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Work Plan
For
Additional Data Collection
Tow Way Fuel Farm

Naval Station Roosevelt Roads

RCRA/HSWA Permit No. PR2170027203

Ceiba, Puerto Rico

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LIST OF ACRONYMS AND ABBREVIATIONS

CAO	Corrective Action Objectives
CMS	Corrective Measures Study
CMSI	Corrective Measures Study Investigation
COPC	Chemical of Potential Concern
CSF	Cancer Slope Factor
DO	Dissolved Oxygen
ERA	Ecological Risk Assessment
ft/bgs	feet below ground surface
GPS	Global Positioning System
HESI	Heartland Environmental Services, Inc.
IDW	Investigation Derived Waste
LNAPL	Light Non-Aqueous Phase Liquid
MNA	Monitored Natural Attenuation
MS/MSD	Matrix Spike/Matrix Spike Duplicate
PAH	Polynuclear Aromatic Hydrocarbons
PID	Photoionization Detector
PSH	Phase Separated Hydrocarbons
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SVOC	Semivolatile Organic Compound
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
TOC	Total Organic Carbon
TWFF	Tow Way Fuel Farm
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The Tow Way Fuel Farm (TWFF) has been the subject of numerous investigations, even before the implementation of Resource Conservation and Recovery Act (RCRA) corrective action requirements. A full RCRA Facility Investigation (RFI) (Baker 1997) was performed at the site and the United States Environmental Protection Agency (USEPA) approved the subsequent report. Additional investigations since the RFI include the Additional Well Installation (Baker 1998), Corrective Measures Study Investigations (CMSI) (Baker 1999), Hydraulic Characteristics Evaluation (McLaren Hart, 1999), TCE Investigation Report (Baker 2000), and Pier 1 Report of Findings authored by McLaren-Hart (McLaren-Hart 2000). As a result of the investigations and in support of ongoing efforts on the Corrective Measures Study (CMS), additional data requirements were identified. On December 19, 2000, a meeting to present a conceptual approach on gathering the necessary data to support the CMS was held at EPA Region II New York office. In addition, on May 23, 2001 discussions continued on data collections to include data for the groundwater model being developed. It was agreed by all that a work plan to address the data needs would be developed. This work plan is a result of those discussions.

The TWFF was divided into five zones (Figure 1-1). Each zone represents a portion of the TWFF that has been impacted by past operations. The first three zones (Zones 1, 2, and 3) are associated with the presence of phase separated hydrocarbons (PSH) on the water table. Zone 4 is the dissolved trichloroethene (TCE) plume near 7MW07, while Zone 5 is the dissolved benzene plume underlying Zones 1 & 2.

The specific elements of the field effort to be performed include:

- A groundwater monitor well installation program associated with the Pier 1 (Zone 3) PSH release to better ascertain the current extent of contamination.

- A groundwater well installation program to establish a down-gradient compliance well for the dissolved TCE in and around 7MW07 (Zone 4).

- A groundwater well installation program to establish a compliance well down-gradient of monitor well 7MW08 which now contains PSH.

- A groundwater monitor well installation program to replace key monitor wells where the top of screen remains below the apparent groundwater interface the majority of time. The purpose of these monitor wells is to assist in the delineation of PSH within the TWFF (Zones 1, 2, and 3).

- A groundwater monitor well installation program to verify presence of hydrocarbons in the unsaturated zone and on the groundwater table down-gradient of active Tanks 82 and 83.

- A groundwater monitor well installation program to verify hydrologic boundaries to the north and west of the TWFF.

- A fingerprinting of the light non-aqueous phase liquid (LNAPL) in the three zones where PSH is expected (Zones 1, 2, and 3 if available).

- A groundwater sampling and analysis program to collect and analyze groundwater associated with dissolved phase constituents (Zones 4 and 5).

- A groundwater sampling and analysis program to collect and analyze groundwater down gradient from UGW02 that has recently had measurable PSH in the monitor well.

- A groundwater sampling and analysis program to characterize groundwater quality in monitor wells south of Forrestal Drive. These data will be used in an ecological risk assessment (ERA) for the TWFF. (See work plan for ERA presented in Appendix C).

- A surface water sampling and analysis program to characterize surface water quality within the Ensenada Honda down gradient from the TWFF. These data will be used in an ERA for the TWFF. (See work plan for ERA presented in Appendix C).

- A surface soil sampling and analysis program to characterize surface soil quality at the TWFF. These data will be used in an ERA for the TWFF. (See work plan for ERA presented in Appendix C).

- The sampling and analysis of subsurface soil for polynuclear aromatic hydrocarbons (PAH) from soil borings and seven new monitor wells in the upper TWFF to help delineate PAH in soil.

- A sediment sampling and analysis program to characterize sediment quality within the Ensenada Honda down gradient from the TWFF. These data will be used in an ERA for the TWFF. (See work plan for ERA presented in Appendix C).

- A slug test program on all new groundwater monitor wells and field selected wells to gather aquifer information for the development of a groundwater model.

When this work is completed, the results will be provided as an appendix to the Draft Final Task I CMS report.

2.0 CURRENT CONDITIONS

The following section is a discussion of conditions that exist at the TWFF to date. To facilitate understanding, the TWFF was divided into five distinct zones. Rationale for additional data needs is also discussed.

2.1 Zones 1 & 2

Results from monthly PSH thickness readings show no connection between Zone 1 and Zone 2. Further analysis of boring logs from this area indicates that several monitor wells (7MW01A, GW02, GW03, UGW03, UGW04, UGW09, UGW13, UGW14, and UGW26) consistently remain screened below the apparent water table. Two additional monitor wells will be installed to verify the presence of PSH in the area between Zone 1 and Zone 2.

The CMSI indicated elevated benzene and total petroleum hydrocarbons (TPH) readings in the unsaturated zone between Tanks 82 & 83 and Zones 1 & 2. It was unclear whether this was “trapped or perched” PSH, or just inconsequential readings. Therefore, a monitor well (7MW07) will be placed in this area to verify the presence of PSH in the unsaturated zone.

In addition, Lt. Bridges (NSRR Fuels Officer) has indicated that Tanks 82 & 83 will remain active. These two tanks are used to transfer fuels between the pier and the "new" aboveground fuel tank located west of TWFF. Therefore, the same monitor well (7MW17) being used to verify the presence of PSH in the unsaturated zone will be used as a "sentinel" well while Tanks 82 & 83 remain active.

2.2 Zone 3

McLaren-Hart investigated the presence of PSH near Pier 1 in December 1999 (McLaren-Hart, Pier 1 Report of Findings). To date, existing monitor wells in and around the investigated area have not indicated the presence of PSH. Further evaluation of boring logs did indicate that groundwater had risen and consistently stayed above the top of screen in UGW09. This well will be replaced to confirm the presence of PSH in this area.

Additionally, the southern and western edges of the PSH plume identified in the McLaren-Hart report has not been confirmed by permanent wells. Therefore, three additional monitor wells will be strategically placed in Zone 3 to either confirm the presence of PSH or act as down-gradient compliance wells.

2.3 Zone 4

Dissolved TCE was detected in and around 7MW07 as indicated in Baker's TCE Investigation Report (February 2000). The report delineated the nature and extent of the dissolved TCE plume; however, a permanent down-gradient compliance well was not completed. A well will be placed down gradient to establish future compliance.

2.4 Zone 5

Dissolved constituents generally associated with the PSH (i.e., previously detected volatile organic compounds [VOCs] and semivolatile organic compounds [SVOCs]) from Zones 1 & 2 make up Zone 5. Only two rounds of sampling and analysis were gathered to delineate Zone 5. Almost seven years transpired between these two sampling events. Therefore, another limited round of sampling and analysis (see Section 3.1) will be conducted to continue to define the leading edge of the dissolved plume.

2.5 TPH Data Interpretation

As previously discussed in the December 19, 2000 meeting in New York with EPA, extensive data has been collected from the soil and groundwater including TPH. This site originally began under the guidance of the Underground Storage Tank (UST) program. Groundwater and soil samples were analyzed for TPH as per UST protocol. The Navy subsequently applied for a Part B permit which put this site into the RCRA program. Under RCRA, individual contaminants were identified and a corrective action plan is under development with clean-up goals based on human health and environmental risk scenarios. To date, EPA had agreed upon the clean up goals developed per individual RCRA contaminants. TPH is made up of a range of possible contaminants and does not have identifiable risk factors associated with it, either human health or environmental. Therefore, the more general TPH data will not be further analyzed or evaluated during this corrective action process.

3.0 SCOPE OF INVESTIGATIONS

The additional investigation at the TWFF will consist of installation of 14 monitor wells, groundwater sampling and analysis of 36 selected monitor wells, analysis of nine surface water samples, analysis of surface soil and subsurface soil from 12 soil borings, analysis of five saturated soil borings, analysis of 12 sediment samples, three fuel fingerprint analysis from three PSH zones, and slug testing of 16 selected monitor wells. A sample matrix for this investigation is provided as Appendix A. The various investigatory elements are described in detail in the following subsections.

3.1 Groundwater Sampling and Analysis Program

Figure 3-1 identifies the 36 monitor wells (14 new and 22 existing monitor wells) selected for sampling. The sampling is to assist in identifying and delineating the mobile constituents down-gradient of Zone 1, 2, and 3 plumes. In addition, three monitor wells (7MW03, 7MW09, and UGW23) will be sampled to validate the presence of dissolved petroleum constituents down gradient from UGW02. Each well will be sampled and analyzed for the full Appendix IX VOCs list, the full Appendix IX SVOCs list, monitored natural attenuation (MNA) parameters, and the full Appendix IX total and dissolved metals list (see Appendix A.1). A total of six of the 36 monitor wells to be sampled will also be analyzed for groundwater density as presented in Appendix A.1. Two of the six monitor wells to be analyzed for groundwater density (7MW21 and 7MW22) are located in the upper portion of the TWFF, two (7MW16 and 7MW17) will be located in the central portion of the TWFF,

while the remaining two (7MW06 and UGW11) will be located south of Forrestal Drive. The 36 monitor wells to be sampled are:

- 7MW03, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
- UGW06, 07, 08, 09, 10, 11, 15, 16, 18, 20R, 23, 26
- GW04, 06
- 470MW01, 03

Table 3-1 identifies the appropriate analytical method for each individual constituent to be reported by the laboratory. Individual constituents were selected for analysis based on the establishment of a chemical of potential concern (COPC). The COPC evaluation and selection process are discussed in the CMS Task 1, Revised Section 3.0 (Baker 2001).

Additional sampling and analysis for five monitor wells (7MW07, 08, 10, 23, and UGW16) near Zone 4 will be conducted. The additional analysis is to assist in determining natural attenuation parameters associated with the TCE plume. Appendix A.1 identifies the additional sampling and analysis parameters for these four monitor wells.

Before sampling, the wells will be gauged with an oil/water interface probe to measure PSH. Even if PSH is encountered above 0.01 feet, the sample will be collected and analyzed. This will be performed by inserting a stilling tube into the well prior to purging. The stilling tube will be a one-inch diameter polyvinyl chloride (PVC) tube with aluminum foil fastened firmly at the bottom. The stilling tube will be lowered into the well to the appropriate depth and then attached firmly to the top of the well casing. When the peristaltic pump drop tube is inserted, the weight of the tube will break the foil covering the end of the stilling tube. The well can then be purged and sampled from below the LNAPL layer, as presented in the EPA RCRA Groundwater Monitoring Draft Technical Guidance Document (USEPA, 1992). The rationale for sampling wells with possible PSH is to assist in determining the partitioning of individual constituents associated with PSH, to the groundwater. Samples will be gathered using EPA Region II low flow sampling technique. Appendix B includes a detailed description of low flow sampling technique.

Quality assurance and quality control (QA/QC) samples should also be collected for analysis. Four duplicate samples, three field blanks, one equipment rinsate sample, and two matrix spike/matrix spike

duplicates (MS/MSD) will be collected for analysis by the laboratory as presented in Appendix A. In addition, one trip blank will be placed in each cooler that requires VOC analysis.

Samples will be packed in ice and shipped next day air to the "fixed base" laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of laden. At least one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the project manager for assisting in verification of receipt.

VOCs, SVOCs, and inorganic constituents will be analyzed in the laboratory using the methods identified in Table 3-1. The dissolved inorganic samples will be filtered in the field.

STL Savannah in Savannah, Georgia will perform the laboratory analysis. Data validation will be performed by Heartland Environmental Services, Inc. (HESI) in St. Charles, Missouri.

3.2 Monitor Well Installation Program

Fourteen monitor wells will be installed in various locations throughout the TWFF (Figure 3-2). Wells will be numbered sequentially starting with 7MW10 and ending with 7MW23. The new monitor wells will either replace existing wells or act as compliance wells.

All monitor wells will be advanced using a mobile B61 drilling rig capable of augering and down hole air hammering or equivalent. All completed wells will be 4 inches in diameter except 7MW10, which will be 2 inches. The 4-inch diameter wells will be drilled using 6 ¼-inch augers. The 2-inch diameter well will be drilled using 4 ¼-inch augers. Every well will be logged and split-spoon sampled continuously at 2-foot intervals unless otherwise noted. A boring log will be maintained indicating, among other things, lithology, PSH, and water occurrence. Soil borings will be logged to verify stratigraphy.

All the wells with the exception of 7MW16, will be screened across the water table with 10 feet of 0.010-slot schedule 40 PVC screen. Monitor well 7MW16 will be screened across the water tablewith 15 feet of 0.010-slot schedule 40 PVC screen. The seasonal high and low water table levels for

several adjacent wells are included in the work plan (Table 3-3). All screens should be set so that the seasonal high for groundwater will be 2 feet below the top of screen. The screen must also be set so that the bottom does not fall outside the seasonal low. Additional screen may be added to meet these requirements. However, approval from the project manager must be obtained prior to completing the well.

All wells will use 20/40 sand filter pack to 2 feet above the top of screen, followed by a 2-foot bentonite seal. The remaining annulus will be grouted to surface and finished with a flush mount cover (round 6-inch bolt down well vault) inside a 2-feet by 2-feet cement pad. All drill cuttings will be logged and collected in 55-gallon drums for analysis and disposal at a later date.

All wells will be developed by continuously pumping the groundwater from the well using the drill rig pump and/or waterra pump. All development water will be captured in 55-gallon drums for disposal at a later date. The monitor well will be allowed sufficient time to recover prior to sampling.

The following paragraphs provide the rationale for the installation of the well and information on the installation of the well.

7MW10

This monitor well will serve as a compliance well for Zone 4. 7MW10 will be a 2-inch well located down gradient from 7MW07. The well will be completed using 2-inch schedule 40 PVC. All other completion requirements are as described in the above-mentioned paragraphs.

7MW11

This monitor well will replace UGW09 in Zone 3. 7MW11 will be split-spoon sampled continuously every two feet with special attention paid to the presence of PSH. If PSH is observed in the split-spoon sample, then the boring will be monitored for PSH accumulation using an oil/water interface probe. A complete description of the PSH will be recorded in the field log. The time and amount of accumulation will be documented prior to boring advancement. In addition, measurable PSH should be removed prior to boring advancement. All other completion requirements are as described in the above-mentioned paragraphs.

7MW12

This monitor well will define the southern most extension of the PSH associated with Zone 3. There will be no additional requirements for 7MW12. All other completion requirements are as described in the above-mentioned paragraphs.

7MW13

This monitor well will define the western limit of the PSH associated with Zone 3. There will be no additional requirements for 7MW13. All other completion requirements are as described in the above-mentioned paragraphs.

7MW14

This monitor well will define the western limit of PSH associated with Zone 3. There will be no additional requirements for 7MW14. All other completion requirements are as described in the above-mentioned paragraphs.

7MW15

This monitor well will replace GW03 and verify the presence of PSH. There will be no additional requirements for 7MW14. All other completion requirements are as described in the above-mentioned paragraphs.

7MW16

This monitor well will replace UGW14 and verify the presence of PSH. Care should be taken for the placement of the screen. It may be necessary to install 15 feet of screen at this location. This is evident from the seasonal groundwater levels listed for adjacent UGW14 in Table 3-3. There will be no additional requirements for 7MW16. All other completion requirements are as described in the above-mentioned paragraphs.

7MW17

This monitor well is located down gradient of Tank 82 and Tank 83. The main purpose of this well is to verify presence of PSH in the unsaturated soils, however; the well will be completed so that groundwater can be monitored. The well will be completed and grouted to ensure any unsaturated PSH is not allowed to migrate to the surface of the groundwater. All other completion requirements are as described in the above-mentioned paragraphs.

7MW18

This monitor well will assist in delineating the groundwater table in the northwest area of the upper TWFF.

7MW19

This monitor well will be located north of Tank 82 and will assist in delineation of the groundwater table in the northern section of the upper TWFF.

7MW20

This monitor well will be located northeast of Tank 1082 and will assist in the groundwater table delineation in this section of the upper TWFF.

7MW21

This monitor well will be located northwest of Tank 82 inside the radio tower fenced area. This well will assist in groundwater table delineation in the upper TWFF.

7MW22

This monitor well will be the northern most well in the upper TWFF. It will be located on the radio tower access road on the backside of the upper TWFF. This well will assist in the delineation of the groundwater table.

7MW23

This monitor well will define the eastern limit of the PSH along Forrestal Drive. Soil samples will not be collected at this location due to the shallow bedrock. There will be no additional requirements for 7MW23. All other completion requirements are as described in the above-mentioned paragraphs. This well will act as compliance well. If PSH is detected within this well then the Project Manager will be contacted to discuss the possibility of installing an additional well further east along Forrestal Drive.

Additional Monitor Wells

One purpose of this work plan is to delineate the PSH plumes in the TWFF. As a result, additional monitor wells, beyond the number identified in this work plan, may be required to better delineate the PSH plumes. Therefore, prior to the demobilization of the drilling crew, the field team leader will contact the "project team" to discuss the need for additional monitor wells. The project team will consist of Baker's field leader and project manager, CH2M Hill's project coordinator, and Navy's remedial project managers. If it is determined in the field that additional monitor wells are needed for better plume delineation, then the EPA will be consulted for subsequent well placement.

3.3 Soil Sampling and Analysis Program

Previous field efforts have identified PAHs in the soil above corrective action objectives (CAOs) in the upper TWFF. Most of these elevated levels for PAHs are attributable to detection limits being above the CAO. Detection limits for individual PAHs, as well as other SVOCs have been elevated in previous sampling events due to matrix interference. Therefore, a series of soil borings in the upper TWFF will be conducted to verify the presence of PAHs above CAOs by carefully analyzing the samples (e.g., using lower detection limits). The soil boring will also assist in delineation of PAHs. Subsurface soil samples collected at these locations will also be used in the ERA for the TWFF.

All surface soil samples will be collected using a disposable stainless steel split-spoon. Prior to sample collection, vegetation (grass and roots) will be removed from the location. Surface soil samples will be collected to a depth of one foot below ground surface as required by EPA Region II guidelines.

All soil borings will be advanced using a mobile B61 drilling rig or direct push rig. The boring will be continuously split-spooned until refusal or groundwater is encountered which ever comes first. A boring log will be maintained indicating, among other things, blows, lithology, PSH, and water occurrence. Samples will be logged to verify stratigraphy.

Seven soil borings resulting from the installation of monitor wells 7MW16 through 7MW22 will be sampled for both surface and subsurface soil. Surface soil and subsurface soil from five additional soil borings, designated 7SB23 through 7SB27, will also be sampled. The surface soil samples will be analyzed for VOCs (Method 8260), SVOCs (Method 8270), and Appendix IX Metals (Method 6010), as presented in Appendix A-1. The subsurface soil samples will be selected based on visual observation and photoionization detector (PID) reading, and analyzed for low level PAHs using Method 8270. The location of these monitor wells and soil borings are identified in Figure 3-3.

The collection of surface soil samples will aid in the ecological risk assessment process. One subsurface soil sample from the most contaminated zone at each soil boring location will be collected and analyzed for low level PAHs using Method 8270. The soil boring selection will be based on visual observation and PID reading. Samples will be labeled by the sample location first (i.e., 7SB23) followed by the sample interval [i.e., “-00” surface, “-01” 2-4 feet below ground surface (ft/bgs), “-02” 4-6 ft/bgs, “-03” 6-8 ft/bgs, “-04” 8-10 ft/bgs, etc.].

Additionally, one soil boring will be collected from the saturated zone from five monitor wells, 7MW18 through 7MW22. The saturated soil boring will be collected within the first two feet below the water interface. If refusal is met prior to reaching the saturated zone, then no sample will be collected. Each saturated soil boring sample will be analyzed for TOC. The collection of saturated soil boring samples will assist in future transport modeling applications.

QA/QC samples should also be collected for analysis. Three duplicate samples, three field blanks, two equipment rinsate samples, and two MS/MSD will be collected for analysis by the laboratory as presented in Appendix A. In addition, one trip blank will be placed in each cooler that requires VOC analysis.

Samples will be packed in ice and shipped next day air to the “fixed base” laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of laden. At least

one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the project manager for assisting in verification of receipt.

VOCs, SVOCs, and Inorganic constituents will be analyzed in the laboratory using the methods identified in Table 3-1.

STL Savannah in Savannah, Georgia will perform the laboratory analysis. Data validation will be performed by HESI in St. Charles, Missouri.

The following paragraphs present the rationale for the selection of each soil sampling location.

7SB23

This soil boring will be located northeast of UGW25 across the road. This boring should be outside the anticipated PAH impacted area. This boring will serve as a delineation point for this area of the upper TWFF. A surface soil sample will be collected at this location to supplement existing surface soil data for use in an ERA.

7SB24

Previous data collection efforts in this area have resulted in PAH analysis that has significant matrix interference. Therefore, a subsurface soil sample will be collected and analyzed with low detection levels to verify presence of PAHs in this area. The boring will be east of RW1 and west of the drainage ditch. A surface soil sample will be collected at this location to supplement existing surface soil data for use in an ERA.

7SB25

This soil boring will be located east of the drainage ditch near RW1 and northwest of Tank 85 up against the roadway bank. This location was selected based on previous data that had elevated detection levels for PAHs. This boring will help to verify the presence of PAHs above CAOs. A

surface soil sample will be collected at this location to supplement existing surface soil data for use in an ERA.

7SB26

This boring will be located between Tank 85 and RW1 just east of the drainage ditch and south of 7SB25. This boring will verify the presence of PAHs using a low level detection method. Again, previous data has identified detection levels above CAOs. A surface soil sample will be collected at this location to supplement existing surface soil data for use in an ERA.

7SB27

This boring will be located along a dirt road between Tank 1080 and Tank 1082. This soil boring will assist in eastward delineation of PAHs in the upper TWFF. A surface soil sample will be collected at this location to supplement existing surface soil data for use in an ERA.

7MW16 – 7MW22

Locations of these soil borings are identified on Figure 3-3. A subsurface soil sample from each of the boring locations will be collected in the most contaminated zone to assist in delineation of the PAH in the upper TWFF. In addition, one saturated soil boring sample will be collected from five monitor wells, 7MW18 through 7MW22.

Monitor well 7MW17 will verify the presence of PSH in the unsaturated zone. In addition, this monitor well will act as a "sentinel" well for the two up-gradient, active tanks in the TWFF. 7MW17 will be sampled continuously with special attention paid to the presence of PSH. If PSH is observed in the split-spoon sample, then the boring will be monitored for PSH accumulation using an oil/water interface probe. The time and amount of accumulation will be documented prior to boring advancement. A surface soil sample will be collected at this location to supplement existing surface soil data for use in an ERA.

3.4 Surface Water Sampling and Analysis Program

A total of nine surface water samples (7SW1 through 7SW9) (See Figure 3-4) will be collected from the Ensenada Honda down gradient from the TWFF as shown on Figure 3-4. Each surface water sample will be analyzed for VOCs, SVOCs, and the full Appendix IX total and dissolved metals list as presented in Appendix A.1. Each surface water sample will also be field analyzed for pH, salinity, dissolved oxygen (DO), and temperature.

Depending on the location of the surface water samples within Ensenada Honda, a boat may be used to access some of these sample points. Each surface water sample will be collected utilizing a Wildco Beta Plus horizontal water bottle and will be collected approximately one foot above the sediment/water interface. The surface water will then be transferred into the designated preserved sample container.

QA/QC samples should also be collected for analysis. One duplicate sample, three field blanks, one equipment rinsate sample, and one MS/MSD will be collected for analysis by the laboratory as presented in Appendix A. In addition, one trip blank will be placed in each cooler that requires VOC analysis.

Samples will be packed in ice and shipped next day air to the “fixed base” laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of laden. At least one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the project manager for assisting in verification of receipt.

VOCs, SVOCs, and inorganic constituents will be analyzed in the laboratory using the methods identified in Table 3-4. The dissolved inorganic samples will be filtered in the field.

STL Savannah in Savannah, Georgia will perform the laboratory analysis. Data validation will be performed by HESI in St. Charles, Missouri.

The sample locations shown are approximate and may change based on observed site conditions (e.g., evidence of contamination and location access). All surface water sampling locations will be surveyed in the field utilizing a portable global positioning system (GPS) unit to gather the horizontal location.

The following paragraphs provide the rationale for the surface water sampling locations chosen.

7SW1

This surface water sample will be collected in the northwestern portion of the shoreline down gradient from the TWFF. This surface water sample will assist in determining if site chemicals are migrating with groundwater to the Ensenada Honda.

7SW2

This surface water sample will be collected southeast of surface water sample 7SW1. This surface water sample will assist in determining if site chemicals are migrating with groundwater to the Ensenada Honda.

7SW3

This surface water sample will be collected immediately adjacent to a storm sewer outfall as presented in Figure 3-4. This surface water sample will assist in determining if site chemicals are migrating with groundwater to the Ensenada Honda.

7SW4

This surface water sample will be collected southeast of surface water sample 7SW3. This surface water sample will assist in determining if site chemicals are migrating with groundwater to the Ensenada Honda.

7SW5

This surface water sample will be collected southeast of surface water sample 7SW4. This surface water sample will assist in determining if site chemicals are migrating with groundwater to the Ensenada Honda.

7SW6

This surface water sample will be collected southeast of surface water sample 7SW5. This surface water sample will assist in determining if site chemicals are migrating with groundwater to the Ensenada Honda.

7SW7

This surface water sample will be collected immediately adjacent to a storm sewer outfall as presented in Figure 3-4. This surface water sample will assist in determining if site chemicals are migrating with groundwater to the Ensenada Honda.

7SW8

This surface water sample will be collected immediately adjacent to a storm sewer outfall as presented in Figure 3-4. This surface water sample will assist in determining if site chemicals are migrating with groundwater to the Ensenada Honda.

7SW9

This surface water sample will be collected southeast of surface water sample 7SW8. This surface water sample will assist in determining if site chemicals are migrating with groundwater to the Ensenada Honda.

3.5 Sediment Sampling and Analysis Program

A total of fourteen sediment samples (7SD1 through 7SD14) will be collected from the Ensenada Honda located down gradient from the TWFF as shown on Figure 3-4. All sediment samples collected will be analyzed for VOCs, SVOCs, Appendix IX Metals, and total organic carbon (TOC) as presented in Appendix A.1.

Depth of water in Ensenada Honda is such that a boat may be necessary to access these sample locations. Depending on the depth of water at each sediment sample location, a variety of sampling methods can be utilized. If the water is deep in the vicinity of a sediment sample location, an Eckman

or petite ponar dredge will be used. If the water in the vicinity of a sediment sample location is shallow, sediment core liners will be used.

QA/QC samples should also be collected for analysis. Two duplicate samples, three field blanks, three equipment rinsate samples, and one MS/MSD will be collected for analysis by the laboratory as presented in Appendix A. In addition, one trip blank will be placed in each cooler that requires VOC analysis.

Samples will be packed in ice and shipped next day air to the "fixed base" laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of laden. At least one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the project manager for assisting in verification of receipt.

VOCs, SVOCs, and inorganic constituents will be analyzed in the laboratory using the methods identified in Table 3-1.

STL Savannah in Savannah, Georgia will perform the laboratory analysis. Data validation will be performed by HESI in St. Charles, Missouri.

The following paragraphs present the rationale for the selection of these sampling locations.

<u>7SD1 - 7SD4</u>

These four sediment sample locations will be placed in the extreme northwestern portion of the Ensenada Honda shoreline down gradient from the TWFF. This area of the shoreline contains sea grass as presented on Figure 2-4 of Appendix C. The purpose for these four locations is to evaluate if chemicals are migrating with groundwater to Ensenada Honda sediment. These sample locations will also allow for the evaluation of potential ecological risks to marine mammals that may utilize this area of the Ensenada Honda as feeding habitat (See Appendix C).

7SD5 – 7SD6

As presented on Figure 3-4, these two sediment sample locations will be collected immediately adjacent to the storm water sewer outfall located northeast of the Fueling Pier. This storm water sewer transfers runoff water from the TWFF to Ensenada Honda. The purpose for these two locations is to evaluate if chemicals are migrating with storm water to Ensenada Honda sediments. These sample locations will also assist in evaluating if chemicals are migrating with groundwater to Ensenada Honda sediments.

7SD7 – 7SD8

These two sediment sample locations will be collected in the inlet located on the northeast side of the Fueling Pier as presented on Figure 3-4. The purpose for these two locations is to determine the extent of contamination migrating from the TWFF if any were to be present.

7SD9 – 7SD10

As presented on Figure 3-4, these two sediment sample locations will be collected immediately adjacent to the storm water sewer outfall located northwest of Pier 2. This storm water sewer transfers runoff water from the TWFF to Ensenada Honda. The purpose for these two locations is to evaluate if chemicals are migrating with storm water to Ensenada Honda sediments. These sample locations will also assist in evaluating if chemicals are migrating with groundwater to Ensenada Honda sediments.

7SD11 – 7SD12

As presented on Figure 3-4, these two sediment sample locations will be collected immediately adjacent to the storm water sewer outfall located southeast of Pier 2. This storm water sewer transfers runoff water from the TWFF to Ensenada Honda. The purpose for two locations is to evaluate if chemicals are migrating with storm water to Ensenada Honda sediments. These sample locations will also assist in evaluating if chemicals are migrating with groundwater to Ensenada Honda sediments.

7SD13 - 7SD14

These two sediment sample locations will be collected adjacent to the landmass leading to the Fueling Pier as presented on Figure 3-4. The purpose for these two locations is to determine if contamination associated with Zone 3 is migrating from the TWFF if any were to be present.

The sample location mentioned above will aid in the ecological risk assessment process. The sample locations shown are approximate and may change based on observed site conditions (e.g., evidence

of contamination and location access). All sediment sampling locations will be surveyed in the field utilizing a portable GPS unit to gather the horizontal location.

3.6 PSH Fingerprinting

A representative sample of PSH will be collected from Zones 1, 2, and 3 for subsequent analysis. RW1 will be used to collect PSH for analysis of Zone 1 while UGW13 will be used for Zone 2. Zone 3 does not currently have any wells within the "PSH plume" therefore; one of the new monitor wells will be used to collect PSH from this zone. 7MW11 or 7MW12 are the two most likely to encounter PSH and one will be field selected for fingerprinting.

The laboratory will fingerprint PSH samples collected from each of the three zones. The PSH will also be analyzed for Brookville Kinematic Viscosity and product density as presented in Table 3-4 and Appendix A.3.

3.7 Slug Test Program

Sixteen slug tests will be performed in selected areas of the TWFF (Figure 3-5). The slug test will be performed using a 1 ½-inch, PVC slug for a 2-inch well and a 3 ½-inch, PVC slug for the 4-inch well. A Hermit data logger with one Teflon® coated transducer will be used to record the groundwater recovery in each slug tested well. Information from the slug tests will be incorporated into the groundwater model currently under development.

Slug tests will be performed in the following wells:

- 7MW05, 08, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23

3.8 Other Investigation Considerations

Investigation Derived Wastes (IDW)

The generation of IDW will be collected and stored temporarily in 55-gallon drums. Upon completion of the well installation, purging, and sampling, the soil and water IDW will be removed from the site by an approved vendor.

Decontamination

Disposable tubing will be employed for the groundwater sampling. New riser and screen will be used for each monitor well. The drill rig will be decontaminated in accordance with the EPA approved RCRA Facility Investigation Work Plans (Baker, 1995) between each well. The Wildco Beta Plus horizontal water bottle used to collect surface water samples will be decontaminated between each location. The Eckman and petite ponar dredges used to collect sediment samples will also be decontaminated between each location. Disposable sediment core liners will be used where water is shallow.

Surveying

All sampling locations (soil borings and new monitor wells) will be flagged in the field and will be surveyed for vertical (+/- 0.01 feet) and horizontal (+/- 0.1 feet) location using established control. The survey will be performed by the same firm, which has performed previous work for Baker at the TWFF. This will ensure that the same level of survey quality and detail is attained.

The surface water and sediment sampling locations will be surveyed for horizontal location utilizing a portable GPS unit, as mentioned in the previous sections.

4.0 REPORTING

A full report on the investigations described herein will be prepared and included as an Appendix to the Draft Final Task I CMS Report for the TWFF. Included will be a description of the field activities, boring logs, all screening and laboratory analytical results and an interpretation of the information obtained.

5.0 SCHEDULE

A schedule for the implementation of this work plan and implementation of the CMS for the TWFF is provided as Figure 5-1. It should be noted that this schedule is dependent upon EPA review time. Many other factors can also extend the schedule such as resampling if further re-characterization is required, weather delays in the field, funding is delayed by the Navy, or consensus cannot be reached on how the USEPA's comments are to be incorporated.

6.0 REFERENCES

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TABLES

TABLE 3-1

LABORATORY ANALYTICAL METHODS
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Volatiles	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
Acetone	50	50	8260
Acetonitrile	200	200	8260
Acrolein	100	100	8260
Acrylonitrile	100	100	8260
Benzene	5.0	5.0	8260
Bromodichloromethane	5.0	5.0	8260
Bromoform	5.0	5.0	8260
Bromomethane	10	10	8260
Carbon Disulfide	5.0	5.0	8260
Carbon Tetrachloride	5.0	5.0	8260
Chlorobenzene	5.0	5.0	8260
Chloroethane	10	10	8260
Chloroform	5.0	5.0	8260
Chloromethane	10	10	8260
Chloroprene	5.0	3.0	8260
3-Chloro-1-propene	5.0	5.0	8260
1,2-Dibromo-3-chloropropane	5.0	10	8260
Dibromochloromethane	5.0	5.0	8260
1,2-Dibromoethane	5.0	5.0	8260
Dibromomethane	5.0	5.0	8260
trans-1,4-Dichloro-2-butene	10	10	8260
Dichlorodifluoromethane	10	5.0	8260
Dibromomethane	5.0	5.0	8260
1,1-Dichloroethane	5.0	5.0	8260
1,2-Dichloroethane	5.0	5.0	8260
trans-1,2-dichloroethene	5.0	5.0	8260
1,1-Dichloroethene	5.0	5.0	8260
Methylene Chloride	5.0	5.0	8260
1,2-Dichloropropane	5.0	5.0	8260
cis-1,3-Dichloropropene	5.0	5.0	8260
trans-1,3-Dichloropropene	5.0	5.0	8260
Ethyl benzene	5.0	5.0	8260
Ethyl methacrylate	5.0	5.0	8260
2-Hexanone	25	25	8260
Iodomethane	5.0	5.0	8260
Isobutanol	200	200	8260
Methacrylonitrile	100	100	8260
2-Butanone	25	25	8260
Methyl methacrylate	5.0	5.0	8260
4-Methyl-2-pentanone	25	25	8260

TABLE 3-1

LABORATORY ANALYTICAL METHODS
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Volatiles (Cont.)	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
Pentachloroethane	25	25	8260
Propionitrile	100	100	8260
Stryene	5.0	5.0	8260
1,1,1,2-Tetrachloroethane	5.0	5.0	8260
1,1,2,2-Tetrachloroethane	5.0	5.0	8260
Tetrachloroethene	5.0	5.0	8260
Toluene	5.0	5.0	8260
1,1,1-Trichloroethane	5.0	5.0	8260
1,1,2-Trichloroethane	5.0	5.0	8260
Trichloroethene	5.0	5.0	8260
Trichlorofluoromethane	5.0	5.0	8260
1,2,3-Trichloropropane	5.0	5.0	8260
Vinyl Acetate	10	10	8260
Vinyl Chloride	10	10	8260
Xylene	10	10	8260

TABLE 3-1

LABORATORY ANALYTICAL METHODS
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Semivolatiles	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
Acenaphthene	10	330	8270
Acenaphthylene	10	330	8270
Acetophenone	10	330	8270
2-Acetylaminofluorene	10	330	8270
4-Aminobiphenyl	20	330	8270
Aniline	20	330	8270
Anthracene	10	330	8270
Aramite	10	330	8270
Benzo(a)anthracene	10	330	8270
Benzo(b)fluoranthene	10	330	8270
Benzo(k)fluoranthene	10	330	8270
Benzo(g,h,i)perylene	10	330	8270
Benzo(a)pyrene	10	330	8270
Benzyl alcohol	10	330	8270
Bis(2-chloroethoxyl)methane	10	330	8270
Bis(2-chloroethyl)ether	10	330	8270
Bis(2-ethylhexyl)phthalate	10	330	8270
4-Bromophenyl phenyl ether	10	330	8270
Butylbenzylphthalate	10	330	8270
4-Chloroaniline	20	660	8270
4-Chloro-3-methylphenol	10	330	8270
2-Chloronaphthalene	10	330	8270
2-Chlorophenol	10	330	8270
4-Chlorophenyl phenyl ether	10	330	8270
Chrysene	10	330	8270
3&4 Methylphenol	10	330	8270
2-Methylphenol	10	330	8270
Diallate	10	330	8270
Dibenzofuran	10	330	8270
Di-n-butyl phthalate	10	330	8270
Dibenzo(a,h)anthracene	10	330	8270
o-Dichlorobenzene	10	330	8270
m-Dichlorobenzene	10	330	8270
p-Dichlorobenzene	10	330	8270
3,3'-Dichlorobenzidine	20	660	8270
2,4-Dichlorophenol	10	330	8270
2,6-Dichlorophenol	10	330	8270
Diethylphthalate	10	330	8270
p-(Dimethylamino)azobenzene	10	330	8270
7,12-Dimethyl benz(a)anthracene	10	330	8270

TABLE 3-1

LABORATORY ANALYTICAL METHODS
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Semivolatiles (Cont.)	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
3,3-Dimethyl benzidine	20	1,700	8270
2,4-Dimethylphenol	10	330	8270
alpha, alpha-Dimethylphenethylamine	2,000	67,000	8270
Dimethyl phthalate	10	330	8270
m-Dinitrobenzene	10	330	8270
4,6-Dinitro-2-methylphenol	50	1,700	8270
2,4-Dinitrophenol	50	1,700	8270
2,4-Dinitrotoluene	10	330	8270
2,6-Dinitrotoluene	10	330	8270
Di-n-octylphthalate	10	330	8270
1,4-Dioxane	10	330	8270
Dinoseb	10	330	8270
Ethylmethanesulfonate	10	330	8270
Fluoranthene	10	330	8270
Fluorene	10	330	8270
Hexachlorobenzene	10	330	8270
Hexachlorobutadiene	10	330	8270
Hexachlorocyclopentadiene	10	330	8270
Hexachloroethane	10	330	8270
Hexachlorophene	5,000	170,000	8270
Hexachloropropene	10	330	8270
Indeno(1,2,3-cd)pyrene	10	330	8270
Isophorone	10	330	8270
Isosafrole	10	330	8270
Methapyrilene	2,000	67,000	8270
3-Methylcholanthrene	10	330	8270
Methyl methanesulfonate	10	330	8270
2-Methylnaphthalene	10	330	8270
Naphthalene	10	330	8270
1,4-Naphthoquinone	10	330	8270
1-Naphthylamine	10	330	8270
2-Naphthylamine	10	330	8270
2-Nitroaniline	50	1,700	8270
3-Nitroaniline	50	1,700	8270
4-Nitroaniline	50	1,700	8270
Nitrobenzene	10	330	8270
2-Nitrophenol	10	330	8270
4-Nitrophenol	50	1,700	8270
4-Nitroquinoline-1-oxide	20	3,300	8270
n-Nitrosodi-n-butylamine	10	330	8270

TABLE 3-1

LABORATORY ANALYTICAL METHODS
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Semivolatiles (Cont.)	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
n-Nitrosodiethylamine	10	330	8270
n-Nitrosodimethylamine	10	330	8270
n-Nitrosodiphenylamine	NA	330	8270
n-Nitrosodi-n-propylamine	10	330	8270
n-Nitrosomethylethylamine	10	330	8270
n-Nitrosomorpholine	10	330	8270
n-Nitrosopiperidine	10	330	8270
n-Nitrosopyrrolidine	10	330	8270
5-Nitro-o-toluidine	10	330	8270
bis-(2-chloroisopropyl)ether	10	330	8270
Pentachlorobenzene	10	330	8270
Pentachloronitrobenzene	10	330	8270
Pentachlorophenol	50	1,700	8270
Phenacetin	10	330	8270
Phenanthrene	10	330	8270
Phenol	10	330	8270
1,4-Phenylenediamine	2,000	1,700	8270
2-Picolin	10	330	8270
Pronamide	10	330	8270
Pyrene	10	330	8270
Pyridine	50	330	8270
Safrole	10	330	8270
1,2,4,5-Tetrachlorobenzene	10	330	8270
2,3,4,6-Tetrachlorophenol	10	330	8270
o-Toluidine	10	330	8270
1,2,4-Trichlorobenzene	10	330	8270
2,4,5-Trichlorophenol	10	330	8270
2,4,6-Trichlorophenol	10	330	8270
1,3,5-Trinitrobenzene	10	330	8270
Miscellaneous Parameters			
TOC	1000	1000	9060

Notes:

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.
NA = Not Available.

TABLE 3-1

LABORATORY ANALYTICAL METHODS
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Inorganics	Quantitation Limits*		Method Number	Method Description
	Water (mg/L)	Low Soil (mg/kg)		
Antimony	20	2.0	6010	Inductively Coupled Plasma
Arsenic	10	1.0	6010	Inductively Coupled Plasma
Barium	10	1.0	6010	Inductively Coupled Plasma
Beryllium	4.0	0.4	6010	Inductively Coupled Plasma
Cadmium	5.0	0.5	6010	Inductively Coupled Plasma
Chromium	10	1.0	6010	Inductively Coupled Plasma
Cobalt	10	1.0	6010	Inductively Coupled Plasma
Copper	20	2.0	6010	Inductively Coupled Plasma
Lead	5.0	0.5	6010	Inductively Coupled Plasma
Mercury	0.2	0.02	7470/7471	Cold Vapor AA
Nickel	40	4.0	6010	Inductively Coupled Plasma
Selenium	10	1.0	6010	Inductively Coupled Plasma
Silver	10	1.0	6010	Inductively Coupled Plasma
Thallium	10	1.0	6010	Inductively Coupled Plasma
Tin	10	5.0	6010	Inductively Coupled Plasma
Vanadium	10	1.0	6010	Inductively Coupled Plasma
Cyanide	0.010	1.0	9012	Colorimetric
Sulfide	1.0	25	9030	Titrimetric, Iodine
Zinc	20	2.0	6010	Inductively Coupled Plasma

Note:

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

TABLE 3-2

GROUNDWATER LABORATORY ANALYTICAL METHODS
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Monitored Natural Attenuation Parameters	Quantitation Limits Water (mg/L)	Method Number
Dissolved Oxygen (DO)	50	Chemets (Field)
Nitrate	50	353.2
Ferrous Iron (Fe+2)	100	Hach Method 8146 (field)
Sulfate	5.0	375.4
Methane	0.19	SW 3810
Alkalinity	1000	Hach Alkalinity Test Kit (field)
Oxidation-Reduction Potential	0.1mV	Redox Meter (Field)
pH	unitless	Conductivity Meter (Field)
Temperature	degrees F	Conductivity Meter (Field)
Ethene[(1)]	0.19	SW 3810
Ethane[(1)]	0.19	SW 3810
Miscellaneous Parameters		
Groundwater Density	unitless	2520C
Salinity	ppt	Conductivity Meter (Field)

Notes:

[(1)] = Zone 4 - TCE Plume.
F = Fahrenheit.
ppt = parts per thousand.

TABLE 3-3

HIGH AND LOW SEASONAL GROUNDWATER LEVELS
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Monitor Well Number	Seasonal High (ft)*	Seasonal Low (ft)*
GW03	4.90	9.49
GW06	5.25	7.67
UGW09	4.76	9.90
UGW10	5.08	8.60
UGW11	5.45	8.27
UGW14	6.20	15.65

* All readings are in feet below surface level

TABLE 3-4

FREE PRODUCT LABORATORY ANALYTICAL METHODS
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Free Product	Quantitation Limits Water (mg/L)	Method Number
Fingerprint	50	8021
Brookville Kinematic Viscosity	Cintopoys	ASTM-2983
Product Density	unitless	2710F

APPENDIX A
SAMPLE MATRIX

APPENDIX A.1
SWMU 7/8 SAMPLES

APPENDIX A.1 *Revised 10/29/01*

SAMPLE MATRIX - SWMU 7/8
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample Media	Sample ID	Sample Depth (ft bgs)	Organics			Monitored Natural Attenuation Parameters									Metals		Misc. Parameter	TCE Parameters		Comments
						Field Measurements						Laboratory								
			Appendix IX Volatiles (8260)	Appendix IX Semivolatiles (8270)	Appendix IX Semivolatiles - (1) (8270)	Dissolved Oxygen (Chemets)	Ferrous Iron (FE+2) (Hach Method 8146)	Alkalinity (Hach Method 8221)	Oxidation-Reduction Potential (Redox Meter)	pH (pH Meter)	Temperature (Conductivity Meter)	Nitrate (300.0/353.2)	Sulfate (375.4)	Methane (SW3810)	Appendix IX Total Metals (6010)	Appendix IX Dissolved Metals (Field Filtered/6010)	Groundwater Density	Ethene & Ethane (SW3810)	TOC (9060)	
Groundwater	7MW03	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW05	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW06	NA	X	X		X	X	X	X	X	X	X	X	X	X	X	X			
	7MW07	NA	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	
	7MW07D	NA	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	Duplicate
	7MW07MS	NA	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	Matrix Spike
	7MW07MSD	NA	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	Matrix Spike Duplicate
	7MW08	NA	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	
	7MW09	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW10	NA	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	
	7MW11	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW12	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW13	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW14	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW15	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW16	NA	X	X		X	X	X	X	X	X	X	X	X	X	X	X			
	7MW17	NA	X	X		X	X	X	X	X	X	X	X	X	X	X	X			
	7MW18	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW18D	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				Duplicate
	7MW19	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW20	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	7MW21	NA	X	X		X	X	X	X	X	X	X	X	X	X	X	X			
	7MW22	NA	X	X		X	X	X	X	X	X	X	X	X	X	X	X			
	7MW23	NA	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	
	UGW06	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	UGW07	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	UGW08	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				

APPENDIX A.1 *Revised 10/29/01*

SAMPLE MATRIX - SWMU 7/8
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample Media	Sample ID	Sample Depth (ft bgs)	Organics			Monitored Natural Attenuation Parameters									Metals		Misc. Parameter	TCE Parameters		Comments
						Field Measurements						Laboratory								
			Appendix IX Volatiles (8260)	Appendix IX Semivolatiles (8270)	Appendix IX Semivolatiles - (1) (8270)	Dissolved Oxygen (Chemets)	Ferrous Iron (FE+2) (Hach Method 8146)	Alkalinity (Hach Method 8221)	Oxidation-Reduction Potential (Redox Meter)	pH (pH Meter)	Temperature (Conductivity Meter)	Nitrate (300.0/353.2)	Sulfate (375.4)	Methane (SW3810)	Appendix IX Total Metals (6010)	Appendix IX Dissolved Metals (Field Filtered/6010)	Groundwater Density	Ethene & Ethane (SW3810)	TOC (9060)	
Groundwater (Cont.)	UGW08D	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				Duplicate
	UGW08MS	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				Matrix Spike
	UGW08MSD	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				Matrix Spike Duplicate
	UGW09	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	UGW10	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	UGW11	NA	X	X		X	X	X	X	X	X	X	X	X	X	X	X			
	UGW15	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	UGW16	NA	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	
	UGW18	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	UGW20R	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	UGW20RD	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				Duplicate
	UGW23	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	UGW26	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	GW04	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	GW06	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	470MW01	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
	470MW03	NA	X	X		X	X	X	X	X	X	X	X	X	X	X				
Surface Water	7SW1	NA	X	X											X	X				
	7SW2	NA	X	X											X	X				
	7SW3	NA	X	X											X	X				
	7SW4	NA	X	X											X	X				
	7SW4D	NA	X	X											X	X				Duplicate
	7SW4MS	NA	X	X											X	X				Matrix Spike
	7SW4MSD	NA	X	X											X	X				Matrix Spike Duplicate
	7SW5	NA	X	X											X	X				
	7SW6	NA	X	X											X	X				
	7SW7	NA	X	X											X	X				

APPENDIX A.1 *Revised 10/29/01*

SAMPLE MATRIX - SWMU 7/8
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample Media	Sample ID	Sample Depth (ft bgs)	Organics			Monitored Natural Attenuation Parameters									Metals		Misc. Parameter	TCE Parameters		Comments
						Field Measurements						Laboratory								
			Appendix IX Volatiles (8260)	Appendix IX Semivolatiles (8270)	Appendix IX Semivolatiles - (1) (8270)	Dissolved Oxygen (Chemets)	Ferrous Iron (FE+2) (Hach Method 8146)	Alkalinity (Hach Method 8221)	Oxidation-Reduction Potential (Redox Meter)	pH (pH Meter)	Temperature (Conductivity Meter)	Nitrate (300.0/353.2)	Sulfate (375.4)	Methane (SW3810)	Appendix IX Total Metals (6010)	Appendix IX Dissolved Metals (Field Filtered/6010)	Groundwater Density	Ethene & Ethane (SW3810)	TOC (9060)	
Surface Water (Cont.)	7SW8	NA	X	X											X	X				
	7SW9	NA	X	X											X	X				
Surface Soil	7MW16-00	0.0-1.0	X	X											X					
	7MW17-00	0.0-1.0	X	X											X					
	7MW18-00	0.0-1.0	X	X											X					
	7MW18-00D	0.0-1.0	X	X											X					Duplicate
	7MW18-00MS	0.0-1.0	X	X											X					Matrix Spike
	7MW18-00MSD	0.0-1.0	X	X											X					Matrix Spike Duplicate
	7MW19-00	0.0-1.0	X	X											X					
	7MW20-00	0.0-1.0	X	X											X					
	7MW21-00	0.0-1.0	X	X											X					
	7MW22-00	0.0-1.0	X	X											X					
	7SB23-00	0.0-1.0	X	X											X					
	7SB24-00	0.0-1.0	X	X											X					
	7SB25-00	0.0-1.0	X	X											X					
	7SB26-00	0.0-1.0	X	X											X					
	7SB27-00	0.0-1.0	X	X											X					
Subsurface Soil	7MW16-XX	(2)			X															
	7MW17-XX	(2)			X															
	7MW18-XX	(2)			X														X	
	7MW18-XXD	(2)			X														X	Duplicate
	7MW18-XXMS	(2)			X														X	Matrix Spike
	7MW18-XXMSD	(2)			X														X	Matrix Spike Duplicate
	7MW19-XX	(2)			X														X	
	7MW20-XX	(2)			X														X	

APPENDIX A.1 *Revised 10/29/01*

SAMPLE MATRIX - SWMU 7/8
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample Media	Sample ID	Sample Depth (ft bgs)	Organics			Monitored Natural Attenuation Parameters									Metals		Misc. Parameter	TCE Parameters		Comments
						Field Measurements						Laboratory								
			Appendix IX Volatiles (8260)	Appendix IX Semivolatiles (8270)	Appendix IX Semivolatiles - [1] (8270)	Dissolved Oxygen (Chemets)	Ferrous Iron (FE+2) (Hach Method 8146)	Alkalinity (Hach Method 8221)	Oxidation-Reduction Potential (Redox Meter)	pH (pH Meter)	Temperature (Conductivity Meter)	Nitrate (300.0/353.2)	Sulfate (375.4)	Methane (SW3810)	Appendix IX Total Metals (6010)	Appendix IX Dissolved Metals (Field Filtered/6010)	Groundwater Density	Ethene & Ethane (SW3810)	TOC (9060)	
Subsurface Soil (Cont.)	7MW21-XX	[2]			X														X	
	7MW22-XX	[2]			X														X	
	7SB23-XX	[2]			X															
	7SB24-XX	[2]			X															
	7SB24-XXD	[2]			X															Duplicate
	7SB25-XX	[2]			X															
	7SB26-XX	[2]			X															
	7SB27-XX	[2]			X															
Sediment	7SD1	0.0-0.5	X	X											X				X	
	7SD2	0.0-0.5	X	X											X				X	
	7SD3	0.0-0.5	X	X											X				X	
	7SD4	0.0-0.5	X	X											X				X	
	7SD4D	0.0-0.5	X	X											X				X	Duplicate
	7SD5	0.0-0.5	X	X											X				X	
	7SD6	0.0-0.5	X	X											X				X	
	7SD7	0.0-0.5	X	X											X				X	
	7SD8	0.0-0.5	X	X											X				X	
	7SD9	0.0-0.5	X	X											X				X	
	7SD10	0.0-0.5	X	X											X				X	
	7SD10D	0.0-0.5	X	X											X				X	Duplicate
	7SD10MS	0.0-0.5	X	X											X				X	Matrix Spike
	7SD10MSD	0.0-0.5	X	X											X				X	Matrix Spike Duplicate
	7SD11	0.0-0.5	X	X											X				X	

APPENDIX A.1 *Revised 10/29/01*

SAMPLE MATRIX - SWMU 7/8
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample Media	Sample ID	Sample Depth (ft bgs)	Organics			Monitored Natural Attenuation Parameters									Metals		Misc. Parameter	TCE Parameters		Comments
						Field Measurements						Laboratory								
			Appendix IX Volatiles (8260)	Appendix IX Semivolatiles (8270)	Appendix IX Semivolatiles - [1] (8270)	Dissolved Oxygen (Chemets)	Ferrous Iron (FE+2) (Hach Method 8146)	Alkalinity (Hach Method 8221)	Oxidation-Reduction Potential (Redox Meter)	pH (pH Meter)	Temperature (Conductivity Meter)	Nitrate (300.0/353.2)	Sulfate (375.4)	Methane (SW3810)	Appendix IX Total Metals (6010)	Appendix IX Dissolved Metals (Field Filtered/6010)	Groundwater Density	Ethene & Ethane (SW3810)	TOC (9060)	
Sediment (Cont.)	7SD12	0.0-0.5	X	X											X				X	
	7SD13	0.0-0.5	X	X											X				X	
	7SD14	0.0-0.5	X	X											X				X	
Totals			89	89	16	44	44	44	44	44	44	44	44	44	89	56	6	8	34	

Notes:

[1] Report: Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Indeno(1,2,3-cd)pyrene, 2-Methlynaphthalene, Naphthalene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene.

[2] Sample will be collected from the most contaminated zone.

XX - The sample depth designator in which the sample was collected (i.e. 01 = 1-3 ft bgs, 02= 3-5 ft bgs, etc.).

ft bgs - feet below ground surface.

NA - Not Applicable.

APPENDIX A.2
QA/QC SAMPLES

TABLE A.2

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
QA/QC SAMPLES - SWMU 7/8
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	Analysis Requested Aqueous Samples					
Sample ID	Appendix IX VOCs	Appendix IX SVOCs	Appenid IX SVOCs [1]	Appendix IX Metals	TOC	Comments
Equipment Rinsates						
7ER01	X	X		X		Equipment Rinsate [2]
7ER02			X			Equipment Rinsate [3]
7ER03	X	X		X		Equipment Rinsate [4]
7ER04	X	X		X	X	Equipment Rinsate [5]
7ER05	X	X		X	X	Equipment Rinsate [6]
7ER06	X	X		X	X	Equipment Rinsate [7]
7ER07	X	X		X		Equipment Rinsate [8]
Trip Blanks						
7TB01	X					Trip Blank
7TB02	X					Trip Blank
7TB03	X					Trip Blank
7TB04	X					Trip Blank
7TB05	X					Trip Blank
7TB06	X					Trip Blank
7TB07	X					Trip Blank
7TB08	X					Trip Blank
7TB09	X					Trip Blank
Field Blanks						
2000FB01	X	X				Field Blank[a]
2000FB02	X	X				Field Blank[b]
2000FB03	X	X				Field Blank[c]
Totals	18	9	1	6	3	

Notes:

[1] - Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Indeno(1,2,3-cd)pyrene, 2-Methylnaphthalene, Naphthalene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene.

[2] - Stainless Steel Spoon.

[3] - Split Spoon.

[4] - Wildco Beta Plus horizontal water bottle.

[5] - Petite Ponar Dredge.

[6] - Eckman Dredge.

[7] - Sediment core liners.

[8] - Tubing used in the low flow sample procedure.

[a] - Lab Grade Deionized H_2O.

[b] - Store Bought Distilled H_2O.

[c] - NSRR Base Potable Water Supply.

APPENDIX A.3
PHASE SEPARATED HYDROCARBON SAMPLES

APPENDIX A.3

PHASE SEPARATED HYDROCARBON SAMPLE MATRIX
ADDITIONAL DATA COLLECTION TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample Media	Sample ID	Sample Depth (ft bgs)	Miscellaneous Parameter			Comments
			Fingerprint	Brookville Kinematic Viscosity	Product Density	
Free Product	PSH01	NA	X	X	X	
	PSH02	NA	X	X	X	
	PSH03	NA	X	X	X	
Totals			3	3	3	

Note:

NA - Not Applicable.
ft bgs - feet below ground surface.

APPENDIX B
USEPA REGION II - GROUNDWATER SAMPLING PROCEDURE
LOW STRESS (Low Flow) PURGING AND SAMPLING

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II

GROUND WATER SAMPLING PROCEDURE
LOW STRESS (Low Flow) PURGING AND SAMPLING

I. SCOPE & APPLICATION

This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region II standard method for collecting low stress (low flow) ground water samples from monitoring wells. Low stress Purging and Sampling results in collection of ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by minimizing stress on the geological formation and minimizing disturbance of sediment that has collected in the well. The procedure applies to monitoring wells that have an inner casing with a diameter of 2.0 inches or greater, and maximum screened intervals of ten feet unless multiple intervals are sampled. The procedure is appropriate for collection of ground water samples that will be analyzed for volatile and semi-volatile organic compounds (VOCs and SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and microbiological and other contaminants in association with all EPA programs.

This procedure does not address the collection of light or dense non-aqueous phase liquids (LNAPL or DNAPL) samples, and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: DNAPL Site Evaluation (Cohen & Mercer, 1993) and the RCRA Ground-Water Monitoring: Draft Technical Guidance (EPA/530-R-93-001), and references therein.

II. METHOD SUMMARY

The purpose of the low stress purging and sampling procedure is to collect ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing.

Sampling at the prescribed (low) flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well,

thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing an additional filtered sample from the same well. Second, this procedure minimizes aeration of the ground water during sample collection, which improves the sample quality for VOC analysis. Third, in most cases the procedure significantly reduces the volume of ground water purged from a well and the costs associated with its proper treatment and disposal.

III. ADDRESSING POTENTIAL PROBLEMS

Problems that may be encountered using this technique include a) difficulty in sampling wells with insufficient yield; b) failure of one or more key indicator parameters to stabilize; c) cascading of water and/or formation of air bubbles in the tubing; and d) cross-contamination between wells.

Insufficient Yield

Wells with insufficient yield (i.e., low recharge rate of the well) may dewater during purging. Care should be taken to avoid loss of pressure in the tubing line due to dewatering of the well below the level of the pump=s intake. Purging should be interrupted before the water level in the well drops below the top of the pump, as this may induce cascading of the sand pack. Pumping the well dry should therefore be avoided to the extent possible in all cases. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, ground water samples may be obtained with techniques designed for the unsaturated zone, such as lysimeters.

Failure to Stabilize Key Indicator Parameters

If one or more key indicator parameters fails to stabilize after 4 hours, one of four options should be considered: a) continue purging in an attempt to achieve stabilization; b) discontinue purging, do not collect samples, and document attempts to reach stabilization in the log book; c) discontinue purging, collect samples, and document attempts to reach stabilization in the log book; or d) Secure the well, purge and collect samples the next day (preferred). The key indicator parameter for samples to be analyzed for VOCs is dissolved

oxygen. The key indicator parameter for all other samples is turbidity.

Cascading

To prevent cascading and/or air bubble formation in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 or 3/8 inch ID) to ensure that the tubing remains filled with ground water during sampling.

Cross-Contamination

To prevent cross-contamination between wells, it is strongly recommended that dedicated, in-place pumps be used. As an alternative, the potential for cross-contamination can be reduced by performing the more thorough Adaily@ decontamination procedures between sampling of each well in addition to the start of each sampling day (see Section VII, below).

Equipment Failure

Adequate equipment should be on-hand so that equipment failures do not adversely impact sampling activities.

IV. PLANNING DOCUMENTATION AND EQUIPMENT

< Approved site-specific Field Sampling Plan/Quality Assurance Project Plan (QAPP). This plan must specify the type of pump and other equipment to be used. The QAPP must also specify the depth to which the pump intake should be lowered in each well. Generally, the target depth will correspond to the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump intake. In all cases, the target depth must be approved by the EPA hydrogeologist or EPA project scientist.

< Well construction data, location map, field data from last sampling event.

< Polyethylene sheeting.

< Flame Ionization Detector (FID) and Photo Ionization Detector (PID).

< Adjustable rate, positive displacement ground water sampling pump (e.g., centrifugal or bladder pumps constructed of stainless steel or Teflon). A peristaltic pump may only be used for inorganic sample collection.

< Interface probe or equivalent device for determining the presence or absence of NAPL.

< Teflon or Teflon-lined polyethylene tubing to collect samples for organic analysis. Teflon or Teflon-lined polyethylene, PVC, Tygon or polyethylene tubing to collect samples for inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.

< Water level measuring device, minimum 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).

< Flow measurement supplies (e.g., graduated cylinder and stop watch or in-line flow meter).

< Power source (generator, nitrogen tank, etc.).

< Monitoring instruments for indicator parameters. Eh and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Specific conductance, pH, and temperature may be monitored either in-line or using separate probes. A nephalometer is used to measure turbidity.

< Decontamination supplies (see Section VII, below).

< Logbook (see Section VIII, below).

< Sample bottles.

< Sample preservation supplies (as required by the analytical methods).

< Sample tags or labels, chain of custody.

V. SAMPLING PROCEDURES

Pre-Sampling Activities

1. Start at the well known or believed to have the least contaminated ground water and proceed systematically to the well with the most contaminated ground water. Check the well, the lock, and the locking cap for damage or evidence of tampering. Record observations.

2. Lay out sheet of polyethylene for placement of monitoring and sampling equipment.

3. Measure VOCs at the rim of the unopened well with a PID and FID instrument and record the reading in the field log book.

4. Remove well cap.

5. Measure VOCs at the rim of the opened well with a PID and an FID instrument and record the reading in the field log book.
6. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Note that the reference point should be surveyed for correction of ground water elevations to the mean geodesic datum (MSL).

7. Measure and record the depth to water (to 0.01 ft) in all wells to be sampled prior to purging. Care should be taken to minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well.

8. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment that has accumulated at the bottom of the well. Record the observations in the log book. If LNAPLs and/or DNAPLs are detected, install the pump at this time, as described in step 9, below. Allow the well to sit for several days between the measurement or sampling of any DNAPLs and the low-stress purging and sampling of the ground water.

Sampling Procedures

9. Install Pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well to the depth specified for that

well in the EPA-approved QAPP or a depth otherwise approved by the EPA hydrogeologist or EPA project scientist. The pump intake must be kept at least two (2) feet above the bottom of the well to prevent disturbance and resuspension of any sediment or NAPL present in the bottom of the well. Record the depth to which the pump is lowered.

10. Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

11. Purge Well: Start pumping the well at 200 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

    ±0.1 for pH
    ±3% for specific conductance (conductivity)
    ±10 mv for redox potential
    ±10% for DO and turbidity

    Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

13. Collect Samples: Collect samples at a flow rate between 100 and 250 ml/min and such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. VOC samples must be collected first and directly into sample

containers. All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container.

Ground water samples to be analyzed for volatile organic compounds (VOCs) require pH adjustment. The appropriate EPA Program Guidance should be consulted to determine whether pH adjustment is necessary. If pH adjustment is necessary for VOC sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 ml). Ground water purged from the well prior to sampling can be used for this purpose.

14. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

15. Measure and record well depth.

16. Close and lock the well.

VI. FIELD QUALITY CONTROL SAMPLES

Quality control samples must be collected to determine if sample collection and handling procedures have adversely affected the quality of the ground water samples. The appropriate EPA Program Guidance should be consulted in preparing the field QC sample requirements of the site-specific QAPP.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples should be collected during the sampling event:

< Field duplicates
< Trip blanks for VOCs only
< Equipment blank (not necessary if equipment is dedicated to the well)

As noted above, ground water samples should be collected systematically from wells with the lowest level of contamination

through to wells with highest level of contamination. The equipment blank should be collected after sampling from the most contaminated well.

VII. DECONTAMINATION

Non-disposable sampling equipment, including the pump and support cable and electrical wires which contact the sample, must be decontaminated thoroughly each day before use (Adaily decon@) and after each well is sampled (Abetween-well decon@). Dedicated, in-place pumps and tubing must be thoroughly decontaminated using Adaily decon@ procedures (see #17, below) prior to their initial use. For centrifugal pumps, it is strongly recommended that non-disposable sampling equipment, including the pump and support cable and electrical wires in contact with the sample, be decontaminated thoroughly each day before use (Adaily decon@).

EPA=s field experience indicates that the life of centrifugal pumps may be extended by removing entrained grit. This also permits inspection and replacement of the cooling water in centrifugal pumps. All non-dedicated sampling equipment (pumps, tubing, etc.) must be decontaminated after each well is sampled (Abetween-well decon,@ see #18 below).

17. **Daily Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Disassemble pump.

E) Wash pump parts: Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate

detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water.

G) Rinse the following pump parts with distilled/ deionized water: inlet screen, the shaft, the suction interconnector, the motor lead assembly, and the stator housing.

H) Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO_3).

I) Rinse impeller assembly with potable water.

J) Place impeller assembly in a large glass bleaker and rinse with isopropanol.

K) Rinse impeller assembly with distilled/deionized water.

18. **Between-Well Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Final Rinse: Operate pump in a deep basin of distilled/deionized water to pump out 1 to 2 gallons of this final rinse water.

VIII. FIELD LOG BOOK

A field log book must be kept each time ground water monitoring activities are conducted in the field. The field log book should document the following:

- Well identification number and physical condition.
- Well depth, and measurement technique.
- Static water level depth, date, time, and measurement technique.
- Presence and thickness of immiscible liquid layers and detection method.
- Collection method for immiscible liquid layers.
- Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Field observations of sampling event.
- Name of sample collector(s).
- Weather conditions.
- QA/QC data for field instruments.

IX. REFERENCES

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APPENDIX C
WORK PLAN FOR ECOLOGICAL RISK ASSESSMENT