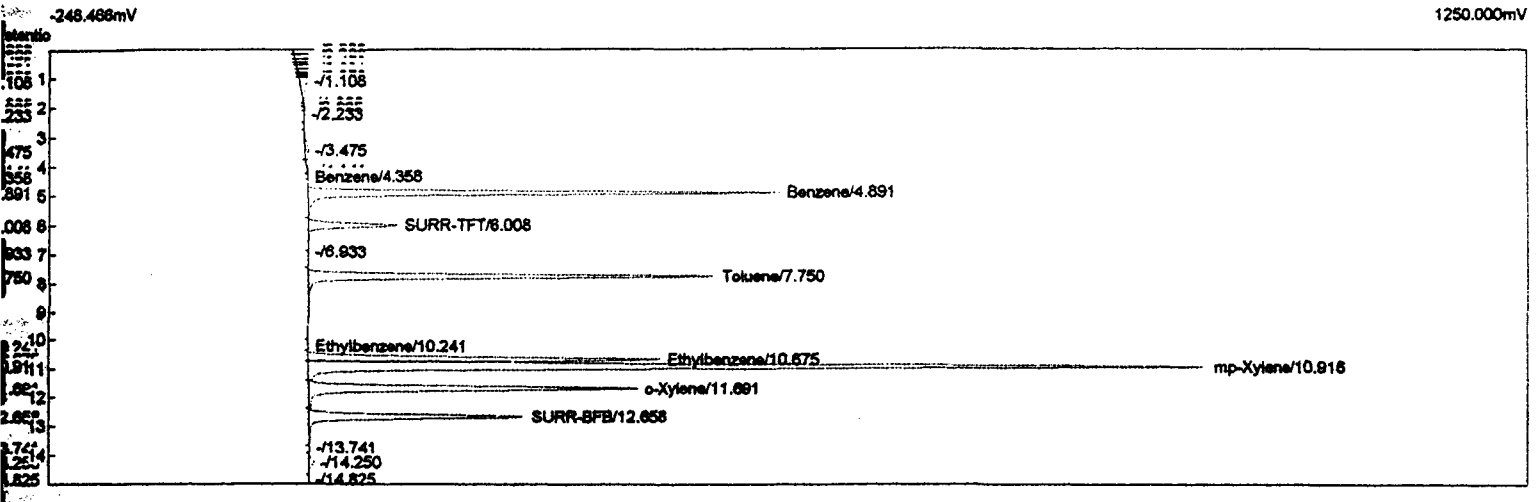
Retention	Component	Number	Area	External	Internal	Units
4.858	Benzene	1	271.270	3.38	3.3841	ppb
5.966	SURR-TFT	2	927.611	10.77	10.7699	ppb
7.708	Toluene	3	117.318	1.53	1.5296	ppb
10.625	Ethylbenzene	4	90.260	1.41	1.4138	ppb
10.866	mp-Xylene	5	247.818	3.11	3.1117	ppb
11.641	o-Xylene	6	111.438	1.71	1.7134	ppb
12.606	SURR-BFB	7	2102.447	11.27	11.2702	ppb
		7	3868.162	33.19	33.1927	

Lab name: TEG Puerto Rico
Analysis date: 01/04/1999 15:14:02
Method: EPA 8021 Mod.
Lab ID: GC-3
Description: PID, GC-3, P&T
Column: RTX-5 (30x.53x5)
Carrier: N2, 15mL/min
Data file: 0104p10.CHR ()
Sample: Matrix Spike Duplicate
Operator: JMP



Retention	Component	Number	Area	External	Internal	Units
4.866	Benzene	1	4224.787	52.70	52.7044	ppb
5.975	SURR-TFT	2	932.058	10.82	10.8215	ppb
7.716	Toluene	3	4109.879	53.58	53.5838	ppb
10.633	Ethylbenzene	4	3391.731	53.13	53.1286	ppb
10.875	mp-Xylene	5	9524.671	119.60	119.5966	ppb
11.650	o-Xylene	6	3512.701	54.01	54.0083	ppb
12.616	SURR-BFB	7	2353.504	12.62	12.6159	ppb
		7	28049.330	356.46	356.4592	

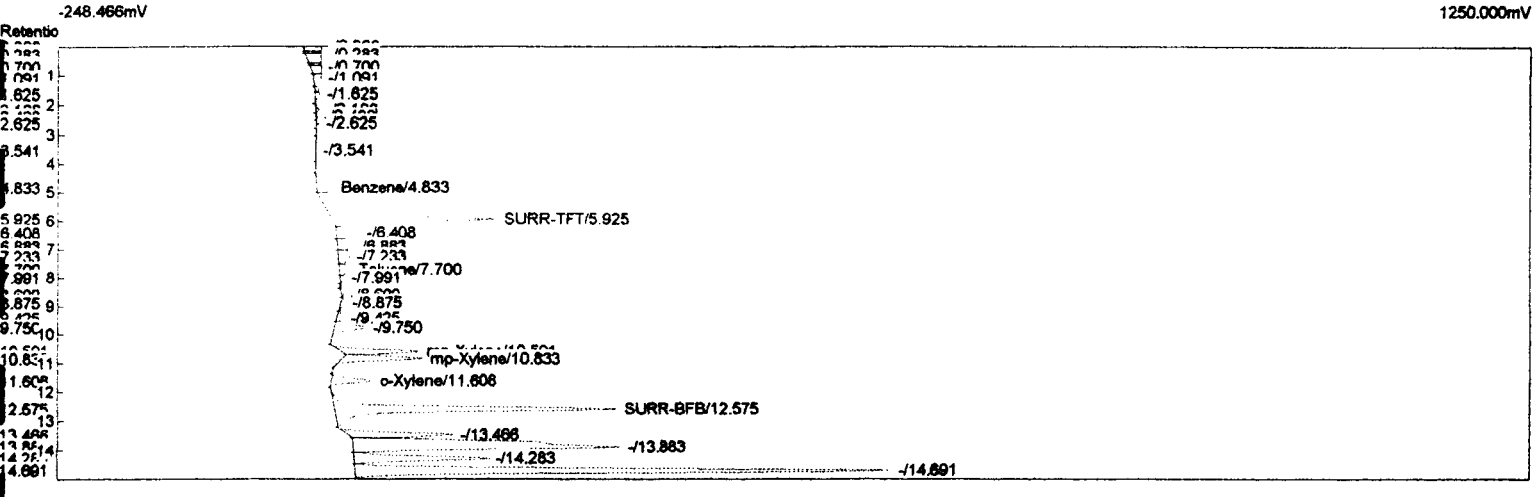
Lab name: TEG Puerto Rico
Analysis date: 01/04/1999 14:13:01
Method: EPA 8021 Mod.
Lab ID: GC-3
Description: PID, GC-3, P&T
Column: RTX-5 (30x.53x5)
Carrier: N2, 15mL/min
Data file: 0104p8.CHR ()
Sample: Matrix Spike
Operator: JMP



Retention	Component	Number	Area	External	Internal	Units
~~4.358~~	~~Benzene~~	~~1~~	~~1.673~~	~~0.02~~	~~0.0209~~	~~ppb~~
4.891	Benzene	1	4155.987	51.85	51.8461	ppb
6.008	SURR-TFT	2	920.021	10.68	10.6818	ppb
7.750	Toluene	3	4033.380	52.59	52.5864	ppb
~~10.241~~	~~Ethylbenzene~~	~~4~~	~~7.605~~	~~0.12~~	~~0.1223~~	~~ppb~~
10.675	Ethylbenzene	4	3306.909	51.80	51.8000	ppb
10.916	mp-Xylene	5	9542.231	119.82	119.8171	ppb
11.691	o-Xylene	6	3599.720	55.35	55.3462	ppb
12.658	SURR-BFB	7	2350.557	12.60	12.6001	ppb
		9	27918.283	354.82	354.8209	

JMP

Lab name: TEG Puerto Rico
Analysis date: 01/05/1999 12:42:12
Method: EPA 8021 Mod.
Lab ID: GC-3
Description: PID, GC-3, P&T
Column: RTX-5 (30x.53x5)
Carrier: N2, 15mL/min
Data file: 0104p27.CHR ()
Sample: DRUMS/1222MAN
Operator: JMP



Retention	Component	Number	Area	External	Internal	Units	
4.833	Benzene	1	352.643	4.40	4.3992	ppb	– < 5
5.925	SURR-TFT	2	2161.241	25.09	25.0928	ppb	
7.700	Toluene	3	198.278	2.59	2.5851	ppb	— < 5
0.000	Ethylbenzene	4	0.000	0.00	0.0000	ppb	
~~10.591~~	~~mp-Xylene~~	~~5~~	~~708.424~~	~~8.00~~	~~8.8953~~	~~ppb~~	
10.833	mp-Xylene	5	776.280	9.75	9.7474	ppb	> 16.38
11.608	o-Xylene	6	431.194	6.63	6.6297	ppb	
12.575	SURR-BFB	7	3476.573	18.64	18.6361	ppb	
		7	8104.633	75.99	75.9856		

KB

RECRA LabNet Use Only

Custody Transfer Record/Lab Work Request

RECRA LabNet

Client: [illegible]
Est. Final Proj. Sampling Date: [illegible]
Project #: [illegible]
Project Contact/Phone #: [illegible]
RECRA Project Manager: [illegible]
QC: [illegible] Del: [illegible] TAT: [illegible]

Date Rec'd _____ Date Due _____
Account # _____

Refrigerator #																			
#/Type Container	Liquid																		
	Solid																		
Volume	Liquid																		
	Solid																		
Preservatives																			
ANALYSES REQUESTED		ORGANIC								INORG									
		VOA	BNA	Pest/ PCB	Herb					Metal	CN								
		RECRA LabNet Use Only																	
		TCLP benzene																	

MATRIX CODES:
S - Soil
SE - Sediment
SO - Solid
SL - Sludge
W - Water
O - Oil
A - Air
DS - Drum Solids
DL - Drum Liquid
WI - Wipe
X - Other
F - Filter

Lab ID	Client ID/Description	Matrix QC Chosen (✓) MS	MSD	Matrix	Date Collected	Time Collected
	DRUM [illegible]			[illegible]	12-9-96	[illegible]

FIELD PERSONNEL: COMPLETE ONLY SHADED AREAS

Special Instructions:

Call Ron Adams for turnaround time
703-814-8363

DATE/REVISIONS:
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Relinquished by	Received by	Date	Time
CFA 12-10			

Relinquished by	Received by	Date	Time

RECRA LabNet Use Only

Samples were:
1) Shipped ___ or Hand Delivered ___
Airbill # _____
2) Ambient or Chilled
3) Received in Good Condition Y or N
4) Labels Indicate Properly Preserved Y or N
5) Received Within Holding Times Y or N

COC Tape was:
1) Present on Outer Package Y or N
2) Unbroken on Outer Package Y or N
3) Present on Sample Y or N
4) Unbroken on Sample Y or N

COC Record Present Upon Sample Rec't Y or N

Discrepancies Between Samples Lables and COC Record? Y or N
NOTES:

FINAL

APPENDIX D

PURGE WATER ANALYTICAL RESULTS

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

AW-1

Lab Name: STL CHICAGO Contract:

Lab Code: Case No.: SAS No.: SDG No.: U01818

Matrix: (soil/water) WATER Lab Sample ID: 9901G818-002

Sample wt/vol: 25.00 (g/mL) ML Lab File ID: FPH14

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/19/99

Column: (pack/cap) CAP Dilution Factor: 2.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene	2	
108-88-3	Toluene	1	U
100-41-4	Ethylbenzene	1	
136777-612	p,m-Xylene	2	
1330-20-7	Xylene (total)	6	
95-47-6	o-Xylene	4	

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

AW-2

Lab Name: STL CHICAGO Contract:

Lab Code: Case No.: SAS No.: SDG No.: U01818

Matrix: (soil/water) WATER Lab Sample ID: 9901G818-006

Sample wt/vol: 25.00 (g/mL) ML Lab File ID: FPH07

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/18/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene	9	
108-88-3	Toluene	4	
100-41-4	Ethylbenzene	37	
136777-612	p,m-Xylene	24	
1330-20-7	Xylene (total)	45	
95-47-6	o-Xylene	20	

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

MTMW-1

Lab Name: STL CHICAGO Contract:

Lab Code: Case No.: SAS No.: SDG No.: U01818

Matrix: (soil/water) WATER Lab Sample ID: 9901G818-001

Sample wt/vol: 25.00 (g/mL) ML Lab File ID: FPH02

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/18/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene	3	
108-88-3	Toluene	2	
100-41-4	Ethylbenzene	20	
136777-612	p,m-Xylene	20	
1330-20-7	Xylene (total)	34	
95-47-6	o-Xylene	13	

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

MTMW-2

Lab Name: STL CHICAGO Contract:

Lab Code: Case No.: SAS No.: SDG No.: U01818

Matrix: (soil/water) WATER Lab Sample ID: 9901G818-008

Sample wt/vol: 25.00 (g/mL) ML Lab File ID: FPH09

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/19/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene	40	
108-88-3	Toluene	10	
100-41-4	Ethylbenzene	57	
136777-612	p,m-Xylene	20	
1330-20-7	Xylene (total)	50	
95-47-6	o-Xylene	29	

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

MTMW-3

Lab Name: STL CHICAGO Contract:

Lab Code: Case No.: SAS No.: SDG No.: U01818

Matrix: (soil/water) WATER Lab Sample ID: 9901G818-005

Sample wt/vol: 25.00 (g/mL) ML Lab File ID: FPH15

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/19/99

Column: (pack/cap) CAP Dilution Factor: 2.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene	1	U
108-88-3	Toluene	1	U
100-41-4	Ethylbenzene	1	
136777-612	p,m-Xylene	2	
1330-20-7	Xylene (total)	5	
95-47-6	o-Xylene	2	

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

MTMW-4

Lab Name: STL CHICAGO Contract:

Lab Code: Case No.: SAS No.: SDG No.: U01818

Matrix: (soil/water) WATER Lab Sample ID: 9901G818-007

Sample wt/vol: 25.00 (g/mL) ML Lab File ID: FPH08

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/18/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene	44	
108-88-3	Toluene	16	
100-41-4	Ethylbenzene	69	
136777-612	p,m-Xylene	46	
1330-20-7	Xylene (total)	95	
95-47-6	o-Xylene	46	

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

RW-1

Lab Name: STL CHICAGO Contract:

Lab Code: Case No.: SAS No.: SDG No.: U01818

Matrix: (soil/water) WATER Lab Sample ID: 9901G818-004

Sample wt/vol: 25.00 (g/mL) ML Lab File ID: FPH05

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/18/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene	2	U
108-88-3	Toluene	2	U
100-41-4	Ethylbenzene	7	
136777-612	p,m-Xylene	4	
1330-20-7	Xylene (total)	9	
95-47-6	o-Xylene	4	

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

UGW-3

Lab Name: STL CHICAGO Contract:

Lab Code: Case No.: SAS No.: SDG No.: U01818

Matrix: (soil/water) WATER Lab Sample ID: 9901G818-003

Sample wt/vol: 25.00 (g/mL) ML Lab File ID: FPH04

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/18/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene	7	
108-88-3	Toluene	2	U
100-41-4	Ethylbenzene	17	
136777-612	p,m-Xylene	7	
1330-20-7	Xylene (total)	12	
95-47-6	o-Xylene	4	

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

UGW-14

Lab Name: STL CHICAGO Contract:

Lab Code: Case No.: SAS No.: SDG No.: U01818

Matrix: (soil/water) WATER Lab Sample ID: 9901G818-009

Sample wt/vol: 25.00 (g/mL) ML Lab File ID: FPH10

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/19/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene	2	U
108-88-3	Toluene	2	U
100-41-4	Ethylbenzene	2	U
136777-612	p,m-Xylene	2	U
1330-20-7	Xylene (total)	2	U
95-47-6	o-Xylene	2	U

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

UGW-25

Lab Name: STL CHICAGO Contract:

Lab Code: Case No.: SAS No.: SDG No.: U01818

Matrix: (soil/water) WATER Lab Sample ID: 9901G818-010

Sample wt/vol: 25.00 (g/mL) ML Lab File ID: FPH11

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/19/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene	10	
108-88-3	Toluene	2	U
100-41-4	Ethylbenzene	10	
136777-612	p,m-Xylene	44	
1330-20-7	Xylene (total)	56	
95-47-6	o-Xylene	11	

GC VOLATILES SHEET

CLIENT SAMPLE NO.

AW-1

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-002

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: AC947858

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/12/99

Column: (pack/cap) CAP Dilution Factor: 1.0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		
86290-81-5	Gasoline Range Organics	640	Y

12/88 Rev.

GC VOLATILES SHEET

CLIENT SAMPLE NO.

AW-2

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-006

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: AC947957

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. Date Analyzed: 01/12/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		
86290-81-5	Gasoline Range Organics	1700	Y

12/88 Rev.

GC VOLATILES SHEET

CLIENT SAMPLE NO.

MTMW-1

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-001

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: AC947838

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. ____ Date Analyzed: 01/12/99

Column: (pack/cap) CAP Dilution Factor: 2.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	
86290-81-5	Gasoline Range Organics	1400	Y

12/88 Rev.

GC VOLATILES SHEET

CLIENT SAMPLE NO.

MTMW-2

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-008

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: AC947993

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. ____ Date Analyzed: 01/12/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		
86290-81-5	Gasoline Range Organics	1900	Y

12/88 Rev.

GC VOLATILES SHEET

CLIENT SAMPLE NO.

MTMW-3

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-005

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: AC947937

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/12/99

Column: (pack/cap) CAP Dilution Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	
86290-81-5	Gasoline Range Organics	760	Y

12/88 Rev.

GC VOLATILES SHEET

CLIENT SAMPLE NO.

MTMW-4

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-007

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: AC947979

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/12/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		
86290-81-5------	Gasoline Range Organics	2600	Y

12/88 Rev.

GC VOLATILES SHEET

CLIENT SAMPLE NO.

RW-1

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-004

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: AD948300

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. ____ Date Analyzed: 01/13/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		
86290-81-5	Gasoline Range Organics	2900	Y

12/88 Rev.

GC VOLATILES SHEET

CLIENT SAMPLE NO.

UGW-3

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-003

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: AC947890

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/12/99

Column: (pack/cap) CAP Dilution Factor: 2.0

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		
86290-81-5	Gasoline Range Organics	550	Y

12/88 Rev.

GC VOLATILES SHEET

CLIENT SAMPLE NO.

UGW-14

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-009

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: AD948290

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/13/99

Column: (pack/cap) CAP Dilution Factor: 5.0

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		
86290-81-5	Gasoline Range Organics	1300	Y

12/88 Rev.

GC VOLATILES SHEET

CLIENT SAMPLE NO.

UGW-25

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-010

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: AD948271

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ Date Analyzed: 01/13/99

Column: (pack/cap) CAP Dilution Factor: 250

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		
86290-81-5	Gasoline Range Organics	220000	Y

12/88 Rev.

1D
ORGANICS ANALYSIS SHEET

CLIENT SAMPLE NO.

AW-1

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-002

Sample wt/vol: 1000 (g/mL) ML Lab File ID: 01149910.49

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ dec. Date Extracted: 01/12/99

Extraction: (SepF/Cont/Sonc) CONT Date Analyzed: 01/16/99

GPC Cleanup: (Y/N) N pH: 7.0 Dilution Factor: 0.50

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/L	
68334-30-5	Diesel Range Organics	0.96	Y

FORM 1 GC-1 12/88 Rev.

1D
ORGANICS ANALYSIS SHEET

CLIENT SAMPLE NO.

AW-2

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-006

Sample wt/vol: 1050 (g/mL) ML Lab File ID: 01149910.53

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ dec. Date Extracted: 01/12/99

Extraction: (SepF/Cont/Sonc) CONT Date Analyzed: 01/16/99

GPC Cleanup: (Y/N) N pH: 7.0 Dilution Factor: 0.50

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/L	
68334-30-5	Diesel Range Organics	3.6	Y

FORM 1 GC-1 12/88 Rev.

1D
ORGANICS ANALYSIS SHEET

CLIENT SAMPLE NO.

MTMW-1

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-001

Sample wt/vol: 1050 (g/mL) ML Lab File ID: 01149910.48

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ dec. Date Extracted: 01/12/99

Extraction: (SepF/Cont/Sonc) CONT Date Analyzed: 01/16/99

GPC Cleanup: (Y/N) N pH: 7.0 Dilution Factor: 0.50

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/L	
68334-30-5	Diesel Range Organics	2.0	Y

FORM 1 GC-1 12/88 Rev.

1D
ORGANICS ANALYSIS SHEET

CLIENT SAMPLE NO.

MTMW-2

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-008

Sample wt/vol: 1050 (g/mL) ML Lab File ID: 01149910.55

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ dec. Date Extracted: 01/12/99

Extraction: (SepF/Cont/Sonc) CONT Date Analyzed: 01/16/99

GPC Cleanup: (Y/N) N pH: 7.0 Dilution Factor: 0.50

CONCENTRATION UNITS: (ug/L or ug/Kg) MG/L

CAS NO.	COMPOUND		
68334-30-5	Diesel Range Organics	3.1	Y

FORM 1 GC-1 12/88 Rev.

1D
ORGANICS ANALYSIS SHEET

CLIENT SAMPLE NO.

MTMW-3

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-005

Sample wt/vol: 1050 (g/mL) ML Lab File ID: 01149910.52

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ dec. Date Extracted: 01/12/99

Extraction: (SepF/Cont/Sonc) CONT Date Analyzed: 01/16/99

GPC Cleanup: (Y/N) N pH: 8.0 Dilution Factor: 0.50

CONCENTRATION UNITS:
(ug/L or ug/Kg) MG/L

CAS NO.	COMPOUND		
68334-30-5	Diesel Range Organics	2.3	Y

FORM 1 GC-1 12/88 Rev.

1D
ORGANICS ANALYSIS SHEET

CLIENT SAMPLE NO.

MTMW-4

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-007

Sample wt/vol: 1050 (g/mL) ML Lab File ID: 01149910.54

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ dec. Date Extracted: 01/12/99

Extraction: (SepF/Cont/Sonc) CONT Date Analyzed: 01/16/99

GPC Cleanup: (Y/N) N pH: 7.0 Dilution Factor: 0.50

CONCENTRATION UNITS:
(ug/L or ug/Kg) MG/L

CAS NO.	COMPOUND		
68334-30-5	Diesel Range Organics	3.7	Y

FORM 1 GC-1 12/88 Rev.

1D
ORGANICS ANALYSIS SHEET

CLIENT SAMPLE NO.

RW-1

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-004

Sample wt/vol: 1060 (g/mL) ML Lab File ID: 01149910.51

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ dec. Date Extracted: 01/12/99

Extraction: (SepF/Cont/Sonc) CONT Date Analyzed: 01/16/99

GPC Cleanup: (Y/N) N pH: 7.0 Dilution Factor: 0.50

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/L	
68334-30-5	Diesel Range Organics	4.7	Y

FORM I GC-1 12/88 Rev.

1D
ORGANICS ANALYSIS SHEET

CLIENT SAMPLE NO.

UGW-3

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-003

Sample wt/vol: 1050 (g/mL) ML Lab File ID: 01149910.50

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ dec. Date Extracted: 01/12/99

Extraction: (SepF/Cont/Sonc) CONT Date Analyzed: 01/16/99

GPC Cleanup: (Y/N) N pH: 7.0 Dilution Factor: 0.50

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/L	
68334-30-5	Diesel Range Organics	3.8	Y

FORM 1 GC-1 12/88 Rev.

1D
ORGANICS ANALYSIS SHEET

CLIENT SAMPLE NO.

UGW-14

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-009

Sample wt/vol: 1000 (g/mL) ML Lab File ID: 01149910.72

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ dec. Date Extracted: 01/12/99

Extraction: (SepF/Cont/Sonc) CONT Date Analyzed: 01/18/99

GPC Cleanup: (Y/N) N pH: 7.0 Dilution Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/L	
68334-30-5	Diesel Range Organics	5.8	Y

FORM 1 GC-1 12/88 Rev.

1D
ORGANICS ANALYSIS SHEET

CLIENT SAMPLE NO.

UGW-25

Lab Name: STL Chicago Work Order: 00000-000-000-0

Client: Tow Way Fuel Farm

Matrix: WATER Lab Sample ID: 9901G818-010

Sample wt/vol: 1060 (g/mL) ML Lab File ID: 01149910.73

Level: (low/med) LOW Date Received: 01/08/99

% Moisture: not dec. _____ dec. Date Extracted: 01/12/99

Extraction: (SepF/Cont/Sonc) CONT Date Analyzed: 01/18/99

GPC Cleanup: (Y/N) N pH: 7.0 Dilution Factor: 50

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/L	
68334-30-5	Diesel Range Organics	360	Y

FORM 1 GC-1 12/88 Rev.

U.S. EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

AW-1

Lab Name: STL_CHICAGO_____ Contract: _____

Lab Code: STL___ Case No.: _____ SAS No.: _____ SDG No.: U01818

Matrix (soil/water): WATER Lab Sample ID: 9901G818-002

Level (low/med): LOW__ Date Received: 01/08/99

% Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_				NR
7440-36-0	Antimony_				NR
7440-38-2	Arsenic__				NR
7440-39-3	Barium___				NR
7440-41-7	Beryllium				NR
7440-43-9	Cadmium__				NR
7440-70-2	Calcium__				NR
7440-47-3	Chromium_				NR
7440-48-4	Cobalt___				NR
7440-50-8	Copper___				NR
7439-89-6	Iron_____	5030			P_
7439-92-1	Lead_____	1.3	U		P_
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury__				NR
7440-02-0	Nickel___				NR
7440-09-7	Potassium				NR
7782-49-2	Selenium_				NR
7440-22-4	Silver___				NR
7440-23-5	Sodium___				NR
7440-28-0	Thallium_				NR
7440-62-2	Vanadium_				NR
7440-66-6	Zinc_____				NR
	Cyanide__				NR

Color Before: BROWN____ Clarity Before: CLOUDY Texture: _____

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

FORM I - IN ILM04.0

U.S. EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

AW-2

Lab Name: STL_CHICAGO_____ Contract: _____

Lab Code: STL___ Case No.: _____ SAS No.: _____ SDG No.: U01818

Matrix (soil/water): WATER Lab Sample ID: 9901G818-006

Level (low/med): LOW__ Date Received: 01/08/99

% Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_				NR
7440-36-0	Antimony_				NR
7440-38-2	Arsenic__				NR
7440-39-3	Barium___				NR
7440-41-7	Beryllium				NR
7440-43-9	Cadmium__				NR
7440-70-2	Calcium__				NR
7440-47-3	Chromium_				NR
7440-48-4	Cobalt___				NR
7440-50-8	Copper___				NR
7439-89-6	Iron_____	23900			P_
7439-92-1	Lead_____	2.9	B		P_
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury__				NR
7440-02-0	Nickel___				NR
7440-09-7	Potassium				NR
7782-49-2	Selenium_				NR
7440-22-4	Silver___				NR
7440-23-5	Sodium___				NR
7440-28-0	Thallium_				NR
7440-62-2	Vanadium_				NR
7440-66-6	Zinc_____				NR
	Cyanide__				NR

Color Before: BROWN____ Clarity Before: CLOUDY Texture: _____

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

FORM I - IN ILM04.0

U.S. EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MTMW-1

Lab Name: STL_CHICAGO_____ Contract: _____

Lab Code: STL___ Case No.: _____ SAS No.: _____ SDG No.: U01818

Matrix (soil/water): WATER Lab Sample ID: 9901G818-001

Level (low/med): LOW__ Date Received: 01/08/99

% Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_				NR
7440-36-0	Antimony_				NR
7440-38-2	Arsenic__				NR
7440-39-3	Barium___				NR
7440-41-7	Beryllium				NR
7440-43-9	Cadmium__				NR
7440-70-2	Calcium__				NR
7440-47-3	Chromium_				NR
7440-48-4	Cobalt___				NR
7440-50-8	Copper___				NR
7439-89-6	Iron_____	7140			P_
7439-92-1	Lead_____	1.3	U		P_
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury__				NR
7440-02-0	Nickel___				NR
7440-09-7	Potassium				NR
7782-49-2	Selenium_				NR
7440-22-4	Silver___				NR
7440-23-5	Sodium___				NR
7440-28-0	Thallium_				NR
7440-62-2	Vanadium_				NR
7440-66-6	Zinc_____				NR
	Cyanide__				NR

Color Before: BROWN____ Clarity Before: CLOUDY Texture: _____

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

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U.S. EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MTMW-2

Lab Name: STL_CHICAGO Contract: _____

Lab Code: STL___ Case No.: _____ SAS No.: _____ SDG No.: U01818

Matrix (soil/water): WATER Lab Sample ID: 9901G818-008

Level (low/med): LOW__ Date Received: 01/08/99

% Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_				NR
7440-36-0	Antimony_				NR
7440-38-2	Arsenic__				NR
7440-39-3	Barium___				NR
7440-41-7	Beryllium				NR
7440-43-9	Cadmium__				NR
7440-70-2	Calcium__				NR
7440-47-3	Chromium_				NR
7440-48-4	Cobalt___				NR
7440-50-8	Copper___				NR
7439-89-6	Iron____	12700			P_
7439-92-1	Lead____	1.3	U		P_
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury__				NR
7440-02-0	Nickel___				NR
7440-09-7	Potassium				NR
7782-49-2	Selenium_				NR
7440-22-4	Silver___				NR
7440-23-5	Sodium___				NR
7440-28-0	Thallium_				NR
7440-62-2	Vanadium_				NR
7440-66-6	Zinc____				NR
	Cyanide__				NR

Color Before: BROWN____ Clarity Before: CLOUDY Texture: _____

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

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1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MTMW-3

Lab Name: STL_CHICAGO_____ Contract: _____

Lab Code: STL___ Case No.: _____ SAS No.: _____ SDG No.: U01818

Matrix (soil/water): WATER Lab Sample ID: 9901G818-005

Level (low/med): LOW__ Date Received: 01/08/99

% Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_				NR
7440-36-0	Antimony_				NR
7440-38-2	Arsenic__				NR
7440-39-3	Barium___				NR
7440-41-7	Beryllium				NR
7440-43-9	Cadmium__				NR
7440-70-2	Calcium__				NR
7440-47-3	Chromium_				NR
7440-48-4	Cobalt___				NR
7440-50-8	Copper___				NR
7439-89-6	Iron_____	90000			P_
7439-92-1	Lead_____	7.1			P_
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury__				NR
7440-02-0	Nickel___				NR
7440-09-7	Potassium				NR
7782-49-2	Selenium_				NR
7440-22-4	Silver___				NR
7440-23-5	Sodium___				NR
7440-28-0	Thallium_				NR
7440-62-2	Vanadium_				NR
7440-66-6	Zinc_____				NR
_____	Cyanide__				NR
_____	_____				

Color Before: BROWN____ Clarity Before: CLOUDY Texture: _____

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

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1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MTMW-4

Lab Name: STL_CHICAGO_____ Contract: _____

Lab Code: STL___ Case No.: _____ SAS No.: _____ SDG No.: U01818

Matrix (soil/water): WATER Lab Sample ID: 9901G818-007

Level (low/med): LOW__ Date Received: 01/08/99

% Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_				NR
7440-36-0	Antimony_				NR
7440-38-2	Arsenic__				NR
7440-39-3	Barium___				NR
7440-41-7	Beryllium				NR
7440-43-9	Cadmium__				NR
7440-70-2	Calcium__				NR
7440-47-3	Chromium_				NR
7440-48-4	Cobalt___				NR
7440-50-8	Copper___				NR
7439-89-6	Iron____	8140			P_
7439-92-1	Lead____	1.4	B		P_
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury__				NR
7440-02-0	Nickel___				NR
7440-09-7	Potassium				NR
7782-49-2	Selenium_				NR
7440-22-4	Silver___				NR
7440-23-5	Sodium___				NR
7440-28-0	Thallium_				NR
7440-62-2	Vanadium_				NR
7440-66-6	Zinc____				NR
	Cyanide__				NR

Color Before: BROWN____ Clarity Before: CLOUDY Texture: _____

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

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1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

RW-1

Lab Name: STL_CHICAGO Contract: _____

Lab Code: STL___ Case No.: _____ SAS No.: _____ SDG No.: U01818

Matrix (soil/water): WATER Lab Sample ID: 9901G818-004

Level (low/med): LOW__ Date Received: 01/08/99

% Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_				NR
7440-36-0	Antimony_				NR
7440-38-2	Arsenic__				NR
7440-39-3	Barium___				NR
7440-41-7	Beryllium				NR
7440-43-9	Cadmium__				NR
7440-70-2	Calcium__				NR
7440-47-3	Chromium_				NR
7440-48-4	Cobalt___				NR
7440-50-8	Copper___				NR
7439-89-6	Iron____	1910			P_
7439-92-1	Lead____	1.3	U		P_
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury__				NR
7440-02-0	Nickel___				NR
7440-09-7	Potassium				NR
7782-49-2	Selenium_				NR
7440-22-4	Silver___				NR
7440-23-5	Sodium___				NR
7440-28-0	Thallium_				NR
7440-62-2	Vanadium_				NR
7440-66-6	Zinc____				NR
	Cyanide__				NR

Color Before: YELLOW___ Clarity Before: CLOUDY Texture: _____

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

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1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

UGW-3

Lab Name: STL_CHICAGO_____ Contract: _____

Lab Code: STL___ Case No.: _____ SAS No.: _____ SDG No.: U01818

Matrix (soil/water): WATER Lab Sample ID: 9901G818-003

Level (low/med): LOW__ Date Received: 01/08/99

% Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_				NR
7440-36-0	Antimony_				NR
7440-38-2	Arsenic__				NR
7440-39-3	Barium___				NR
7440-41-7	Beryllium				NR
7440-43-9	Cadmium__				NR
7440-70-2	Calcium__				NR
7440-47-3	Chromium_				NR
7440-48-4	Cobalt___				NR
7440-50-8	Copper___				NR
7439-89-6	Iron____	12900			P_
7439-92-1	Lead____	1.3	U		P_
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury__				NR
7440-02-0	Nickel___				NR
7440-09-7	Potassium				NR
7782-49-2	Selenium_				NR
7440-22-4	Silver___				NR
7440-23-5	Sodium___				NR
7440-28-0	Thallium_				NR
7440-62-2	Vanadium_				NR
7440-66-6	Zinc____				NR
	Cyanide__				NR

Color Before: YELLOW___ Clarity Before: CLEAR_ Texture: _____

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

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1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

UGW-14

Lab Name: STL_CHICAGO Contract: _____

Lab Code: STL___ Case No.: _____ SAS No.: _____ SDG No.: U01818

Matrix (soil/water): WATER Lab Sample ID: 9901G818-009

Level (low/med): LOW__ Date Received: 01/08/99

% Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_				NR
7440-36-0	Antimony_				NR
7440-38-2	Arsenic__				NR
7440-39-3	Barium___				NR
7440-41-7	Beryllium				NR
7440-43-9	Cadmium__				NR
7440-70-2	Calcium__				NR
7440-47-3	Chromium_				NR
7440-48-4	Cobalt___				NR
7440-50-8	Copper___				NR
7439-89-6	Iron____	37100			P_
7439-92-1	Lead____	4.8	B		P_
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury__				NR
7440-02-0	Nickel___				NR
7440-09-7	Potassium				NR
7782-49-2	Selenium_				NR
7440-22-4	Silver___				NR
7440-23-5	Sodium___				NR
7440-28-0	Thallium_				NR
7440-62-2	Vanadium_				NR
7440-66-6	Zinc____				NR
	Cyanide__				NR

Color Before: GREY_____ Clarity Before: CLOUDY Texture: _____

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

U.S. EPA - CLP

1
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

UGW-25

Lab Name: STL_CHICAGO_____ Contract: _____

Lab Code: STL___ Case No.: _____ SAS No.: _____ SDG No.: U01818

Matrix (soil/water): WATER Lab Sample ID: 9901G818-010

Level (low/med): LOW__ Date Received: 01/08/99

% Solids: __0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L_

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum_				NR
7440-36-0	Antimony_				NR
7440-38-2	Arsenic__				NR
7440-39-3	Barium___				NR
7440-41-7	Beryllium				NR
7440-43-9	Cadmium__				NR
7440-70-2	Calcium__				NR
7440-47-3	Chromium_				NR
7440-48-4	Cobalt___				NR
7440-50-8	Copper___				NR
7439-89-6	Iron____	2320			P_
7439-92-1	Lead____	1.5	B		P_
7439-95-4	Magnesium				NR
7439-96-5	Manganese				NR
7439-97-6	Mercury__				NR
7440-02-0	Nickel___				NR
7440-09-7	Potassium				NR
7782-49-2	Selenium_				NR
7440-22-4	Silver___				NR
7440-23-5	Sodium___				NR
7440-28-0	Thallium_				NR
7440-62-2	Vanadium_				NR
7440-66-6	Zinc____				NR
_____	Cyanide__				NR

Color Before: COLORLESS Clarity Before: CLEAR_ Texture: _____

Color After: YELLOW___ Clarity After: CLEAR_ Artifacts: _____

Comments:

FORM I - IN ILM04.0

To: **Tow Way Fuel Farm**
14290 Sullyfield Circle
Suite 100
Chantilly, VA 20151

Attn: **Mr. Ron Adams**

Date: Tuesday January 26th, 1999

RE: **AW-1**
Project # 00000-000-000-0000
Lab ID: **9901G818-002**
Sample Date: 01/06/99
Date Received: 01/08/99

Inorganic Data Report

Parameters	Result	Units	Reporting Limit
Alkalinity	783	mg/L	10.0
Hardness by EDTA	1590	mg/L	5.0
Nitrate, as N	3.3	mg/L	0.50
Sulfate	238	mg/L	50.0
Total Dissolved Solids	4800	mg/L	10

To: **Tow Way Fuel Farm**
14290 Sullyfield Circle
Suite 100
Chantilly, VA 20151

Attn: **Mr. Ron Adams**

Date: Tuesday January 26th, 1999

RE: **AW-2**
Project # 00000-000-000-0000
Lab ID: **9901G818-006**
Sample Date: 01/06/99
Date Received: 01/08/99

Inorganic Data Report

Parameters	Result		Units	Reporting Limit
Alkalinity	609		mg/L	10.0
Hardness by EDTA	342		mg/L	5.0
Nitrate, as N	0.10	u	mg/L	0.10
Sulfate	43.0		mg/L	10.0
Total Dissolved Solids	1600		mg/L	10

To: **Tow Way Fuel Farm**
14290 Sullyfield Circle
Suite 100
Chantilly, VA 20151

Attn: **Mr. Ron Adams**

Date: Tuesday January 26th, 1999

RE: **MTMW-1**
Project # 00000-000-000-0000
Lab ID: **9901G818-001**
Sample Date: 01/06/99
Date Received: 01/08/99

Inorganic Data Report

Parameters	Result	Units	Reporting Limit
Alkalinity	767	mg/L	10.0
Hardness by EDTA	1920	mg/L	5.0
Nitrate, as N	6.5	mg/L	0.50
Sulfate	320	mg/L	50.0
Total Dissolved Solids	5600	mg/L	10

To: **Tow Way Fuel Farm**
14290 Sullyfield Circle
Suite 100
Chantilly, VA 20151

Attn: **Mr. Ron Adams**

Date: Tuesday January 26th, 1999

RE: **MTMW-2**
Project # 00000-000-000-0000
Lab ID: **9901G818-008**
Sample Date: 01/07/99
Date Received: 01/08/99

Inorganic Data Report

Parameters	Result		Units	Reporting Limit
Alkalinity	700		mg/L	10.0
Hardness by EDTA	1820		mg/L	5.0
Nitrate, as N	0.10	u	mg/L	0.10
Sulfate	152		mg/L	25.0
Total Dissolved Solids	5300		mg/L	10

To: **Tow Way Fuel Farm**
14290 Sullyfield Circle
Suite 100
Chantilly, VA 20151

Attn: **Mr. Ron Adams**

Date: Tuesday January 26th, 1999

RE: **MTMW-3**
Project # 00000-000-000-0000
Lab ID: **9901G818-005**
Sample Date: 01/06/99
Date Received: 01/08/99

Inorganic Data Report

Parameters	Result	Units	Reporting Limit
Alkalinity	716	mg/L	10.0
Hardness by EDTA	1650	mg/L	5.0
Nitrate, as N	12.2	mg/L	1.0
Sulfate	287	mg/L	50.0
Total Dissolved Solids	4200	mg/L	10

To: **Tow Way Fuel Farm**
14290 Sullyfield Circle
Suite 100
Chantilly, VA 20151

Attn: **Mr. Ron Adams**

Date: Tuesday January 26th, 1999

RE: **MTMW-4**
Project # 00000-000-000-0000
Lab ID: **9901G818-007**
Sample Date: 01/06/99
Date Received: 01/08/99

Inorganic Data Report

Parameters	Result		Units	Reporting Limit
Alkalinity	767		mg/L	10.0
Hardness by EDTA	1430		mg/L	5.0
Nitrate, as N	0.10	u	mg/L	0.10
Sulfate	77.2		mg/L	25.0
Total Dissolved Solids	4300		mg/L	10

To: **Tow Way Fuel Farm**
14290 Sullyfield Circle
Suite 100
Chantilly, VA 20151

Attn: **Mr. Ron Adams**

Date: Tuesday January 26th, 1999

RE: **RW-1**
Project # 00000-000-000-0000
Lab ID: **9901G818-004**
Sample Date: 01/06/99
Date Received: 01/08/99

Inorganic Data Report

Parameters	Result		Units	Reporting Limit
Alkalinity	674		mg/L	10.0
Hardness by EDTA	384		mg/L	5.0
Nitrate, as N	0.10	u	mg/L	0.10
Sulfate	21.5		mg/L	5.0
Total Dissolved Solids	1500		mg/L	10

To: **Tow Way Fuel Farm**
14290 Sullyfield Circle
Suite 100
Chantilly, VA 20151

Attn: **Mr. Ron Adams**

Date: Tuesday January 26th, 1999

RE: **UGW-3**
Project # 00000-000-000-0000
Lab ID: **9901G818-003**
Sample Date: 01/06/99
Date Received: 01/08/99

Inorganic Data Report

Parameters	Result	Units	Reporting Limit
Alkalinity	783	mg/L	10.0
Hardness by EDTA	1870	mg/L	5.0
Nitrate, as N	0.95	mg/L	0.10
Sulfate	275	mg/L	50.0
Total Dissolved Solids	5600	mg/L	10

To: **Tow Way Fuel Farm**
14290 Sullyfield Circle
Suite 100
Chantilly, VA 20151

Attn: **Mr. Ron Adams**

Date: Tuesday January 26th, 1999

RE: **UGW-14**
Project # 00000-000-000-0000
Lab ID: **9901G818-009**
Sample Date: 01/07/99
Date Received: 01/08/99

Inorganic Data Report

Parameters	Result	Units	Reporting Limit
Alkalinity	990	mg/L	10.0
Hardness by EDTA	1270	mg/L	5.0
Nitrate, as N	0.14	mg/L	0.10
Sulfate	23.2	mg/L	5.0
Total Dissolved Solids	3900	mg/L	10

To: **Tow Way Fuel Farm**
14290 Sullyfield Circle
Suite 100
Chantilly, VA 20151

Attn: **Mr. Ron Adams**

Date: Tuesday January 26th, 1999

RE: **UGW-25**
Project # 00000-000-000-0000
Lab ID: **9901G818-010**
Sample Date: 01/07/99
Date Received: 01/08/99

Inorganic Data Report

Parameters	Result		Units	Reporting Limit
Alkalinity	998		mg/L	10.0
Hardness by EDTA	310		mg/L	5.0
Nitrate, as N	0.10	u	mg/L	0.10
Sulfate	54.0		mg/L	10.0
Total Dissolved Solids	2200		mg/L	10

APPENDIX E

REFLUX LIQUID ANALYTICAL RESULTS

CARIBBEAN BIORESEARCH, INC.

Environmental & Biological Testing Laboratories

EL RETIRO INDUSTRIAL ZONE

P.O. BOX 325, SAN GERMAN, PUERTO RICO, 00683

TEL.: (787) 892-2630 / 892-2690

FAX: (787) 892-1054

CBI REPORT NO: 71147-01-99 Page 1 of 2

REPORT TO: ENVIRONMENTAL SAMPLING & LAB. SERVICES, INC. Attn.: KEVIN S. SHELBURNE

TEG Project No.: 991012100 MAN

Sample Description: Liquid samples - REFLUX - of January 21, 1999, Four (4) bottles & three (3) vials.

Sample Received: January 22, 1999 Sample Reported: January 28, 1999

PARAMETERS	RESULTS	REGULATORY LIMITS	DETECTION LIMITS
Arsenic (As)	0.058	5.0	0.005
Barium (Ba)	0.404	100.0	0.005
Cadmium (Cd)	0.045	1.0	0.0005
Chromium (Cr)	6.56	5.0	0.50
Lead (Pb)	2.68	5.0	0.50
Mercury (Hg)	0.108	0.2	0.01
Selenium (Se)	0.031	1.0	0.005
Silver (Ag)	0.011	5.0	0.0005

QC DATA

METALS	BATCH NUMBER	CBI SAMPLE NO.	ORIGINAL VALUE (mg/L)	DUPLICATE (mg/L)	SPIKE % Recovery
Arsenic (As)	012899	71147	0.048	0.057	91
Barium (Ba)	012799	71147	0.444	0.461	112
Cadmium (Cd)	012899	71147	0.0036	0.0038	84
Chromium (Cr)	012799	71147	5.08	5.27	79
Lead (Pb)	012799	71147	1.98	2.44	62.1
Mercury (Hg)	012899	71147	0.087	0.088	80
Selenium (Se)	012799	71147	0.028	0.026	88
Silver (Ag)	012899	71147	0.0128	0.0134	116

Notes:
(1) Sampling by Client Representative.
(2) Reference: EPA's SW -846 (third edition).
(3) Results expressed as mg/L of TCLP extract.
(4) TCLP Data may have been adjusted to correct for matrix Spike Recoveries of less than 100%

Analyzed by: HR, LAV Approved by: [signature]

Please see reverse side for explanations and other information.

CARIBBEAN BIORESEARCH, INC.
Environmental & Biological Testing Laboratories
EL ESTERO INDUSTRIAL ZONE
P.O. BOX 325, SAN GERMAN, PUERTO RICO, 00683
TEL.: (787) 892-2650 / 892-2680

CBI REPORT NO: 71147-01-99 Page 2 of 2

REPORT TO: ENVIRONMENTAL SAMPLING & LABORATORY SERVICES
PMB 627, HC 01, BOX 29030
CAGUAS, PUERTO RICO 00725

ATTN: MR. KEVIN SHELBURNE

TEG Project No.: 9910121 MAN

SAMPLE DESCRIPTION: Liquid samples - REFLUX - of January 21, 1999, Four (4) Bottles and Three (3) Vials

Sample Received: January 22, 1999 **Sample Reported:** February 02, 1999

PARAMETER	RESULTS	DETECTION LIMIT
TCLP Benzene	ND	0.01
TOX	ND	200 ppm

Reactivity	Negative
Corrosivity	Negative (pH 3.17 unit)
Ignitability	Negative up to 213 °F

Notes: (1) Sampling by Client Representative.
(2) Reference: EPA's SW-846 (third edition).
(3) Results expressed as mg/L of TCLP extract unless otherwise specified.

Analyzed by: LU LAU AS RS

Approved by:

Please see reverse side for explanations and other information.

teg Transglobal Environmental Geochemistry

Chain of Custody Record

PO # 8207-000

Client: ManTech Env. Corp

Address: 14160-100 Sullyfield Ct

Phone: 703-814-8360 FAX: 703-378-3396

Client Project #: 8207-000 Project Manager: R. Adams

Date: 1/21/99 Page 1 of 1

TEG Project #: 99T0121 MAN Outside Lab.#:

Location: Tow Way, NSRR, Ceiba PR

Collector: B. Pedeteo Date of Collection: 1/21/99

Sample #	Depth	Time	Sample Type	Container Type	VOA 8010	VOA 8020 (BTEX)	VOA 8260	SEMI VOL 8270	TRPH 418.1	TPH 8015 (gasoline)	TPH 8015 (diesel)	TPH 8015 (gas & diesel)	TPH 8015 (oil)	PNA 610/8100	TOTAL LEAD	pH	METALS	RCI	VOA	250ml	1-l amber				FIELD NOTES / PRESERVATION	Total # of Containers
Baseline		1200	W																3	2	2				Client to	
Reflux		1400	W																3	2	2				Call w/	
																									analysis	
																									*Baseline Samples	
																									may have petro	
																									Prod in sample	
																									*Reflux may be	
																									low pH + high	
																									Solids.	

RELINQUISHED BY (signature)	Date/Time	RECEIVED BY (signature)	Date/Time
[signature]	1/21/99 1650	[signature]	1/21/99 4:35
RELINQUISHED BY (signature)	Date/Time	RECEIVED BY (signature)	Date/Time

Total # of containers	14
Chain of Custody seals Y / N / NA	/
Seals intact? Y / N / NA	/
Received good conditions / cold	✓

TEMPERATURE: ice bath

Sample disposal instructions: ____ TEG Disposal @ $2.00 each ____ Return to client ____ Pickup

FINAL

APPENDIX F

WASTE DISPOSAL DOCUMENTATION

EL COQUÍ LANDFILL
A WASTE MANAGEMENT COMP.

Road 3, Int. 923, Bo. Buena Vi
Humacao, PR 00791
Mailing: P.O. Box 594
Caguas, PR 00726-0594
(787) 852-4444
(787) 850-3435/852-4141 Fax

ACKNOWLEDGEMENT OF RECEIPT OF NONHAZARDOUS WASTE

DATE : April 21/99

COMPANY AND LOCATION : Mantech

NAME OF WASTE MATERIAL : Agua de Conducto

AMOUNT OF WASTE MATERIAL : 3 Drums

WPS CODE NUMBER :

HANDLING METHOD :

FACILITY AREA : Humacao

THIS IS TO CERTIFY THAT THE ABOVE NAMED WASTE MATERIAL WAS HANDLED AND DISPOSED SAFELY ACCORDING TO INTERNAL PRACTICES AND ENVIRONMENTAL REGULATIONS.

REPORTED BY COMPLIANCE DEPARTMENT

RELEASED BY: _____
AUTHORIZED SIGNATURE

Daily Report Reference number: 21019
Contractor :

EL COQUÍ LANDFILL
A WASTE MANAGEMENT COMPANY

Road 3, Int. 923, Bo. Buena Vista
Humacao, PR 00791
Mailing: P.O. Box 594
Caguas, PR 00726-0594
(787) 852-4444
(787) 850-3435/852-4141 Fax

ACKNOWLEDGEMENT OF RECEIPT OF NONHAZARDOUS WASTE

DATE : June 30/99

COMPANY AND LOCATION : Montech

NAME OF WASTE MATERIAL :

AMOUNT OF WASTE MATERIAL : 440 lbs

WPS CODE NUMBER :

HANDLING METHOD : solidification

FACILITY AREA : Solidification Area

EL COQUI LANDFILL COMPANY
Aprobado Por:
DEPARTAMENTO DE CUMPLIMIENTO
WASTE MANAGEMENT DE PUERTO RICO

THIS IS TO CERTIFY THAT THE ABOVE NAMED WASTE MATERIAL WAS HANDLED AND DISPOSED SAFELY ACCORDING TO INTERNAL PRACTICES AND ENVIRONMENTAL REGULATIONS.

REPORTED BY COMPLIANCE DEPARTMENT

RELEASED BY: _____
AUTHORIZED SIGNATURE

Daily Report Reference number: 26548
Contractor : Ecwaste

FINAL

APPENDIX G

DATA QUALITY ASSURANCE REVIEW RESULTS INCLUDING SOIL AND GROUNDWATER ANALYTICAL RESULTS

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9904G003
Date:	October 7, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	April 14, 1999
Number of Samples:	6 Aqueous Sample(s) with 1 MS/MSD(s)
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	SW846 Third Edition and USEPA Approved Methodology
Analytical Fractions:	Iron, Lead, Alkalinity, Hardness, Nitrite, Nitrate, Sulfate and Total Dissolved Solids

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Sexton
Paul B. Humburg, President

10-12-99
Date

4127 Plaza 94 South • St. Charles, MO 63304
(636) 936-1332 • Fax (636) 936-1335

SDG# 9904G003

Samples and Fractions Reviewed

Sample Identifications | Analytical Fractions

MANTECH ID	MATRIX	FE		PB		ALK		HARD		NITE		NATE		SUL		TDS	
MTMW-4	WATER	X		X		X		X		X		X		X		X	
MTMW-4 MS	WATER	X		X						X							
MTMW-4 MSD	WATER	X								X							
MTMW-1	WATER	X		X		X		X		X		X		X		X	
MTMW-2	WATER	X		X		X		X		X		X		X		X	
AW-1	WATER	X		X		X		X		X		X		X		X	
AW-2	WATER	X		X		X		X		X		X		X		X	
UGW-3	WATER	X		X		X		X		X		X		X		X	
Total Billable Samples (Water/Soil)		8	0	7	0	6	0	6	0	8	0	6	0	6	0	6	0

FE= Iron
PB= Lead
ALK= Alkalinity
HARD= Hardness
NITE= Nitrite
NATE= Nitrate
SUL= Sulfate
TDS= Total Dissolved Solids

DATA ASSESSMENT NARRATIVE
METALS

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the CLP ILM3.0 Methods; the Functional Guidelines for Inorganic Data Validation, February 1994 with Region II modifications, and DQO NEESA D requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDGs # U4003

A validation was performed on the Metals Data from SDG U4003. The data was evaluated based on the following parameters.

*	●	Data Completeness
*	●	Holding Times
	●	Calibrations
	●	Blanks
*	●	Interferences
*	●	Matrix Spike Recovery
*	●	Matrix Duplicates
*	●	Field Duplicates
*	●	Laboratory Control Samples
*	●	Serial Dilutions

* - All criteria were met for this parameter.

Calibration results

1. The CRDL standard for Iron was below the lower control limits (<80%). All positive and non-detect results below two times the CRDL standard are qualified as estimated, "J" or "UJ". This had no impact on the data.

2. The CRDL standard for Lead for GFAA and ICP were greater than the control limits (>120%). This had no impact on the data.

Preparation and Calibration Blank results

3. The preparation blank contamination for Lead (11.4 ug/l) was greater thna the CRDL. The sample results for MYMW-2 was rejected because it was less than ten times the blank contamination.

GFAA Spiking Recovery results

4. The GFAA spike recoveries for Lead were below the lower control limits (>10% but <85%). All positive and non-detect results are qualified as estimated, "J" or "UJ" for samples MTMW-4, UGW-3, AW-1 and AW-2.

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL
3. MTMW-2	Pb.	+	R
4. MTMW-4, UGW-3, AW-1 and AW-2.	Pb.	+/U	+/U

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9906G954
Date:	September 2, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	June 28 - 29, 1999
Number of Samples:	12 Aqueous Sample(s) with 5 MS/MSD(s) and 1 MS(s)
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	SW846 Third Edition and USEPA Approved Methodology
Analytical Fractions:	Volatiles, BTEX, Gasoline Range Organics, Diesel Range Organics, Iron, Lead, Alkalinity, Hardness, Nitrite, Nitrate, Sulfate and Total Dissolved Solids

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Sewyson
for Paul B. Humburg, President

9-7-99
Date

4127 Plaza 94 South • St. Charles, MO 63304
(636) 936-1332 • Fax (636) 936-1335

SDG# 9906G954

Samples and Fractions Reviewed

Sample Identifications — Analytical Fractions

MANTECH ID	MATRIX	VOA		BTEX		DRO		GRO		FE		PB		ALK		HARD		NITE		NATE		SUL		TDS	
AW-1	WATER			X		X		X		X		X		X		X		X		X		X		X	
AW-1 MS	WATER									X		X													
AW-1 MSD	WATER									X		X													
AW-2	WATER	X				X		X		X		X		X		X		X		X		X		X	
MTMW-1	WATER			X		X		X		X		X		X		X		X		X		X		X	
MTMW-1 MS	WATER																	X		X					
MTMW-1 MSD	WATER																	X		X					
MTMW-2	WATER			X		X		X		X		X		X		X		X		X		X		X	
MTMW-2 MS	WATER																	X							
MTMW-3	WATER			X		X		X		X		X		X		X		X		X		X		X	
MTMW-4	WATER			X		X		X		X		X		X		X		X		X		X		X	
MTMW-4 MS	WATER							X																	
MTMW-4 MSD	WATER							X																	
UGW-3	WATER			X		X		X		X		X		X		X		X		X		X		X	
UGW-14	WATER			X		X		X		X		X		X		X		X		X		X		X	
UGW-14 MS	WATER																					X			
UGW-14 MSD	WATER																					X			
UGW-25	WATER			X		X		X		X		X		X		X		X		X		X		X	
UGW-25 MS	WATER													X										X	
UGW-25 MSD	WATER													X										X	
RW-1	WATER			X		X		X		X		X		X		X		X		X		X		X	
DUP	WATER			X		X		X		X		X		X		X		X		X		X		X	
TBO62399	WATER			X																					
Total Billable Samples (Water/Soil)		1	0	11	0	11	0	13	0	13	0	13	0	13	0	11	0	14	0	13	0	13	0	13	0

VOA= Volatiles
BTEX= BTEX
DRO= Diesel Range Organics
GRO= Gasoline Range Organics
FE= Iron
PB= Lead

ALK= Alkalinity
HARD= Hardness
NITE= Nitrite
NATE= Nitrate
SUL= Sulfate
TDS= Total Dissolved Solids

DATA ASSESSMENT AND NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW846 Method 8260B; the National Functional Guidelines for Organic Data Review, Region II and DQO Level IV. All comments made within this report should be considered when examining the analytical results.

SDG # 9906G954

A validation was performed on the Volatile Data from SDG 9906G954. The data was evaluated based on the following parameters.

* Data Completeness
* Holding Times
* GC/MS Tuning
  Calibrations
* Internal Standard Performance
* Blanks
* Surrogate Recoveries
* Laboratory Control Samples
* Matrix Spike / Matrix Spike Duplicate
* Field Duplicates
* Compound Identification /Quantitation

* - All criteria were met for this parameter

Initial Calibration

The initial calibration, analyzed on 07/09/99, contained compounds with RRFs less than 0.050. For the samples and non-compliant compounds listed below, qualify all positive results as estimated (J) and non detects as rejected (R).

All Samples	acetone
	2-butanone
	2-hexanone

Continuing Calibration

The continuing calibration, OA711, contained compounds with RRFs less than 0.050. For the samples and non-compliant compounds listed below, qualify all positive results as estimated (J) and non detects as rejected (R).

All Samples	acetone
	2-butanone
	4-methyl-2-pentanone
	2-hexanone

System Performance and Overall Assessment

The data as presented requires qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
All Samples	acetone 2-butanone 2-hexanone	+/-	J/R
All Samples	acetone 2-butanone 4-methyl-2-pentanone 2-hexanone	+/-	J/R

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT AND NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW846 Method 8260B; the National Functional Guidelines for Organic Data Review, Region II and DQO Level IV. All comments made within this report should be considered when examining the analytical results.

SDG # 9906G954

A validation was performed on the Volatile Data from SDG 9906G954. The data was evaluated based on the following parameters.

* Data Completeness
* Holding Times
* GC/MS Tuning
* Calibrations
* Internal Standard Performance
* Blanks
* Surrogate Recoveries
* Laboratory Control Samples
* Matrix Spike / Matrix Spike Duplicate
  Field Duplicates
* Compound Identification /Quantitation

* - All criteria were met for this parameter

Field Duplicates

Sample RW-1 and duplicate sample DUP did not exhibit comparable results for benzene, ethylbenzene, p,m-xylene, xylene (total), and o-xylene. Qualify both samples as estimated (J/UJ) for these compounds.

System Performance and Overall Assessment

The data as presented requires qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected.

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
RW-1	benzene	+/-	J/UJ
DUP	ethylbenzene		
	p,m-xylene		
	xylene (total)		
	o-xylene		

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
DIESEL RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015 and the California LUFT Manual; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9906G954

A validation was performed on the Diesel Range Organics Data from SDG 9906G954. The data was evaluated based on the following parameters:

* • Data Completeness
* • Holding Times
* • Calibration
* • Blanks
* • Surrogate Recoveries
* • Matrix Spike/Matrix Spike Duplicates
* • Field Duplicates
* • Compound Identification
* • Compound Quantitation

* - All criteria were met for this parameter.

System Performance and Overall Assessment

The data did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
GASOLINE RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9906G954

A validation was performed on the Gasoline Range Organics Data from SDG 9906G954. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	Calibration
*	•	Blanks
	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

Surrogates

The samples listed below exhibited high 4-Bromofluorobenzene recoveries. For the following samples, the positive results are qualified as estimated, J.

UGW-3
UGW-25

System Performance and Overall Assessment

The data required qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
UGW-3	ALL	+	J
UGW-25			

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
LEAD, IRON AND WET CHEMISTRY

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the CLP ILM 4.0 Methods for metals and SW846 for wet chemistry ; the Functional Guidelines for Inorganic Data Validation, February 1994 with Region II modifications, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDGs # 9906G954

A validation was performed on the wet chemistry, lead and iron Data from SDG 9906G954. The data was evaluated based on the following parameters.

*	●	Data Completeness
*	●	Holding Times
*	●	Calibrations
*	●	Blanks
*	●	Interferences
*	●	Matrix Spike Recovery
	●	Matrix Duplicates
*	●	Field Duplicates
*	●	Laboratory Control Samples
	●	Serial Dilutions

* - All criteria were met for this parameter.

Matrix Duplicate results

The matrix duplicate RPD for waters for Lead (86%) was greater than 20%. All positive results are qualified as estimated, "J".

Serial Dulition results

The serial dilution results for waters for Iron (17.2%) was greater than 10%. All positive results are qualified as estimated, "J".

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL
all water samples	Pb.	+	J
all water samples	Fe.	+	J

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9907G974
Date:	September 2, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	June 29, 1999
Number of Samples:	3 Non-aqueous Sample(s) with 1 MS/MSD(s)
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	SW846 Third Edition and USEPA Approved Methodology
Analytical Fractions:	BTEX, Gasoline Range Organics, Diesel Range Organics, Iron, Lead and Sulfate

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Simpson
for Paul B. Humburg, President

9-7-99
Date

4127 Plaza 94 South • St. Charles, MO 63304
(636) 936-1332 • Fax (636) 936-1335

SDG# 9907G974

Samples and Fractions Reviewed

Sample Identifications | Analytical Fractions

MANTECH ID	MATRIX	BTEX		GRO		DRO		FE		PB		SUL	
AW-1	SOIL		X		X		X		X		X		X
AW-2	SOIL		X		X		X		X		X		X
AW-2 MS	SOIL				X				X		X		
AW-2 MSD	SOIL				X				X		X		
MTMW-4	SOIL		X		X		X		X		X		X
Total Billable Samples (Water/Soil)		0	3	0	5	0	3	0	5	0	5	0	3

BTEX= BTEX
GRO= Gasoline Range Organics
DRO= Diesel Range Organics
FE= Iron
PB= Lead
SUL= Sulfate

DATA ASSESSMENT AND NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW846 Method 8260B; the National Functional Guidelines for Organic Data Review, Region II and DQO Level IV. All comments made within this report should be considered when examining the analytical results.

SDG # 9907G974

A validation was performed on the Volatile Data from SDG 9907G974. The data was evaluated based on the following parameters.

* Data Completeness
  Holding Times
* GC/MS Tuning
* Calibrations
* Internal Standard Performance
* Blanks
  Surrogate Recoveries
* Laboratory Control Samples
* Matrix Spike / Matrix Spike Duplicate
* Field Duplicates
  Compound Identification /Quantitation

* - All criteria were met for this parameter

Holding Times

The following samples exceeded the Region II ten (10) day analysis holding time by three (3) to four (4) days. Qualify the sample results as estimated (J/UJ).

AW-1
AW-2
MTMW-4
MTMW-4DL

Surrogates

Sample MTMW-4 exhibited high surrogate recovery for toluene-d8 and low recovery for p-bromofluorobenzene. Qualify all positive results as estimated (J) and non detected compound results as estimated (UJ).

Compound Identification /Quantitation

Do not use E-flagged compound results for sample MTMW-4, in favor of the D-flagged compound in the dilution.

System Performance and Overall Assessment

The data as presented requires qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
AW-1 AW-2 MTMW-4 MTMW-4DL	all results	+/-	J/UJ
MTMW-4	all results	+/-	J/UJ
MTMW-4	all E-flagged compounds	+	R
MTMW-4DL	all results except D-flagged compounds	+/-	R

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
GASOLINE RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9907G974

A validation was performed on the Gasoline Range Organics Data from SDG 9907G974. The data was evaluated based on the following parameters:

* • Data Completeness
* • Holding Times
* • Calibration
* • Blanks
* • Surrogate Recoveries
* • Matrix Spike/Matrix Spike Duplicates
* • Field Duplicates
* • Compound Identification
* • Compound Quantitation

* - All criteria were met for this parameter.

System Performance and Overall Assessment

The data did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
DIESEL RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015 and the California LUFT Manual; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9907G974

A validation was performed on the Diesel Range Organics Data from SDG 9907G974. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	Calibration
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

System Performance and Overall Assessment

The data did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
LEAD, IRON AND WET CHEMISTRY

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the CLP ILM 4.0 Methods for metals and SW846 for wet chemistry ; the Functional Guidelines for Inorganic Data Validation, February 1994 with Region II modifications, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDGs # 9907G974

A validation was performed on the wet chemistry, lead and iron Data from SDG 9907G974. The data was evaluated based on the following parameters.

*	●	Data Completeness
*	●	Holding Times
*	●	Calibrations
*	●	Blanks
*	●	Interferences
	●	Matrix Spike Recovery
*	●	Matrix Duplicates
*	●	Field Duplicates
*	●	Laboratory Control Samples
*	●	Serial Dilutions

* - All criteria were met for this parameter.

Matrix Spike Recovery results

The matrix spike recovery for soils for Lead (210%) was greater than 200%.. All positive results are rejected, "R".

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL
all soil samples	Pb.	+	R

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9905G559
Date:	September 2, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	April 15 & 27, 1999
Number of Samples:	2 Non-aqueous Sample(s) with 1 MS/MSD(s)
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	USEPA Approved Methodology
Analytical Fractions:	Sulfate

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Searson

Paul B. Humburg, President

9-7-99.

Date

4127 Plaza 94 South • St. Charles, MO 63304
(636) 936-1332 • Fax (636) 936-1335

SDG# 9905G559

Samples and Fractions Reviewed

Sample Identifications Analytical Fraction

MANTECH ID	MATRIX	SUL	
SB MTMW-4	SOIL		X
SBAW-1	SOIL		X
SBAW-1 MS	SOIL		X
SBAW-1 MSD	SOIL		X
Total Billable Samples (Water/Soil)		0	4

SUL= Sulfate

DATA ASSESSMENT NARRATIVE
WET CHEMISTRY

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW846 for wet chemistry ; the Functional Guidelines for Inorganic Data Validation, February 1994 with Region II modifications, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDGs # 9905G559

A validation was performed on the wet chemistry Data from SDG 9905G559. The data was evaluated based on the following parameters.

*	●	Data Completeness
*	●	Holding Times
*	●	Calibrations
*	●	Blanks
*	●	Interferences
*	●	Matrix Spike Recovery
*	●	Matrix Duplicates
*	●	Field Duplicates
*	●	Laboratory Control Samples
*	●	Serial Dilutions

* - All criteria were met for this parameter.

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL

Data stands as reported without qualification.

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9904G172
Date:	September 2, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	April 27, 1999
Number of Samples:	1 Non-aqueous Sample(s) with 1 MS/MSD(s)
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	SW846 Third Edition and USEPA Approved Methodology
Analytical Fractions:	BTEX, Gasoline Range Organics, Diesel Range Organics, Iron, Lead and pH

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

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Craig G. Searson
Paul B. Humburg, President

9-7-99
Date

4127 Plaza 94 South • St. Charles, MO 63304
(636) 936-1332 • Fax (636) 936-1335

SDG# 9904G172

Samples and Fractions Reviewed

Sample Identifications | Analytical Fractions

MANTECH ID	MATRIX	BTEX		GRO		DRO		FE		PB		PH	
SBAW-1	SOIL		X		X		X		X		X		X
SBAW-1 MS	SOIL						X		X		X		
SBAW-1 MSD	SOIL						X		X		X		
Total Billable Samples (Water/Soil)		0	1	0	1	0	3	0	3	0	3	0	1

BTEX= BTEX
GRO= Gasoline Range Organics
DRO= Diesel Range Organics
FE= Iron
PB= Lead
PH= pH

DATA ASSESSMENT AND NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW846 Method 8260B; the National Functional Guidelines for Organic Data Review, Region II and DQO Level IV. All comments made within this report should be considered when examining the analytical results.

SDG # 9904G172

A validation was performed on the Volatile Data from SDG 9904G172. The data was evaluated based on the following parameters.

* Data Completeness
* Holding Times
* GC/MS Tuning
* Calibrations
* Internal Standard Performance
* Blanks
* Surrogate Recoveries
* Laboratory Control Samples
* Matrix Spike / Matrix Spike Duplicate
* Field Duplicates
* Compound Identification /Quantitation

* - All criteria were met for this parameter

System Performance and Overall Assessment

The data as presented requires no qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

No qualifications required.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
GASOLINE RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9904G172

A validation was performed on the Gasoline Range Organics Data from SDG 9904G172. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	Calibration
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

System Performance and Overall Assessment

The data did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
DIESEL RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015 and the California LUFT Manual; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9904G172

A validation was performed on the Diesel Range Organics Data from SDG 9904G172. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	Calibration
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

System Performance and Overall Assessment

The data did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
LEAD, IRON AND WET CHEMISTRY

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the CLP ILM 4.0 Methods for metals and SW846 for wet chemistry ; the Functional Guidelines for Inorganic Data Validation, February 1994 with Region II modifications, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDGs # 9904G172

A validation was performed on the wet chemistry, lead and iron Data from SDG 9904G172. The data was evaluated based on the following parameters.

*	●	Data Completeness
*	●	Holding Times
*	●	Calibrations
*	●	Blanks
*	●	Interferences
*	●	Matrix Spike Recovery
*	●	Matrix Duplicates
*	●	Field Duplicates
*	●	Laboratory Control Samples
*	●	Serial Dilutions

* - All criteria were met for this parameter.

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL

Data stands as reported without qualification.

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9902G402
Date:	September 2, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	February 23 - 24, 1999
Number of Samples:	12 Aqueous Sample(s) with 1 MS/MSD(s)
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	SW846 Third Edition
Analytical Fractions:	BTEX, Gasoline Range Organics, Diesel Range Organics

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

for Craig G. Sewson
Paul B. Humburg, President

9-7-99.
Date

4127 Plaza 94 South • St. Charles, MO 63304
(636) 936-1332 • Fax (636) 936-1335

SDG# 9902G402

Samples and Fractions Reviewed

Sample Identifications Analytical Fractions

MANTECH ID	MATRIX	BTEX		GRO		DRO	
UGW-03	WATER	X		X			
MTMW-01	WATER	X		X			
AW-1	WATER	X		X			
MTMW-2	WATER	X		X			
RW-1	WATER	X		X			
RW-1 MS	WATER			X			
RW-1 MSD	WATER			X			
DUP	WATER	X		X			
MTMW-3	WATER	X		X		X	
AW-2	WATER	X		X		X	
MTMW-4	WATER	X		X		X	
UGW-25	WATER	X		X		X	
UGW-14	WATER	X		X		X	
TRIP	WATER	X		X			
Total Billable Samples (Water/Soil)		12	0	14	0	5	0

BTEX= BTEX
GRO= Gasoline Range Organics
DRO= Diesel Range Organics

DATA ASSESSMENT AND NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW846 Method 8260B; the National Functional Guidelines for Organic Data Review, Region II and DQO Level IV. All comments made within this report should be considered when examining the analytical results.

SDG # 9902G402

A validation was performed on the Volatile Data from SDG 9902G402. The data was evaluated based on the following parameters.

* Data Completeness
* Holding Times
* GC/MS Tuning
* Calibrations
* Internal Standard Performance
* Blanks
* Surrogate Recoveries
* Laboratory Control Samples
* Matrix Spike / Matrix Spike Duplicate
  Field Duplicates
* Compound Identification /Quantitation

* - All criteria were met for this parameter

Field Duplicates

Sample UGW-03 and duplicate sample DUP did not exhibit comparable results for benzene, toluene, p.m-xylene, xylene (total) and o-xylene. Qualify both samples as estimated (J/UJ) for these compounds.

System Performance and Overall Assessment

The data as presented requires qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
UGW-03	benzene	+/-	J/UJ
DUP	toluene		
	p.m-xylene		
	xylene (total)		
	o-xylene		

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
GASOLINE RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9902G402

A validation was performed on the Gasoline Range Organics Data from SDG 9902G402. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	Calibration
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

System Performance and Overall Assessment

The data did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
DIESEL RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015 and the California LUFT Manual; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9902G402

A validation was performed on the Diesel Range Organics Data from SDG 9902G402. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	Calibration
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

System Performance and Overall Assessment

The data did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
\+ in the DL column denotes a positive result
\- in the DL column denotes a non detect result

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9902G345
Date:	September 2, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	February 23, 1999
Number of Samples:	6 Aqueous Sample(s) with 2 MS/MSD(s) and 1 MSD
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	SW846 Third Edition and USEPA Approved Methodology
Analytical Fractions:	Iron, Lead, Alkalinity, Hardness, Nitrite, Nitrate, Sulfate and Total Dissolved Solids

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Sayson
Paul B. Humburg, President

9-7-99.
Date

4127 Plaza 94 South • St. Charles, MO 63304
(636) 936-1332 • Fax (636) 936-1335

SDG# 9902G345

Samples and Fractions Reviewed

Sample Identifications | Analytical Fractions

MANTECH ID	MATRIX	FE		PB		ALK		HARD		NITE		NATE		TDS		SUL	
UGW-03	WATER	X		X		X		X		X		X		X		X	
UGW-03 MS	WATER	X		X						X							
UGW-03 MSD	WATER	X		X		X											
MTMW-1	WATER	X		X		X		X		X		X		X		X	
AW-1	WATER	X		X		X		X		X		X		X		X	
AW-1 MS	WATER									X							
AW-1 MSD	WATER									X							
MTMW-2	WATER	X		X		X		X		X		X		X		X	
MTMW-2 MSD	WATER									X							
RW-1	WATER	X		X		X		X		X		X		X		X	
DUP	WATER	X		X		X		X		X		X		X		X	
Total Billable Samples (Water/Soil)		8	0	8	0	7	0	6	0	10	0	6	0	6	0	6	0

FE= Iron
PB= Lead
ALK= Alkalinity
HARD= Hardness

NITE= Nitrite
NATE= Nitrate
TDS= Total Dissolved Solids
SUL= Sulfate

DATA ASSESSMENT NARRATIVE
LEAD, IRON AND WET CHEMISTRY

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the CLP ILM 4.0 Methods for metals and SW846 for wet chemistry ; the Functional Guidelines for Inorganic Data Validation, February 1994 with Region II modifications, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDGs # 9902G345

A validation was performed on the wet chemistry, lead and iron Data from SDG 9902G345. The data was evaluated based on the following parameters.

*	•	Data Completeness
*	•	Holding Times
*	•	Calibrations
*	•	Blanks
*	•	Interferences
*	•	Matrix Spike Recovery
*	•	Matrix Duplicates
*	•	Field Duplicates
*	•	Laboratory Control Samples
*	•	Serial Dilutions

* - All criteria were met for this parameter.

The matrix spike recovery for Nitrite (138%) was above the upper control limits but had impact on the data (all samples non-detect).

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL

Data stands as reported without qualification.

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9902G369
Date:	September 2, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	February 23 - 24, 1999
Number of Samples:	11 Aqueous Sample(s) with 3 MS/MSD(s)
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	SW846 Third Edition and USEPA Approved Methodology
Analytical Fractions:	Diesel Range Organics, Iron, Lead, Alkalinity, Hardness, Nitrite, Nitrate, Sulfate and Total Dissolved Solids

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Senson — 9-7-99.

Paul B. Humburg, President — Date

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SDG# 9902G369

Samples and Fractions Reviewed

Sample Identifications | Analytical Fractions

MANTECH ID	MATRIX	DRO		FE		PB		ALK		HARD		NITE		NATE		SUL		TDS	
UGW-03	WATER	X																	
MTMW-1	WATER	X																	
AW-1	WATER	X																	
MTMW-2	WATER	X																	
RW-1	WATER	X																	
DUP	WATER	X																	
MTMW-3	WATER			X		X		X		X		X		X		X		X	
AW-2	WATER			X		X		X		X		X		X		X		X	
UGW-14	WATER			X		X		X		X		X		X		X		X	
UGW-14 MS	WATER											X							
UGW-14 MSD	WATER											X							
UGW-25	WATER			X		X		X		X		X		X		X		X	
UGW-25 MS	WATER													X					
UGW-25 MSD	WATER													X					
MTMW-4	WATER			X		X		X		X		X		X		X		X	
MTMW-4 MS	WATER									X									
MTMW-4 MSD	WATER									X									
Total Billable Samples (Water/Soil)		6	0	5	0	5	0	5	0	7	0	7	0	7	0	5	0	5	0

DRO= Diesel Range Organics
FE= Iron
PB= Lead
ALK= Alkalinity
HARD= Hardness

NITE= Nitrite
NATE= Nitrate
SUL= Sulfate
TDS= Total Dissolved Solids

DATA ASSESSMENT NARRATIVE
DIESEL RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015 and the California LUFT Manual; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9902G369

A validation was performed on the Diesel Range Organics Data from SDG 9902G369. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	Calibration
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
	•	Field Duplicates
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

Field Duplicates

The field duplicate pair of samples RW-1 and DUP exhibited a high RPD for one (1) compound and required qualifications. For the following samples and compound, the positive results are qualified as estimated, J.

RW-1	DRO
DUP	

System Performance and Overall Assessment

The data required qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
RW-1 DUP	DRO	+	J

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
LEAD, IRON AND WET CHEMISTRY

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the CLP ILM 4.0 Methods for metals and SW846 for wet chemistry ; the Functional Guidelines for Inorganic Data Validation, February 1994 with Region II modifications, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDGs # 9902G369

A validation was performed on the wet chemistry, lead and iron Data from SDG 9902G369. The data was evaluated based on the following parameters.

*	●	Data Completeness
*	●	Holding Times
*	●	Calibrations
*	●	Blanks
*	●	Interferences
*	●	Matrix Spike Recovery
*	●	Matrix Duplicates
*	●	Field Duplicates
*	●	Laboratory Control Samples
*	●	Serial Dilutions

* - All criteria were met for this parameter.

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL

Data stands as reported without qualification.

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9902G205
Date:	September 2, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	February 9 - 11, 1999
Number of Samples:	12 Aqueous Sample(s) with 2 MS/MSD(s) 3 Non-aqueous Sample(s) with 2 MS(s) and 3 MSD(s)
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	SW846 Third Edition and USEPA Approved Methodology
Analytical Fractions:	BTEX, Diesel Range Organics, Gasoline Range Organics, Iron, Lead, Alkalinity, pH, and Sulfate

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Searson

Paul B. Humburg, President

9-9-99.

Date

4127 Plaza 94 South • St. Charles, MO 63304
(636) 936-1332 • Fax (636) 936-1335

SDG# 9902G205

Samples and Fractions Reviewed

Sample Identifications — Analytical Fractions

MANTECH ID	MATRIX	BTEX		DRO		GRO		FE		PB		ALK		PH		SUL	
UGW-03	WATER	X		X		X		X		X		X					
UGW-03 MS	WATER							X		X							
UGW-03 MSD	WATER							X		X							
MTMW-1	WATER	X		X		X		X		X		X					
MTMW-1 MS	WATER					X											
MTMW-1 MSD	WATER					X											
AW-1	WATER	X		X		X		X		X		X					
MTMW-2	WATER	X		X		X											
MTMW-3	WATER	X		X		X											
AW-2	WATER	X		X		X											
MTMW-4	WATER	X		X		X											
RW-1	WATER	X		X		X											
UGW-14	WATER	X		X		X											
UGW-25	WATER	X		X		X											
DUP	WATER	X		X		X		X		X		X					
TB011899	WATER	X				X											
SB-AW-1	SOIL		X		X		X		X		X				X		X
SB-AW-1 MS	SOIL		X		X				X		X						X
SB-AW-1 MSD	SOIL		X		X				X		X				X		X
SB-AW-2	SOIL		X		X		X		X		X				X		X
SB-AW-2 MS	SOIL						X										
SB-AW-2 MSD	SOIL						X										
SB-MTMW-4	SOIL		X		X		X		X		X				X		X
SB-MTMW-4 MSD	SOIL														X		
Total Billable Samples (Water/Soil)		12	5	11	5	14	5	6	5	6	5	4	0	0	5	0	5

BTEX= BTEX
DRO= Diesel Range Organics
GRO= Gasoline Range Organics
FE= Iron
PB= Lead

ALK= Alkalinity
PH= pH
SUL= Sulfate

DATA ASSESSMENT AND NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW846 Method 8260B; the National Functional Guidelines for Organic Data Review, Region II and DQO Level IV. All comments made within this report should be considered when examining the analytical results.

SDG # 9902G205

A validation was performed on the Volatile Data from SDG 9902G205. The data was evaluated based on the following parameters.

* Data Completeness
* Holding Times
* GC/MS Tuning
* Calibrations
* Internal Standard Performance
* Blanks
  Surrogate Recoveries
* Laboratory Control Samples
* Matrix Spike / Matrix Spike Duplicate
* Field Duplicates
  Compound Identification /Quantitation

* - All criteria were met for this parameter

Surrogates

Sample SB-MTMW-4 exhibited high surrogate recoveries for toluene-d8. Qualify all positive results as estimated (J).

Compound Identification /Quantitation

Do not use E-flagged compound results for samples AW-2 and SB-MTMW-4, in favor of the D-flagged compound in the dilution.

System Performance and Overall Assessment

The data as presented requires qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
SB-MTMW-4	all compounds	+	J
AW-2 SB-MTMW-4	all E-flagged compounds	+	R
AW-2DL SB-MTMW-4DL	all results except D-flagged compounds	+/-	R

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
DIESEL RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015 and the California LUFT Manual; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9902G205

A validation was performed on the Diesel Range Organics Data from SDG 9902G205. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	Calibration
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
	•	Field Duplicates
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

Field Duplicates

The field duplicate pair of samples MTMW-4 and DUP exhibited a high RPD for one (1) compound and required qualifications. For the following samples and compound, the positive results are qualified as estimated, J.

MTMW-4	DRO
DUP	

System Performance and Overall Assessment

The data required qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
MTMW-4 DUP	DRO	+	J

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
\+ in the DL column denotes a positive result
\- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
GASOLINE RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9902G205

A validation was performed on the Gasoline Range Organics Data from SDG 9902G205. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	Calibration
*	•	Blanks
*	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
	•	Field Duplicates
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

Field Duplicates

The field duplicate pair of samples MTMW-4 and DUP exhibited a high RPD for one (1) compound and required qualifications. For the following samples and compound, the positive results are qualified as estimated, J.

MTMW-4	GRO
DUP	

System Performance and Overall Assessment

The data required qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
MTMW-4 DUP	GRO	+	J

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
LEAD, IRON AND WET CHEMISTRY

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the CLP ILM 4.0 Methods for metals and SW846 for wet chemistry ; the Functional Guidelines for Inorganic Data Validation, February 1994 with Region II modifications, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDGs # 9902G205

A validation was performed on the wet chemistry, lead and iron Data from SDG 9902G205. The data was evaluated based on the following parameters.

*	●	Data Completeness
*	●	Holding Times
*	●	Calibrations
*	●	Blanks
*	●	Interferences
*	●	Matrix Spike Recovery
	●	Matrix Duplicates
*	●	Field Duplicates
*	●	Laboratory Control Samples
*	●	Serial Dilutions

* - All criteria were met for this parameter.

Matrix Duplicate results

The matrix duplicate RPD for waters for Iron (23.7%) was greater than 20%. All positive results are qualified as estimated, "J".

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL
all water samples	Fe.	+	J

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9901G818
Date:	September 2, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	January 6 - 7, 1999
Number of Samples:	11 Aqueous Sample(s) with 4 MS/MSD(s)
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	SW846 Third Edition and USEPA Approved Methodology
Analytical Fractions:	BTEX, Gasoline Range Organics, Diesel Range Organics, Iron, Lead, Alkalinity, Hardness, Nitrate, Sulfate and Total Dissolved Solids

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Searson

Paul B. Humburg, President

9.7.99.

Date

4127 Plaza 94 South • St. Charles, MO 63304
(636) 936-1332 • Fax (636) 936-1335

SDG# 9901G818

Samples and Fractions Reviewed

Sample Identifications — Analytical Fractions

MANTECH ID	MATRIX	BTEX		DRO		GRO		FE		PB		ALK		HARD		NATE		SUL		TDS	
MTMW-1	WATER	X		X		X		X		X		X		X		X		X		X	
MTMW-1 MS	WATER	X														X					
MTMW-1 MSD	WATER	X														X					
AW-1	WATER	X		X		X		X		X		X		X		X		X		X	
UGW-3	WATER	X		X		X		X		X		X		X		X		X		X	
RW-1	WATER	X		X		X		X		X		X		X		X		X		X	
MTMW-3	WATER	X		X		X		X		X		X		X		X		X		X	
MTMW-3 MS	WATER							X		X											
MTMW-3 MSD	WATER							X		X											
AW-2	WATER	X		X		X		X		X		X		X		X		X		X	
AW-2 MS	WATER					X															
AW-2 MSD	WATER					X															
MTMW-4	WATER	X		X		X		X		X		X		X		X		X		X	
MTMW-2	WATER	X		X		X		X		X		X		X		X		X		X	
UGW14	WATER	X		X		X		X		X		X		X		X		X		X	
UGW25	WATER	X		X		X		X		X		X		X		X		X		X	
UGW25 MS	WATER													X						X	
UGW25 MSD	WATER													X						X	
TB122898	WATER	X																			
Total Billable Samples (Water/Soil)		13	0	10	0	12	0	12	0	12	0	10	0	12	0	12	0	10	0	12	0

BTEX= BTEX
DRO= Diesel Range Organics
GRO= Gasoline Range Organics
FE= Iron
PB= Lead

ALK= Alkalinity
HARD= Hardness
NATE= Nitrate
SUL= Sulfate
TDS= Total Dissolved Solids

DATA ASSESSMENT AND NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW846 Method 8260B; the National Functional Guidelines for Organic Data Review, Region II and DQO Level IV. All comments made within this report should be considered when examining the analytical results.

SDG # 9901G818

A validation was performed on the Volatile Data from SDG 9901G818. The data was evaluated based on the following parameters.

* Data Completeness
* Holding Times
* GC/MS Tuning
* Calibrations
* Internal Standard Performance
* Blanks
* Surrogate Recoveries
* Laboratory Control Samples
* Matrix Spike / Matrix Spike Duplicate
* Field Duplicates
* Compound Identification /Quantitation

* - All criteria were met for this parameter

System Performance and Overall Assessment

The data as presented requires no qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

No qualifications required.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
DIESEL RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015 and the California LUFT Manual; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9901G818

A validation was performed on the Diesel Range Organics Data from SDG 9901G818. The data was evaluated based on the following parameters:

*	•	Data Completeness
*	•	Holding Times
*	•	Calibration
*	•	Blanks
	•	Surrogate Recoveries
*	•	Matrix Spike/Matrix Spike Duplicates
*	•	Field Duplicates
*	•	Compound Identification
*	•	Compound Quantitation

* - All criteria were met for this parameter.

Surrogates

The samples listed below exhibited high 2-Fluorobiphenyl recoveries. For sample UGW-14, the 2-Fluorobiphenyl recovery was flagged I due to interferences. The reviewer calculated the recovery. The recovery was above the QC limits. For the following samples, the positive results are qualified as estimated, J.

UGW-3
RW-1
UGW-14

System Performance and Overall Assessment

The data required qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
UGW-3	ALL	+	J
RW-1			
UGW-14			

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
GASOLINE RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9901G818

A validation was performed on the Gasoline Range Organics Data from SDG 9901G818. The data was evaluated based on the following parameters:

* • Data Completeness
* • Holding Times
* • Calibration
* • Blanks
* • Surrogate Recoveries
* • Matrix Spike/Matrix Spike Duplicates
* • Field Duplicates
* • Compound Identification
* • Compound Quantitation

* - All criteria were met for this parameter.

System Performance and Overall Assessment

The data did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
LEAD, IRON AND WET CHEMISTRY

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the CLP ILM 4.0 Methods for metals and SW846 for wet chemistry ; the Functional Guidelines for Inorganic Data Validation, February 1994 with Region II modifications, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDGs # 9901G818

A validation was performed on the wet chemistry, lead and iron Data from SDG 9901G818. The data was evaluated based on the following parameters.

*	●	Data Completeness
*	●	Holding Times
*	●	Calibrations
*	●	Blanks
*	●	Interferences
*	●	Matrix Spike Recovery
*	●	Matrix Duplicates
*	●	Field Duplicates
*	●	Laboratory Control Samples
*	●	Serial Dilutions

* - All criteria were met for this parameter.

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL

Data stands as reported without qualification.

HEARTLAND
ENVIRONMENTAL SERVICES, INC.

Data Validation Report

SDG#:	9812G589
Date:	September 2, 1999
Client Name:	Mantech Environmental Corporation
Project/Site Name:	Tow Way Fuel Farm
Date Sampled:	December 14 - 16, 1998
Number of Samples:	1 Aqueous Sample(s) with 0 MS/MSD(s) 3 Non-aqueous Sample(s) with 2 MS/MSD(s)
Laboratory:	Severn Trent Laboratories
Validation Guidance:	National Functional Guidelines for Organic and Inorganic Data, February, 1994 with Region II Modifications
QA/QC Level:	DQO Level IV
Method(s) Utilized:	SW846 Third Edition and USEPA Approved Methodology
Analytical Fractions:	BTEX, Gasoline Range Organics, Diesel Range Organics, Iron, Lead, Sulfate and pH

Analytical data in this report were screened to determine usability of results and also to determine contractual compliance relative to these requirements and deliverables. This screening assumes analytical results are correct as reported and merely provides an interpretation of the reported quality control results. A minimum of 10% of all laboratory calculations have been verified as part of this validation. All instrument output, i.e. spectra, chromatograms, etc., for each sample have been carefully reviewed. The end-user is urged to review the Specific Findings and associated Data Qualifications presented in this report. Annotated Form 1s or spreadsheets for all samples reviewed are included after the Data Assessment Narratives. Form 1s for MS/MSD samples or spreadsheets are not annotated.

The release of this Data Validation Report is authorized by the following signature:

Craig G. Searson
for Paul B. Humburg, President

9-7-99.
Date

4127 Plaza 94 South • St. Charles, MO 63304
(636) 936-1332 • Fax (636) 936-1335

SDG# 9812G589

Samples and Fractions Reviewed

Sample Identifications — Analytical Fractions

MANTECH ID	MATRIX	BTEX		GRO		DRO		FE		PB		SUL		PH	
AW-1	SOIL		X		X		X		X		X		X		X
AW-1 MS	SOIL				X		X		X		X				
AW-1 MSD	SOIL				X		X		X		X				
AW-2	SOIL		X		X		X		X		X		X		X
AW-2 MS	SOIL												X		
AW-2 MSD	SOIL												X		
MTMW-4	SOIL		X		X		X		X		X		X		X
TB121098	WATER	X													
Total Billable Samples (Water/Soil)		1	3	0	5	0	5	0	5	0	5	0	5	0	3

BTEX= BTEX
GRO= Gasoline Range Organics
DRO= Diesel Range Organics
FE= Iron
PB= Lead
SUL= Sulfate
PH= pH

DATA ASSESSMENT AND NARRATIVE

VOLATILE ORGANICS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC/MS performance, tuning results, calibration results and internal standard areas. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW846 Method 8260B; the National Functional Guidelines for Organic Data Review, Region II and DQO Level IV. All comments made within this report should be considered when examining the analytical results.

SDG # 9812G589

A validation was performed on the Volatile Data from SDG 9812G589. The data was evaluated based on the following parameters.

* Data Completeness
  Holding Times
* GC/MS Tuning
* Calibrations
* Internal Standard Performance
* Blanks
  Surrogate Recoveries
* Laboratory Control Samples
* Matrix Spike / Matrix Spike Duplicate
* Field Duplicates
  Compound Identification /Quantitation

* - All criteria were met for this parameter

Holding Times

The following samples exceeded the Region II ten (10) day analysis holding time by two (2) to four (4) days. Qualify the sample results as estimated (J/UJ).

AW-1RE
AW-2
MTMW-4
MTMW-4DL

Surrogates

Sample MTMW-4 exhibited high surrogate recoveries for toluene-d8 and p-bromofluorobenzene. Qualify all positive results as estimated (J).

Compound Identification /Quantitation

Do not use sample AW-1, in favor of the re-analysis, due to non compliant surrogate recoveries.

Do not use E-flagged compound results for sample MTMW-4, in favor of the D-flagged compound in the dilution.

System Performance and Overall Assessment

The data as presented requires qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported quantitation limit is qualified as estimated

UR = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 10X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 10X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
AW-1RE AW-2 MTMW-4 MTMW-4DL	all results	+/-	J/UJ
MTMW-4	all results	+	J
AW-1	all results	+/-	R
MTMW-4	all E-flagged compounds	+	R
MTMW-4DL	all results except D-flagged compounds	+/-	R

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
GASOLINE RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9812G589

A validation was performed on the Gasoline Range Organics Data from SDG 9812G589. The data was evaluated based on the following parameters:

* • Data Completeness
* • Holding Times
* • Calibration
* • Blanks
* • Surrogate Recoveries
* • Matrix Spike/Matrix Spike Duplicates
* • Field Duplicates
* • Compound Identification
* • Compound Quantitation

* - All criteria were met for this parameter.

System Performance and Overall Assessment

The data did not require qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL

NO QUALIFICATIONS WERE REQUIRED.

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
DIESEL RANGE ORGANICS ANALYSIS

General

The organic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, surrogate and matrix spike recoveries, GC performance, and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the SW-846 Method 8015 and the California LUFT Manual; Region II modifications to the National Functional Guidelines for Organic Data Validation, February 1994, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDG # 9812G589

A validation was performed on the Diesel Range Organics Data from SDG 9812G589. The data was evaluated based on the following parameters:

- * Data Completeness
- * Holding Times
- * Calibration
- Blanks
- Surrogate Recoveries
- * Matrix Spike/Matrix Spike Duplicates
- * Field Duplicates
- * Compound Identification
- * Compound Quantitation

* - All criteria were met for this parameter.

Method Blanks

The associated method blank exhibited contamination for target compounds and qualifications were required. The end user should note that the action levels indicated for the blank analysis may not involve the same weights, volumes, dilution factors, or percent moistures as associated samples. These factors must be taken into consideration when applying the 5X criteria to field samples. The method blank results were compared to the associated samples.

Blank ID	Compound	Concentration	Action Level
PBLKAN	DRO	8.5 mg/Kg	42.5 mg/Kg

Method Blanks, Continued

The following samples have been qualified for method blank contamination. The qualifications are for all the blanks.

Sample	Compound	Qualification
AW-1	DRO	U

Surrogates

For sample AW-2 the 2-Fluorobiphenyl recovery was flagged I due to interferences. The reviewer calculated the recovery. The recovery was above the QC limits. The positive results are qualified as estimated, J.

AW-2

System Performance and Overall Assessment

The data required qualifications.

GLOSSARY OF DATA QUALIFIERS

QUALIFICATION CODES

U = Not detected

J = Estimated value

UJ = Reported Quantitation limit is qualified as estimated

NJ = Presumptive evidence for the presence of the material at an estimated value

R = Result is rejected and unusable

D = Result value is based on dilution analysis

METHOD BLANK QUALIFICATION CODES

CRQL = The sample result for the blank contaminant is less than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is rejected and the CRQL for that compound is reported.

U = The sample result for the blank contaminant is greater than the sample CRQL and is less than 5X the method blank value. The sample result for the blank contaminant is qualified as non detected at the compound value reported.

No Action = The sample result for the blank contaminant is greater than the sample CRQL and is greater than 5X the method blank value. The sample result for the blank contaminant is not qualified with any blank qualifiers.

SUMMARY OF DATA QUALIFICATIONS

SAMPLE ID	COMPOUND ID	DL	QL
AW-1	DRO	+	U
AW-2	ALL	+	J

* DL denotes the Form I qualifier supplied by the laboratory
QL denotes the qualifier used by the data validation firm
+ in the DL column denotes a positive result
- in the DL column denotes a non detect result

DATA ASSESSMENT NARRATIVE
LEAD, IRON AND WET CHEMISTRY

General

The inorganic findings offered in this screening report assumes that all analytical results are correct as reported and is based upon the examination of the reported holding times, blank analysis results, matrix spike and LCS recoveries, matrix duplicates and calibration results. This report was prepared in compliance relative to the analytical and deliverable requirements specified in the CLP ILM 4.0 Methods for metals and SW846 for wet chemistry ; the Functional Guidelines for Inorganic Data Validation, February 1994 with Region II modifications, and DQO Level IV requirements. All comments made within this report should be considered when examining the analytical results. Please refer the specific findings found in each category to the Summary of Data Qualification table.

SDGs # 9902G589

A validation was performed on the wet chemistry, lead and iron Data from SDG 9902G589. The data was evaluated based on the following parameters.

*	●	Data Completeness
*	●	Holding Times
*	●	Calibrations
*	●	Blanks
*	●	Interferences
*	●	Matrix Spike Recovery
	●	Matrix Duplicates
*	●	Field Duplicates
*	●	Laboratory Control Samples
*	●	Serial Dilutions

* - All criteria were met for this parameter.

Matrix Duplicate results

The matrix duplicate RPD for soils for Sulfate (42%) was greater than 35%. All positive results are qualified as estimated, "J".

SUMMARY OF DATA QUALIFICATIONS

Sample ID	Analyte	DL	QL
all soil samples	sulfate	+	J