Areas B and C Pre-Design Investigation Work Plan

Central Hudson Gas & Electric Corporation
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1. Introduction

On behalf of Central Hudson Gas & Electric Corporation (CHGE), BBL, an ARCADIS Company (BBL), has prepared this Pre-Design Investigation (PDI) Work Plan in accordance with an Order on Consent (Order) between the New York State Department of Environmental Conservation (NYSDEC) and CHGE (Index #D3-0001-95-06) dated October 1995. Under the Order, CHGE is required to investigate and, if necessary, remediate hazardous substances located at CHGE's former manufactured gas plant (MGP) in Newburgh, New York and in other areas where constituents from the former MGP may have migrated (the site). A site location map is provided on Figure 1.

Remedial investigation and feasibility study (RI/FS) activities were conducted at the site from 1996 to 2003. The objectives of the RI/FS were to characterize the nature and extent of impacts associated with the former MGP and to screen, evaluate, and select remedial alternatives to address those impacts. During the RI/FS process, the site was divided into three distinct areas primarily due to the varied land uses and physical characteristics of each of the three areas. This was also done for ease of evaluating remedial alternatives. Area A is the former MGP itself; Area B is the area between the former MGP and the Hudson River currently primarily occupied by the City of Newburgh sewage treatment plant (STP); and Area C is the Hudson River offshore from the former MGP and STP. These areas are shown on Figures 1 and 2.

A PDI Work Plan for Area A (BBL, 2006) was submitted to the NYSDEC in April 2006, and PDI activities in Area A were implemented in May and June 2006. This PDI Work Plan presents the scope of work for PDI activities that will be conducted in Areas B and C.

1.1 History and Background

This section provides a brief summary of the history of Areas B and C and a summary of the previous investigations and remedial actions performed in Areas B and C. A thorough evaluation of the site history and details pertaining to previous investigations and remedial actions can be found in the *Newburgh Project Remedial Investigation Report* (RI Report; BBL, 1999) and the *Revised Feasibility Study Report Newburgh Project* (FS Report; BBL, 2003).

1.1.1 History of Areas B and C

Between 1835 and 1926, the STP property and portions thereof were used for various industrial operations, including:

- Sawmills;
- Shipyards;
- Lumber dealers;
- Manufacturers of engines, boilers, and general machinery;
- Shipbuilders; and
- Railroad depots, freight yards, and repair shops.

In 1926, the City of Newburgh purchased the northernmost portion of the current STP property from the West Shore Railroad and New York Central Railroad Company. In 1963, the City of Newburgh built an incinerator on the northernmost portion of the property; the incinerator was in operation until approximately 1976. The remaining two parcels of the current STP property were purchased by the City of Newburgh in 1963 and 1967. The railroad facilities at the property were abandoned in 1968 prior to construction of the existing STP in the late 1960s. The shoreline/dockline of the Hudson River adjacent to the STP property has changed several times since 1865, as documented in the RI Report.

1.1.2 Pre RI/FS Investigations and Remedial Activities

This section provides an overview of investigation and remediation activities conducted in Area B prior to (or outside the scope of) the RI/FS process (no investigation/remediation activities were conducted in Area C prior to or outside the scope of the RI/FS).

Four geotechnical and three environmental investigations have been conducted at the STP. The geotechnical investigations were conducted in 1963, 1967, 1993, and 1994 in preparation for the original construction and planned expansion of the sewage treatment facilities. An investigation was conducted in 1994 by First Environment for the City of Newburgh. In 1995 and 1996, investigations were conducted by BBL in accordance with CHGE's Order with the NYSDEC.

The 1994 First Environment investigation was conducted in phases and included the advancement of soil borings and installation of monitoring wells at locations throughout the STP, and the collection and laboratory analysis of soil and groundwater samples. The detailed results of this investigation are presented in the *Initial Subsurface Investigation at Newburgh, New York, Sewage Treatment Facility* (First Environment, 1994).

BBL conducted additional investigations in 1995 and 1996 under the Order with NYSDEC to assess the extent of impacted soil in an area at the STP proposed by the City for the construction of a third clarifier. The data generated during these investigations were also used to evaluate short-term health and safety considerations of the workers during construction of the clarifier. These investigations included the advancement of soil borings and the collection and laboratory analysis of soil and groundwater samples. BBL also conducted a pump test in the proposed clarifier area to obtain data on the groundwater quality and anticipated groundwater-pumping rate to dewater the excavation during the clarifier construction activities. The detailed results of these investigations are presented in the *Soil Assessment Report, Proposed Clarifier Area, City of Newburgh Sewage Treatment Plant* (BBL, 1996).

In 1998 and 1999, CHGE implemented an interim remedial measure (IRM) to facilitate the City's construction of the third clarifier at the STP. The IRM consisted of the following:

- Excavation of soil (including MGP-impacted soil) to facilitate construction of the third clarifier;
- Transportation and offsite treatment/disposal of the excavated soil; and
- Removal and treatment of groundwater from the excavations.

A detailed description of the IRM is presented in the *Remedial Action Report for the Interim Remedial Measure* (Langan Engineering and Environmental Services, P.C., 1999).

1.1.3 Remedial Investigation/Feasibility Study

This section provides an overview of the activities conducted in Areas B and C during the RI/FS process, as well as a brief description of remedies selected for these areas as presented in the *Record of Decision Central Hudson Newburgh Site* (ROD; NYSDEC, 2005).

1.1.3.1 Remedial Investigation Activities

Initial RI activities were completed in 1996. Supplemental RI activities were performed in 1997, 1998, and 1999. The RI activities conducted in Areas B and C included a project area topographic survey, source investigation, geologic investigation, hydrogeologic investigation, Hudson River investigation, and ecological investigation. These investigations were conducted in general accordance with the following documents:

- Remedial Investigation Newburgh Project Work Plan (RI Work Plan; BBL, 1996);
- Sampling and Analysis Plan (BBL, 1996);
- Health and Safety Plan (BBL, 1996);
- Citizens Participation Plan (BBL, 1996);
- Supplemental Hudson River Investigation Plan (BBL, 1997);
- Supplemental Source and Hydrogeologic Investigation Plan (BBL, 1997);
- 1998 Supplemental RI Scope of Work (BBL, 1998); and
- Non-Aqueous Phase Liquid (NAPL) Evaluation Work Plan (BBL, 1998).

A detailed summary of the activities conducted and results obtained during the RI of Areas B and C is presented in the RI Report (BBL 1999). In addition, supplemental RI activities are also summarized in the FS Report (BBL, 2003).

1.1.3.2 Feasibility Study

Following the RI, an FS was prepared for the site to identify and evaluate remedial alternatives that: are appropriate for project-area-specific conditions; protective of human health and the environment; consistent with applicable laws, regulations, and guidance documents; cost-effective; and satisfy the site-specific remedial action objectives (RAOs). Several remedial alternatives were evaluated for each project area as part of the FS. The recommended remedial alternatives (as presented in the FS) for Areas B and C are summarized below:

- *Area B* – a combination of institutional controls, overburden NAPL removal along River Street and near the primary settling tanks, and the construction of a NAPL barrier wall (without long-term groundwater treatment).

- *Area C* – a combination of institutional controls, dredging of NAPL-impacted sediments, backfill/capping of the dredged area, dredging and below-grade sediment capping in remaining near-shore areas, and above-grade sediment capping over the remaining area with sediments containing PAHs at concentrations exceeding 20 milligrams per kilogram (mg/kg).

A more thorough description of each remedial alternative evaluated, as well as the details related to the selected alternatives, are presented in the FS Report.

1.1.4 Record of Decision

The ROD was issued by the NYSDEC in December 2005. The ROD presents the remedy selected for the site by the NYSDEC in accordance with the New York State Environmental Conservation Law. The following subsections summarize the components of the remedy selected by the NYSDEC for Areas B and C.

Area B – STP

- Development of a remedial design program to provide the details necessary to implement the selected remedy.

- Installation of tar collection wells and removal of MGP tar from the River Street area of the STP.

- In-situ chemical oxidation following the tar removal in the River Street area.

- Installation of a NAPL barrier wall on the bank of the Hudson River.

- Delineation and removal (if necessary) of contaminated soil along Renwick Street in an area identified by the City for expansion of the STP.

- Development of a Site Management Plan (SMP). The SMP will include the institutional controls and engineering controls (ICs/ECs) to: (a) address handling and disposal procedures for impacted soils that may be excavated from the site during future use or redevelopment; (b) evaluate the potential for vapor intrusion for any buildings developed on the site; (c) provide for the operation and maintenance of the components of the remedy; and (d) monitor groundwater quality and the presence of NAPL in collection wells. The SMP will also include a requirement to periodically provide an IC/EC certification and require the property owners to assist Central Hudson in the preparation of the IC/EC preparation.

- A requirement for Central Hudson to utilize best efforts to obtain an institutional control with the property owners in Area B that will restrict the use of groundwater and limit the use and development of the property to commercial, industrial, or restricted residential.

Area C – Hudson River

- Development of a remedial design program that will provide the details necessary to implement the selected remedy.

- Removal (and restoration as appropriate) of the existing rip-rap in the impacted shoreline area.

- Removal by dredging of NAPL-containing sediments with backfill/capping of the dredged area.

- Installation of a sediment cap in areas where PAH contamination remains in surficial sediments above the local background level of 20 milligrams per kilogram (mg/kg), or a modified concentration based on the results of toxicity testing to be conducted during the PDI. Construction of the cap will not be allowed to reduce average water depths below 6 feet (equivalent to 4 feet at low tide). In near-shore areas, this will require prior removal of sediment to create sufficient room for the cap. In areas of deeper water, the sediment cap may be built on the existing sediment surface, provided it can be constructed so that it will not significantly erode, the finished river bottom elevation provides at least 6 foot average water depth (equivalent to 4 feet at mean low tide), and does not interfere with near-shore boating access.

- Development of an SMP. The SMP will include the ICs/ECs to: (a) inspect, monitor, and maintain the sediment cap; (b) repair any damage or erosion of the cap; and (c) otherwise prohibit cap removal or activities in the area that will impact the integrity of the cap. The SMP will also include a requirement to periodically provide an IC/EC certification and require the property owners to assist Central Hudson in the preparation of the IC/EC preparation.

- Provide a notification of the existence of the cap to appropriate Federal and State agencies with jurisdiction over dredging activities to ensure that the cap is not removed without also managing the underlying contaminated sediment.

A full discussion of the selected alternative summarized above can be found in the ROD (NYSDEC, 2005).

1.2 PDI Objectives

The investigations conducted in Areas B and C to date were performed to provide sufficient information to characterize the current conditions at the site and to evaluate various remedial alternatives. However, prior to implementation of the alternatives selected by the NYSDEC as outlined above, a remedial design will be prepared. This PDI Work Plan presents a scope of work for the collection of the additional data necessary to facilitate the preparation of the remedial design for Areas B and C.

1.3 Work Plan Organization

This PDI Work Plan is organized into the following sections:

Section	Purpose
Section 1 – Introduction	Provides a discussion of the site history and background, objectives of the PDI, and organization of the PDI Work Plan.
Section 2 – Area B PDI Activities	Provides the scope of work for the PDI activities in Area B.
Section 3 – Area C PDI Activities	Provides the scope of work for the PDI activities in Area C.
Section 4 – Quality Assurance/ Quality Control	Provides an overview of the Quality Assurance/Quality Control (QA/QC) elements and procedures for the Area B and Area C PDI activities.
Section 5 – Data Reporting and Schedule	Provides a description of the data reporting activities to be completed following field activities, and a schedule for completion of the PDI.
Section 6– References	Presents a list of references cited in the PDI Work Plan.
Figures	Presents the Figures that are referenced throughout the PDI Work Plan.
Tables	Presents the Tables that are referenced throughout the PDI Work Plan.

Section	Purpose
Appendices	Appendix A presents the Standard Operating Procedures (SOPs) that will be followed in completing the PDI activities outlined herein. Appendix B presents the *Sediment Sample Collection and Analysis Work Plan for Evaluating PAH Bioavailability* (RETEC, 2006).

2. Area B PDI Activities

This section presents the scope of work for PDI activities in Area B. The PDI activities in Area B are being conducted to provide the following information required for the completion of the remedial design:

- The extent (horizontal and vertical) of NAPL-impacted soil along and west of the NAPL barrier wall area and in the vicinity of the proposed STP aeration tank expansion area;

- The elevation of the silt and clay layer along the NAPL barrier wall area;

- Topographic information in the vicinity of the proposed NAPL barrier wall and in the vicinity of the proposed STP aeration tank expansion;

- Geotechnical information along the NAPL barrier wall area;

- Waste disposal characteristics for soil that may be removed to facilitate the construction of the proposed NAPL barrier wall and the proposed STP aeration tank expansion;

- Hydrogeologic information for the STP property; and

- Identification and location of subsurface utilities and structures on the STP property.

To obtain this additional information, the following activities will be conducted as part of the PDI:

- Soil boring advancement and TarGOST probing;
- Cone-penetrometer test (CPT) probing;
- Soil and groundwater sampling, with laboratory analyses for waste disposal characterization;
- Piezometer installation;
- Long-term water-level monitoring;
- Specific capacity testing; and
- Field survey of topography, utilities, and site features.

The following sections present a scope of work for the PDI activities to be conducted for each task outlined above. Specific methods for the completion of the investigation activities outlined herein are presented in the SOPs included in Appendix A. Health and safety procedures to be followed during implementation of the PDI fieldwork will be as outlined in the Site-Specific Health and Safety Plan (HASP), which was submitted with the Area A PDI Work Plan.

The fieldwork will be conducted in such a way as to allow flexibility to modify this scope of work based upon field conditions. Additional investigation locations may also be added if field conditions (e.g., observations regarding the presence or absence of NAPL) indicate that such additional investigation is warranted.

The investigation locations discussed below will be surveyed with conventional survey equipment. Wastes generated during the investigation activities will be properly containerized for subsequent disposal by CHGE. Utility clearances will be obtained prior to initiating any subsurface investigation activities. This will require coordination with the City of Newburgh.

Additional information regarding the analytical methods and QA/QC requirements associated with the laboratory analyses/testing discussed in this section is presented in Section 4.

2.1 Delineation of NAPL-Impacted Soil

The objective of this task is to visually delineate the horizontal and vertical limits of NAPL-impacted soil along and west of the NAPL barrier wall and the proposed STP aeration tank expansion. PDI activities to be completed to achieve these objectives will consist of the following:

- Up to 10 TarGOST probes will be advanced west of the proposed NAPL barrier wall area (Figure 3). TarGOST probes will be advanced to a depth of approximately 1 foot into the silt and clay layer (approximate depth of 20 to 30 feet below ground surface [bgs]). At approximately 25% of the TarGOST locations, direct push technology (DPT) soil borings will also be completed, and soil samples will be collected continuously in 4-foot increments using a Macro-Core sampling device with disposable acetate liners. Field staff will record soil classification, depth to groundwater, and the presence and/or absence of NAPL, sheens, staining and odors.

- Up to 10 TarGOST probes will be advanced in the proposed STP aeration tank expansion area (Figure 3). TarGOST probes will be advanced approximately 1 foot into the silt and clay layer (approximate depth of 20 to 30 feet bgs). At approximately 25% of the TarGOST locations, DPT soil borings will also be completed, and soil samples will be collected continuously in 4-foot increments using a Macro-Core sampling device with disposable acetate liners. Field staff will record soil classification, depth to groundwater, and the presence and/or absence of NAPL, sheens, staining and odors.

2.2 Geotechnical Investigation

The objectives of this task are to obtain geotechnical data to support the design of the NAPL barrier wall and to determine the elevation of the top of the subsurface silt/clay layer along the proposed NAPL barrier wall area.

These data will be obtained by alternately advancing CPT probes (at six locations) and soil borings (at five locations) within the NAPL barrier wall area (Figure 3). The soil borings and CPT probes will be advanced to a depth of approximately 40 feet bgs (i.e., approximately 10 feet below the anticipated depth of the barrier wall) using a conventional drill rig. At each soil boring, continuous standard penetration testing (SPT) of the overburden will be performed using 2-inch outside diameter (O.D.) split-spoon samplers in accordance with ASTM D1586 (except where Shelby tubes or 3-inch diameter samples are collected). Prior to advancing the soil borings and CPT probes located within the inter-tidal zone of the river, the existing rip-rap material lining the bank will be removed and a drilling access pad will be built. The rip-rap material will be replaced following completion of the soil borings and CPT probes.

Up to five Shelby tube samples of silt/clay materials will also be collected (i.e., one at each of the soil boring locations) for the following laboratory analyses (sample locations and depth intervals to be determined in the field with consultation between field personnel and senior geotechnical engineering personnel in the office):

- moisture content (six samples; ASTM D2216);
- Atterberg limits (six samples; ASTM D4318);
- grain size – sieve and hydrometer (six samples; ASTM D422 and D1140);
- one-dimensional consolidation (three samples; ASTM D2435); and

- CU tri-axial compression with pore water measurement (three samples; ASTM D4767).

Up to eight samples of the sand/silt materials will be collected (using a 3-inch diameter split spoon with a brass-ringed liner, if necessary) for the following laboratory analyses (sample locations and depth intervals to be determined in the field based on subsurface conditions encountered):

- moisture content (eight samples; ASTM D2216);
- unit weight (eight samples);
- grain size – sieve and hydrometer (eight samples; ASTM D422 and D1140); and
- 3-point direct shear (three samples; ASTM D3080).

2.3 Waste Characterization

The primary purpose of waste characterization sampling is to provide information required to support the selection of a treatment and/or disposal facility for soil that may be removed during the Area B remediation activities. Three composite soil samples will be collected from the following locations in Area B:

- One sample along the barrier wall area;
- One sample from the area west of the barrier wall area; and
- One sample from the proposed STP aeration tank expansion area.

Each composite sample will be comprised of a minimum of three aliquots collected from the soil cuttings generated during the soil boring activities. The composite soil samples will be collected from borings where NAPL is observed in order to document the worst-case scenario for disposal. If NAPL is not encountered, the samples will be collected from borings evenly dispersed throughout the respective areas.

Two groundwater samples will also be collected and submitted for laboratory analyses. These data will be used to characterize groundwater that may be generated during the implementation of the remedial activities in this area for waste characterization purposes. Samples will be collected during development from the two shallow piezometers where the most visibly impacted soils were observed during the well drilling activities as described below in Section 2.4.

The analytical parameters for soil and groundwater waste characterization samples are listed in Table 2-1.

2.4 Hydraulic Characterization

The primary objective of this task is to evaluate hydraulic conditions to support the design of the barrier wall. In addition, secondary objectives are to determine the anticipated dewatering rates for excavations west of and along the barrier wall alignment (if required) and to obtain analytical data for use in evaluating groundwater treatment/disposal options.

Five piezometer clusters will be installed along the barrier wall area (Figure 3). Each piezometer cluster will consist of three piezometers, except for the cluster located east of the existing “W-8 series” monitoring wells, which will consist of four piezometers. At each cluster location, piezometers will be installed to screen the following depth intervals (depth intervals will be determined during drilling of the geotechnical soil borings discussed above in Section 2.2):

- The water table;
- The interval directly above the top of the silt/clay layer; and
- An interval in between the water table and the top of the silt/clay layer.

At the piezometer cluster located east of the existing W-8 series monitoring wells, a fourth piezometer will be installed to a depth of approximately 20 feet below the top of the silt/clay layer. The piezometers will consist of 1- or 2-inch diameter, schedule 40 polyvinylchloride (PVC) casings equipped with 1 to 2-foot long, 1- or 2-inch diameter 0.010-inch slotted screens. The piezometers installed directly above the silt/clay layer will include a 2 to 4-foot long sump grouted into the silt/clay. The piezometers will be installed and developed in accordance with the SOPs included in Appendix A. As indicated above in Section 2.3, during development of the shallow piezometers, two groundwater samples will be collected and submitted for laboratory analysis to characterize the groundwater for disposal purposes (samples will be collected from the two shallow piezometers where the most visibly impacted soils were observed during the piezometer installations).

As described further below in Section 2.5, the piezometers will be surveyed following installation, including location, ground-surface elevation, and top-of-casing elevation.

A stream gauge will be installed on the high water side of the inter-tidal zone within the Hudson River. The stream gauge will be surveyed (location and elevation) following installation.

Pressure transducers will be installed in nine piezometers and at the surface water gauge to collect continuous water level data**.** Monthly site visits will be conducted following installation to download the water level data collected by the transducers. Measurements will be recorded for a period of approximately one year to assess seasonal variability in hydraulic conditions. Each newly installed piezometer and existing monitoring well within Area B will be manually gauged during each site visit to verify the data collected by the pressure transducers and to document the presence/absence of NAPL. If sufficient NAPL is observed, up to four NAPL samples will be collected for laboratory analysis for density, solubility, viscosity, surface tension, and interfacial tension. NAPL not collected for laboratory analysis will be removed from the wells/piezometers (to the extent possible) and placed into containers for subsequent disposal by CHGE.

Specific capacity testing will be conducted at each of the newly installed piezometers and at up to 10 existing monitoring wells located adjacent to the barrier wall area. The specific capacity testing will be conducted in accordance with the SOP included in Appendix A.

2.5 Survey

Survey activities during the PDI at Areas B will be completed by a New York State licensed professional land surveyor. Survey should be completed to or exceeding third order accuracy. Survey activities will consist of the following:

- Obtaining a one-foot contour interval topographic survey along the barrier wall area. The survey will extend from approximately 50 feet west of the top of the slope to the low-tide line in the Hudson River, between the approximate locations of existing borings TB-29 and TB-31 (Figure 3);

- Identifying and surveying the locations of subsurface utilities that may interfere with the installation of the barrier wall;

- Identifying and surveying the location of the sunken barge;
- Identifying and surveying the locations of permanent site features (e.g., concrete slabs, buildings);
- Surveying the location and ground surface elevation at each investigation location (e.g., soil borings, TarGOST probes, CPT probes);
- Surveying the location, ground surface elevation, and top of casing elevation for each of the new piezometers to be installed as described above; and
- Surveying the location and elevation of the stream gauge to be installed on the high water side of the inter-tidal zone within the Hudson River as described above.

This task will also involve a review of utility drawings that cover the affected area and conducting site meetings with STP personnel and representatives from the various utility companies with knowledge of the subsurface utilities present at the site. If sufficient documentation is not available for review, a private third-party utility clearance contractor may be hired to assess conditions along the barrier wall area.

3. Area C PDI Activities

This section presents the scope of work for PDI activities in Area C (the Hudson River). The PDI activities in Area C are being conducted to provide the following information needed for the completion of the remedial design:

- The extent (horizontal and vertical) of NAPL-impacted sediments;
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- The extent (horizontal) of PAH-impacted sediments requiring capping (based on the potential toxicity and bioavailability of the PAH-impacted sediments);

- Waste disposal characterization for sediment to be removed during dredging and to facilitate capping;

- Geotechnical information for the sediment capping and dredging areas;

- Bathymetric survey data; and

- Hydrodynamic data.

To provide this information, the following activities will be conducted:

- Sediment boring advancement;
- Sediment sampling and laboratory analyses;
- TarGOST probing;
- CPT probing;
- Bathymetric survey; and
- Hydrodynamic modeling.

The following sections provide a scope of work for the PDI activities that will be conducted for each task outlined above. Specific methods for the completion of the investigation activities outlined herein are presented in the SOPs included in Appendix A. Health and safety procedures to be followed during implementation of the PDI fieldwork will be as outlined in the Site-Specific HASP, which was submitted with the Area A PDI Work Plan.

The fieldwork will be conducted in such a way as to allow flexibility to modify this scope of work based upon field conditions. Additional investigation locations may also be added if field conditions (e.g., observations regarding the presence or absence of NAPL) indicate that such additional investigation is warranted.

The investigation locations discussed below will be surveyed with survey-grade global positioning system (GPS). The survey accuracy using this instrumentation given the existing control at the site should be within less than one 1 inch. Wastes generated during the investigation activities will be properly containerized for subsequent disposal by CHGE. Utility clearances will be obtained prior to initiating any subsurface investigation activities.

Additional information regarding the analytical methods and QA/QC requirements associated with the laboratory analyses discussed in this section is presented in Section 4.

3.1 Horizontal and Vertical Delineation of NAPL-Impacted Sediments

Figure 4 shows the preliminary NAPL-impacted sediment dredging limits that were presented in the ROD. The objective of this task is to collect the additional data necessary to refine the horizontal and vertical extents of NAPL-impacted sediments requiring dredging. To accomplish this objective, TarGOST probes and/or sediment borings will be advanced at 20 locations as shown on Figure 4. Additional TarGOST probes (up to a total of 25 locations) and/or sediment borings may be advanced if the limits of NAPL-impacted sediments are not adequately delineated by the initial 20 locations shown on Figure 4.

At each location, TarGOST probing will initially be performed. After the TarGOST probing is conducted, sediment borings will be advanced at approximately 25% of the TarGOST probe locations to confirm the TarGOST results. The TarGOST probes and sediment borings will be advanced using a drill rig positioned on a flat-deck barge. The target depth of the TarGOST probes and sediment borings will be approximately 2 feet below observed NAPL impacts (a minimum depth of 10 feet below the sediment surface will be targeted). For the sediment borings, continuous sediment samples will be collected for visual observations; field staff will record sediment types/characteristics and the presence/absence of NAPL, sheens, staining, and odors. As indicated above, additional “step-out” or “step-in” TarGOST probes/sediment borings may be performed to delineate the NAPL-impacted sediment area, as appropriate. NAPL-impacted sediments will be considered those that contain oil- and/or tar-like material (sediments with just staining and/or sheens will not be considered NAPL-impacted) or have TarGOST fluorescence signatures that clearly indicate the presence of NAPL.

3.2 Horizontal Delineation of PAH-Impacted Sediments

Figure 5 shows the preliminary PAH-impacted sediment capping limits that were presented in the ROD. The objective of this task is to collect the additional data necessary to refine the horizontal extent of PAH-impacted sediments that may require capping. To accomplish this objective, a surficial sediment sampling program will be conducted and will include collection of sediment samples for PAH analysis as well as toxicity testing, benthic community testing, and PAH bioavailability analyses. The scope of this sampling program is summarized in the following subsections. A detailed work plan for the sediment toxicity and bioavailability study is presented in Appendix B.

The primary objective of the sampling and analysis program is to identify those areas of the Hudson River (outside of the proposed dredging area) where surficial sediments have total PAH concentrations greater than 20 mg/kg and exhibit PAH-related sediment toxicity greater than reference or background conditions. A secondary objective of the program is to provide bioavailability and sediment toxicity data to evaluate the feasibility of using new chemical methods for estimating the bioavailability and toxicity of PAHs.

3.2.1 Overall Approach to Capping Area Delineation

The program will follow an overall approach where the sediment capping area will be determined based on site-specific information regarding sediment chemistry and toxicity. The required data will be collected in a step-wise fashion to maximize efficiency and cost-effectiveness of the program. Specifically, the program will be conducted according to the following sequence of steps:

Step 1: Surficial sediment samples (i.e., samples collected from the 0- to 0.5-foot depth interval) will be collected at up to 32 locations (plus two background locations to be selected in the field) and analyzed for PAHs via USEPA SW-846 Method 8270 and total organic carbon (TOC) using USEPA SW-846 Method 9060. The rationale for selection of the number and location of samples is discussed in Section 3.2.2 below. The sediment sampling locations of samples that exhibit a total PAH concentration less than 20 milligrams per kilogram (mg/kg) will not require capping and no toxicity or bioavailability testing at those locations will be necessary.

Step 2: Following receipt of the PAH analytical results, sediment material collected and archived from 20 of the sampling locations where surficial sediment samples exhibit total PAH concentrations greater than 20 mg/kg (plus the two background locations) will be submitted for potential toxicity testing, benthic community studies, and bioavailability testing as described in Steps 3 through 5 below. The specific locations that will be selected for additional testing will be based (in part) on the number of samples that exceed 20 mg/kg and the overall range of total PAH concentrations. Ideally, the sample locations selected for additional testing would cover the full range of total PAH concentrations detected in the potential capping area. Surface water parameters consisting of water depth, pH, temperature, conductivity, salinity, dissolved oxygen (DO), and turbidity will also be measured and recorded during collection of the additional sediment samples.

Step 3: Samples will be submitted for toxicity testing from each of the locations selected under Step 2 (up to 20 locations plus the two background locations). The components of the sediment toxicity-testing program will include the following:

- Laboratory analysis of grain size, pH, ammonia, and TOC; and
- Amphipod 28-day chronic toxicity tests (*Hyalella azteca*).

Step 4: At up to 15 of the locations selected for toxicity testing under Step 2, bioavailability testing will be performed to supplement the on-going bioavailability research. The bioavailability testing will include the following:

- Analysis of pore water samples for parent and alkylated PAHs by solid-phase microextraction (SPME) followed by GC/MS;

- Analysis of pore water samples for dissolved organic carbon (DOC); and

- Analysis of sediment samples for soot organic carbon (SOC).

Step 5: Initially, benthic community testing will be performed at 15 of the sampling locations selected for toxicity testing under Step 2 (i.e., the same locations selected for bioavailability testing) for identification and enumeration of taxa to assess impairment. However, benthic community testing will also be completed on any of the remaining seven samples (i.e., 22 toxicity samples less the initial 15 benthic samples) that are positive for toxicity and not initially tested for benthic community. If necessary, the benthic community data will be compared to site-specific background data and/or regional background data from historic studies (i.e., the *Hudson River Estuary Biocriteria Report* [NYSDEC, 2003]).

Sediment sample locations that will require capping will include those locations having total PAH concentrations greater than 20 mg/kg and that exhibit toxic effects (based on both the sediment toxicity tests and impaired benthic communities). If necessary, the data may also be used to determine a “no-effects level” such that sample locations where total PAHs are greater than 20 mg/kg, but where toxicity testing was not performed, can be defined as requiring or not requiring capping based on total PAH concentration only (i.e., a “no-effects level” greater than 20 mg/kg).

3.2.2 Sample Locations

The sediment samples will be collected from areas of the Hudson River that are outside of the proposed NAPL-impacted sediment dredging area and have historically been shown to have total PAH concentrations greater than 20 mg/kg. Sample locations will be established using a grid approach. The grid pattern will be established with transects spaced approximately every 50 feet and extending from the shoreline up to approximately 250 feet into the river. Samples will be collected approximately every 50 feet at the approximate center points of the grid boxes. A sampling grid of this size results in approximately 32 sample locations. The proposed sample grid and sampling locations are shown on Figure 5. Note, however, that the sample locations are subject to modification based on the results of the NAPL-impacted sediment delineation described in Task 3.1.

The two background samples identified in the sampling scheme above will be selected in the field. The background areas will be outside of the immediate area of potential influence from the site, yet will exhibit habitat and sediment characteristics similar to those observed in areas adjacent to the site (to the extent practical).

3.2.3 Sample Collection and Analysis

As discussed above in Section 3.2.1, sediment samples will be collected during one sampling effort. Initially sediment samples will be collected with a Lexan tube, split-spoon, and/or core-barrel sampler. Sediment samples will be collected to a depth of approximately three feet below the sediment surface. Samples from the 0.5- to 1-foot, 1- to 2-foot, and 2- to 3-foot depth intervals will be archived for potential future analysis. These archived samples will be stored in a freezer at CHGE’s offices in Poughkeepsie, New York. Field observations will be recorded during sample collection and will include a description of the sediment materials, the presence of sheens or tar-like materials, sediment odor, color, and texture.

Surface sediment samples will then be collected from the 0 to 0.5 foot depth interval using a dredge-type sampler (e.g., ponar dredge). Sufficient sediment volume will be collected for PAH and TOC analysis as well as toxicity, benthic community, and bioavailability testing. Sediment will be collected and homogenized in a 5 gallon pail. A sediment sample from the homogenized surface sediment will then be collected and submitted for laboratory analysis of PAHs via USEPA SW-846 Method 8270 and TOC using USEPA SW-846 Method 9060 on an expedited 5-day turnaround basis for receipt of preliminary results. The remainder of the surface sediment sample volume will be processed and archived for potential analysis for toxicity, benthic community, and bioavailability testing.

Up to 20 of the sampling locations where surficial sediment samples exhibit total PAH concentrations greater than 20 mg/kg (plus the two background locations) will be submitted for toxicity testing. As indicated above, the locations selected for toxicity testing will be based (in part) on the number of samples that exceed 20 mg/kg and the overall range of total PAH concentrations. Ideally, the sample locations selected for additional testing would cover the full range of total PAH concentrations detected in the potential capping area. Additionally, 15 of the 22 samples chosen for toxicity testing will be selected and submitted by RETEC for benthic community and bioavailability testing. However, as indicated above, benthic community testing will also be completed on any of the remaining seven samples (i.e., 22 toxicity samples less the initial 15 benthic samples) that are positive for toxicity and not initially tested for benthic community.

If after completion of the sediment toxicity studies, it is determined that capping of the PAH-impacted sediments is necessary, then the sediment samples from the 0.5- to 1.5-foot, 1.5- to 2.5-foot, and/or the 2.5- to 3-foot depth intervals may also be submitted for analysis of PAHs. These samples will be analyzed, as necessary, to determine PAH mass for cap design considerations. In the addition, for near-shore capping areas where sediment may require removal prior to capping, (i.e. in order to maintain minimum water depth requirements as stipulated in the ROD), these samples will be analyzed, as necessary, to determine the depth of removal and evaluate whether backfill or capping will be necessary following removal of the sediments.

Additional information regarding the sample collection and analysis techniques are presented in the SOPs included as Appendix A and the RETEC work plan included as Appendix B.

As indicated above, the sediment samples will be analyzed for one or more of the parameters described in Section 3.2.1. Additional details regarding the analytical methods are presented in Section 4.2.

3.3 Waste Characterization

The primary purpose of waste characterization sampling is to provide information required to support the selection of a treatment and/or disposal facility for sediments removed during the Area C remediation activities. Two composite sediment samples will be collected from the NAPL-impacted sediment dredging area: one from the northern half and one from the southern half of the dredging area. Each composite sample will be composed of a minimum of three aliquots collected from sediment borings spatially distributed within each targeted area. To document the worst-case scenario, aliquots will be collected from borings containing NAPL-impacted sediments. If NAPL is not encountered, the samples will be collected from borings evenly dispersed throughout the area (i.e., the northern or southern half of the dredging area). Waste characterization sediment samples will be collected in conjunction with the NAPL-impacted sediment delineation activities described in Section 3.1.

The analytical parameters for the sediment waste characterization samples are detailed in Table 2-1.

3.4 Geotechnical Evaluation

The objectives of this task are to:

1) obtain geotechnical data required to design the excavation support systems for the NAPL-impacted sediment dredging area; 2) obtain geotechnical data for designing the above- and below-grade PAH-impacted sediment caps (if necessary); and 3) assess potential material handling requirements during sediment removal activities.

To accomplish these objectives, the following geotechnical evaluation activities will be performed:

- Geotechnical borings will be advanced at up to three locations (shown on Figure 4) and CPT probes will be advanced at up to five locations (outside the proposed limits of the NAPL-impacted sediment dredging area – locations to be determined in the field). The geotechnical borings and CPT probes will be advanced to approximately 40 feet below the sediment surface. At each boring, continuous SPT testing of the sediments will be performed using 2-inch O.D. split-spoon samplers in accordance with ASTM D1586. Field personnel will visually characterize each sediment sample for soil type and the presence of any NAPL, visual staining, sheens, and obvious odors. The CPT will be conducted using a high-sensitivity probe (e.g., a "sludge cone"); and

- Soil samples will be collected from each of the TarGOST confirmation soil boring locations (as described in Section 3.1) completed within the NAPL-impacted sediment removal area (up to 5 samples) and submitted for laboratory testing for moisture content (ASTM D2216); Atterberg limits (ASTM D4318); and grain size – sieve and hydrometer.

If after completion of the sediment toxicity studies, capping the PAH-impacted sediments is necessary, then additional geotechnical borings and testing will be completed. The exact scope of work will be submitted as an addendum to the PDI Work Plan and will include the following elements: geotechnical borings, CPT borings, and laboratory geotechnical testing. The following laboratory geotechnical tests are anticipated: direct shear or C.U. triaxial shear (to be determined in the field), grain size with hydrometer (ASTM D422 and D1140), Atterberg limits (ASTM D4318), unit weight, and moisture content (ASTM D2216).

3.5 Bathymetric Survey

The objective of this task is to obtain bathymetric survey information to aid in designing the NAPL-impacted sediment dredging and PAH-impacted sediment capping alternatives. To accomplish this objective, a detailed (i.e., 1-foot contour interval) bathymetric survey of the proposed dredging and capping areas will be performed. The bathymetric survey will be performed across transects established throughout the targeted survey area. A surface water gauge will be installed near the site to aid in interpreting the bathymetric data. Upon the completion of field activities, the bathymetric profiles will be adjusted using the tide data so that the depth data is reported relative to mean sea level. The accuracy of the bathymetry survey will meet or exceed the United States Army Corps of Engineers (USACE) Class 1 Hydrographic Survey Standard (USACE, 2002).

3.6 Hydrodynamic Modeling

The objective of this task is to obtain the data necessary to develop a model to predict post-remediation (i.e., post-sediment-dredging and capping) velocities, water depths**,** sediment characteristics**,** and hydrodynamic forces under various hydraulic conditions (e.g., long-term and episodic events). The modeling data will be used to determine specific design parameters related to the capping activities.

Following a review of the PAH distribution and toxicity testing data, and determination of the need for and extent of sediment capping, the need for this task will be re-assessed and, if determined to be needed, a scope of work would be submitted as an addendum to the PDI Work Plan.

4. Quality Assurance/Quality Control

This section provides a summary of appropriate and applicable QA/QC elements and procedures for the Area B and Area C PDI activities.

4.1 Project Organization

On behalf of CHGE, BBL will be responsible for implementing the PDI field activities and protocols described herein, including the specified investigation activities and preparation of the specified report deliverables. RETEC will be subcontracted to CHGE to perform various activities associated with the sediment toxicity testing and bioavailability study work. Laboratory chemical analyses will be performed by NYSDOH ELAP certified laboratories[1]. Geotechnical analyses will be performed by a qualified geotechnical laboratory. Overall project direction will be provided by CHGE, with review by NYSDEC.

Key personnel involved with the implementation of this PDI work plan are anticipated to include:

CHGE

- Tera Stoner, Project Manager

BBL

- Nancy Gensky – Client Principal-in-Charge
- Mark Gravelding, P.E. – Vice President, Engineer-in-Charge
- Doug Weeks – Project Manager
- Jason Brien, P.E., – PDI Task Manager
- Dave Bessingpas – PDI Task Manager
- Steve Montagna, P.E. – Project Geotechnical Engineer
- David Cornell – Field Supervisor
- Dennis Capria – Data Management Supervisor

BBL Subcontractors

- Parratt-Wolff, Inc. – Drilling
- Dakota Technologies Inc.– TarGOST Probing
- Severn Trent Laboratories (STL) – Analytical Laboratory
- PW Laboratories, Inc. – Geotechnical Laboratory
- Morris Associates, P.L.L.C. - Surveying

BBL and CHGE are currently in the process of procuring other subcontractors for field services. The names of the selected subcontractors will be provided to NYSDEC via email after the entities have been selected.

[1] As discussed in Appendix B, some of the laboratory analyses to be conducted as part of the toxicity/bioavailability testing components of the Area C PDI will be conducted by laboratories that were used by RETEC on other sites as part of their MGP sediment toxicity/bioavailability study. These laboratories may not be NYSDOH ELAP certified.

RETEC

- Joe Kreitinger – Project Manager

RETEC Subcontractors

- AquaTox Research, Inc. – Toxicity Laboratory
- Energy & Environment Research Center (EERC) – University of North Dakota – Bioavailability Laboratory
- STL – Analytical Laboratory
- Aquatec Biological Sciences, Inc. – Benthic Invertebrate Laboratory

4.2 Analytical Procedures and Laboratories

In general, laboratory analyses will be performed using USEPA SW-846 Methods (as referenced in the NYSDEC Analytical Service Protocol) and QA/QC requirements[2]. Category B deliverables will be provided for all chemical analyses (excluding disposal/characterization samples). A summary of the sample matrices, analyses/tests, analytical/test methods, and approximate sample numbers (both investigation and QA/QC samples) is provided in Table 4-1. The laboratories selected for each analysis are also summarized in Table 4-1.

Waste disposal characterization samples will be analyzed by STL using the analytical methods specified in Table 4-1. QA/QC associated with the disposal characterization samples will include analysis of one trip blank sample for VOC analysis per cooler.

Geotechnical laboratory testing will be performed by PW Laboratories, Inc. using the ASTM methods listed in Sections 2.2 and 3.4. No QA/QC samples are anticipated to be collected and analyzed as part of the geotechnical sampling.

4.3 Standard Operating Procedures

The Area B and Area C PDI activities will be performed in accordance with the SOPs presented in Appendix A. SOPs for the following activities are provided in Appendix A:

- Soil Boring Installation and Sampling;
- Monitoring Well Installation;
- Monitoring Well Development;
- Fluid Level Measurement and Sampling for Monitoring Wells;
- Specific Capacity Testing;
- Sediment Sampling;
- Surficial Sediment Sampling;
- Benthic Community Sampling;
- TarGOST Probing;

[2] As discussed in Appendix B, non-NYSDEC ASP methods may be used for some of the toxicity/bioavailability analyses. In addition, for the waste characterization samples, the analytical methods to be used are as specified by the treatment/disposal facility and may not be NYSDEC ASP methods.

- Field Documentation;
- Chain-of-Custody, Handling, Packing, and Shipping;
- Equipment Cleaning; and
- Handling and Storage of Investigation-Derived Waste.

SOPs for Toxicity Testing and Bioavailability Testing are provided in Appendix B.

4.4 Training Requirements/Certifications

In compliance with the Occupational Safety and Health Administration's (OSHA) final rule, "Hazardous Waste Operations and Emergency Response," 29CFR§1910.120(e), personnel performing PDI field activities will have completed the training requirements for OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER). Persons in field supervisory positions will also have completed the requisite OSHA Supervisory Training. Additional training/certification requirements are presented in the HASP.

4.5 Field Instrument Calibration and Maintenance

Field instrumentation will be required for air monitoring activities as outlined in the HASP. Field personnel will be responsible for ensuring that the field instruments used on the site are properly calibrated and maintained in accordance with the manufacturer's specifications. The field personnel will also be responsible for ensuring that a master calibration/maintenance log is maintained following the procedures specified for each measuring device. Instruments and equipment used to gather, generate, or measure environmental data will be calibrated at the intervals specified by the manufacturer or more frequently, and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. In the event that an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be returned to the manufacturer for service. Equipment found to be out of tolerance during the period of use shall be removed from the field.

Equipment which requires charging or batteries will be fully charged and have fresh batteries. Appropriate spare parts will be made available for field meters, as practicable.

4.6 Field Documentation

Field personnel will provide appropriate documentation of the Area B and Area C PDI activities. This documentation consists of a record that allows reconstruction of field events to aid in the data review and interpretation process. Documents, records, and information relating to the performance of the fieldwork will be retained in the project file.

The various forms of documentation to be maintained throughout the PDI activities include:

- <u>Daily Documentation</u> – A field logbook consisting of a waterproof, bound notebook will be maintained each day by field personnel. The field logbook will contain a record of the weather conditions and the PDI activities performed at the Site.

- <u>Photo/Video Documentation</u> – Field personnel will document the PDI field activities and conditions using photos taken with a digital camera. A videotape recorder may also be used, as appropriate.

- Sampling Information – Detailed notes will be made as to the investigation locations and physical observations of the materials being sampled. Land-based investigation locations (e.g., soil borings) will be staked and labeled in the field for subsequent surveying.

- Sample Custody – Chain-of-custody (COC) forms will provide the record of responsibility for sample collection, transport, and submittal to the laboratories. COC forms will be filled out at the end of each day of sampling by field personnel responsible for sample custody. In the event that the samples are relinquished by the designated sampling person to other sampling or field personnel, the COC form will be signed and dated by the appropriate personnel to document the sample custody transfer. The original COC form will accompany the samples to the laboratory, and copies will be placed in the project files. A sample COC form is included in Appendix A in the SOP titled *Field Sample Designation, Containerization, Preservation, Handling, Packaging, and Shipping.* Persons will have custody of samples when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

5. Data Reporting and Schedule

5.1 Data Reporting

CHGE will prepare a data summary report summarizing the data generated by the PDI activities outlined herein. The data summary report will be submitted to the NYSDEC. It is anticipated that the data summary report will include a description of the field activities conducted, summary tables and figures presenting the data, boring locations and logs, well construction logs, relevant site photographs, and modeling results. The data summary report will present the following:

- geologic and hydraulic information, and NAPL distribution, along and west of the NAPL barrier wall area;
- limits of NAPL-impacted sediments requiring dredging; and
- limits of PAH-impacted sediments requiring below-grade and/or above-grade capping (if any).

Upon concurrence by the NYSDEC, these conceptual remediation locations/limits will form the basis of the remedial design for Area B and Area C.

Prior to submittal of the data summary report, a separate letter report presenting the toxicity testing, benthic community and bioavailability testing results will be submitted to NYSDEC. The results of this testing will be used to determine the need for and extent of capping of PAH-impacted sediments. If capping is required, the scope of the conditional work efforts outlined in this work plan will be finalized in an addendum to the PDI Work Plan.

5.2 Preliminary Schedule

As previously discussed with the NYSDEC, we anticipate that the Area B and Area C PDI activities will begin the week of August 21, 2006. Some of the PDI activities (e.g., long-term water level monitoring) will require approximately 9 to 12 months to complete, while others are anticipated to be completed in one month or less. CHGE anticipates that the data summary report for intrusive PDI activities will be submitted to the NYSDEC in the fourth quarter of 2006 with a secondary submittal summarizing the results of the long-term monitoring in the fourth quarter of 2007.

6. References

First Environment, 1994. *Initial Subsurface Investigation at Newburgh, New York, Sewage Treatment Facility.*

NYSDEC, 1995. *Order on Consent between NYSDEC and CHGE, Index #D3-0001-95-06.*

BBL, 1996. *Soil Assessment Report, Proposed Clarifier Area, City of Newburgh Sewage Treatment Plant.*

BBL, 1996. *Remedial Investigation Newburgh Project Work Plan.*

BBL, 1996. *Sampling and Analysis Plan.*

BBL, 1996. *Health and Safety Plan.*

BBL, 1996. *Citizens Participation Plan.*

BBL, 1997. *Supplemental Hudson River Investigation Plan.*

BBL, 1997. *Supplemental Source and Hydrogeologic Investigation Plan.*

BBL, 1998. *Supplemental RI Scope of Work.*

BBL, 1998. *Non-Aqueous Phase Liquid Evaluation Work Plan.*

Langan Engineering and Environmental Services, P.C., 1999. *Remedial Action Report for the Interim Remedial Measure.*

BBL, 1999. *Newburgh Project Remedial Investigation Report.*

BBL, 2003. *Revised Feasibility Study Report Newburgh Project.*

NYSDEC, 2005. *Record of Decision Central Hudson Newburgh Site.*

BBL, 2006. *PDI Work Plan for Area A.*

Tables

TABLE 2-1

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
NEWBURGH PROJECT
NEWBURGH, NEW YORK

WASTE CHARACTERIZATION LABORATORY ANALYTICAL METHODS

Sample Type	Analytical Method
Soil and Sediment	• TPH – USEPA SW-846 8015 • TCLP VOCs – USEPA SW-846 8260B • Total VOCs – USEPA SW-846 8260B • Total BTEX – USEPA SW-846 8260B • TCLP SVOCs – USEPA SW-846 8270C • Total SVOCs – USEPA SW-846 8270C • Total PCBs – USEPA SW-846 8082 • TCLP Pesticides – USEPA SW-846 8081 • TCLP Herbicides – USEPA SW-846 8150 • Total Metals – USEPA SW-846 6000/7000 Series • TCLP Metals – USEPA SW-846 6000/7000 Series • Total Cyanide – USEPA SW-846 9010 • Corrosivity – USEPA SW-846 9040/9045 • Reactivity – USEPA SW-846 8082 7.3.2 • Ignitability – USEPA SW-846 1010 • pH – USEPA SW-846 9045 • Total Organic Halogens (TOX) • Moisture Content – ASTM D2216 • Total Sulfur • Percent Sulfur • BTU Content
Groundwater	• VOCs – USEPA SW-846 8260 • SVOCs – USEPA SW-846 8270 • PCBs – USEPA SW-846 8082 • TAL Inorganics (including cyanide) – USEPA SW-846 6010/ 9010 • Oil and Grease – USEPA SW-846 1664 • Chemical Oxygen Demand (COD) – USEPA SW-846 410.4 • Total Suspended Solids (TSS) – USEPA SW-846 160.2

TABLE 4-1 *DRAFT*

CENTRAL HUDSON GAS & ELECTRIC CORPORATION

NEWBURGH PROJECT
NEWBURGH, NEW YORK

AREAS B AND C PRE-DESIGN INVESTIGATIONS - SUMMARY OF FIELD AND QA/QC SAMPLING/ANALYSIS

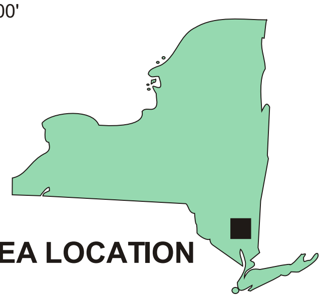
Matrix	Parameter/Test	Analytical/ Test Method [3]	Laboratory [4]	Field Samples[6]	Blind Duplicates	Blanks (Aqueous)	Matrix Spikes	Spike Duplicates	Total
NAPL	Density	--	QU	4	0	0	0	0	4
	Solubility	--	QU	4	0	0	0	0	4
	Viscosity	--	QU	4	0	0	0	0	4
	Interfacial tension	--	QU	4	0	0	0	0	4
Sediment	Polycyclic aromatic hydrocarbons (PAHs	USEPA SW-846 8270	STL	32	2	0	2	2	38
	Total organic carbon (TOC)	USEPA SW-846 9060	STL	32	2	0	2	2	38
	Grain Size (Sieve and Hydrometer) [2]	ASTM D421/D422/D1140	STL	15	0	0	0	0	15
	pH	USEPA SW 846 9045C	STL	15	1	1	1	1	19
	Ammonia	USEPA 350.2	STL	15	1	1	1	1	19
	Total organic carbon (TOC)	B	EERC	15	3	3	3	3	27
	Amphipod 28-day toxicity tests	USEPA 100.4	AquaTOX	22	0	0	0	0	22
	Benthic community identification and enumeration	--	Aquatec	15	0	0	0	0	15
	Soot organic carbon (SOC) [5]	C	EERC	15	0	0	0	0	15
Pore Water	Parent and alkylated PAHs [5]	D	EERC	15	0	0	0	0	15
	Dissolved organic carbon (DOC) [5]	E	EERC	15	0	0	0	0	15

Notes:
1. If the actual number of samples differs from those indicated above, QA/QC samples will be collected at a frequency of 1 per 20 field samples.
2. Additional samples may be tested for grain size as part of the geotechnical evaluations; those samples are not accounted for in this table.
3. Analytical test methods:
   A = sonication in 1:1 methylene chloride: acetone mixture for 18 hours followed by GC/MS analysis
   B = sample acidified to remove carbonates, followed by triplicate analysis using a Leeman CE 44 Elemental Analyzer modified for sediment analysis
   C = heat stable TOC following pretreatment at 375^{o}C for 24 hours
   D = centrifugation and flocculation of sediment samples followed by solid phase micro extraction and GC/MS analysis
   E = SM 5310C Persulfate-Ultraviolet Oxidation Method
4. Laboratories:
   QU = Queens University of Queens, Ontario, Canada
   EERC = Energy & Environment Research Center, University of North Dakota
   STL = Severn Trent Laboratories, Inc. of Burlington, VT
   AquaTOX = AquaTOX Research, Inc. of Syracuse, NY
   Aquatec = Aquatec Biological Sciences of Williston, Vermont
5. The QA/QC samples for the sediment bioavailability studies will be consistent with the procedures outlined in the RETEC Work Plan (Appendix B).
6. Initially 15 of the 22 samples selected for toxicity testing will be tested for benthic community. However, benthic community testing will be conducted on any of the remaining seven samples that are positive for toxicity and not initially selected for benthic community testing.

Figures

900' 0 900'

Approximate Scale: 1" = 900'



AREA LOCATION

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
NEWBURGH, NEW YORK

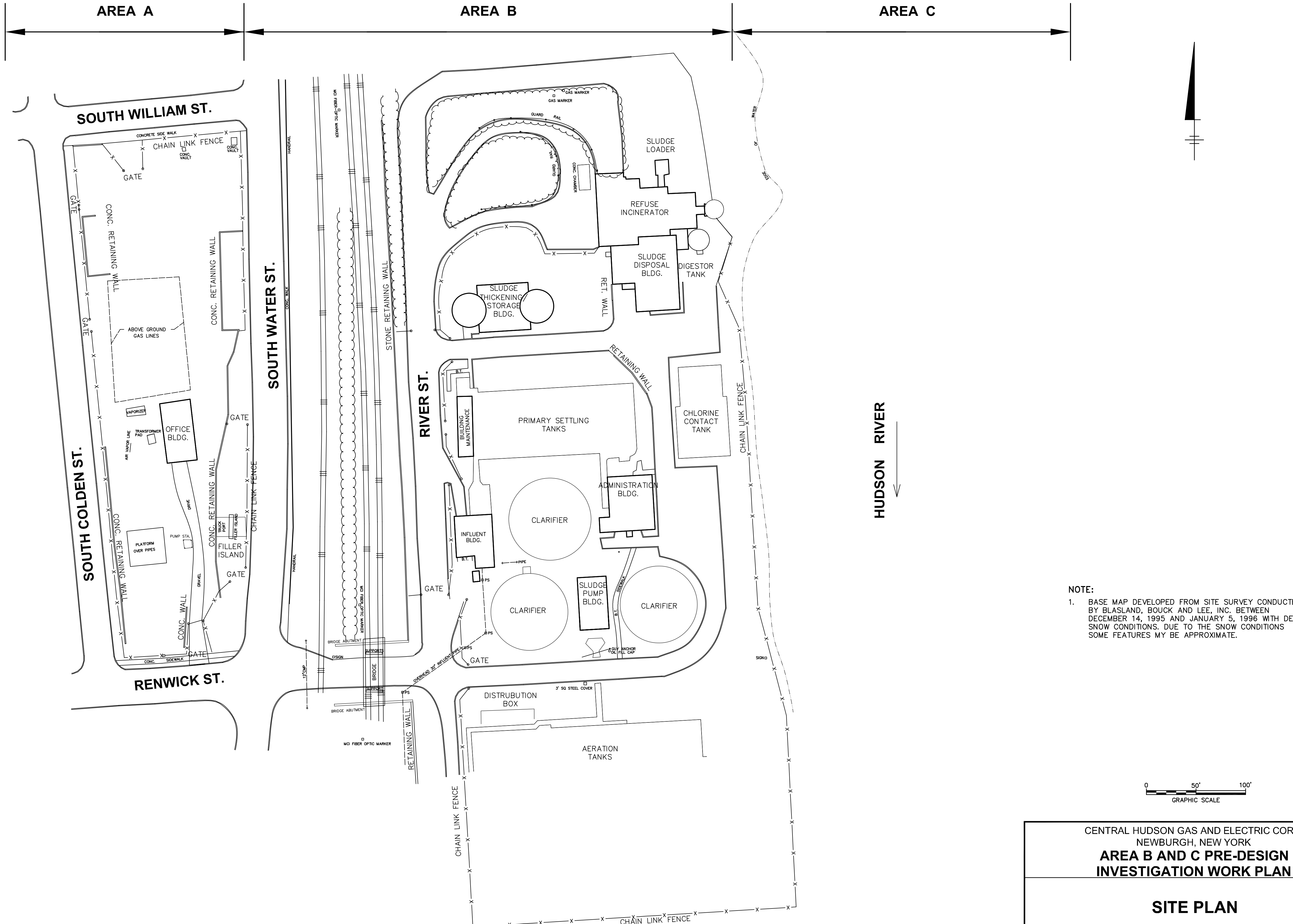
AREA B AND C PRE-DESIGN INVESTIGATION WORK PLAN

SITE LOCATION MAP

BBL® an ARCADIS company

FIGURE
1

07/24/06 SYR-D85-DJH MRC KLS DJH
20537003/20537n01.cdr



CENTRAL HUDSON GAS AND ELECTRIC CORP.
NEWBURGH, NEW YORK

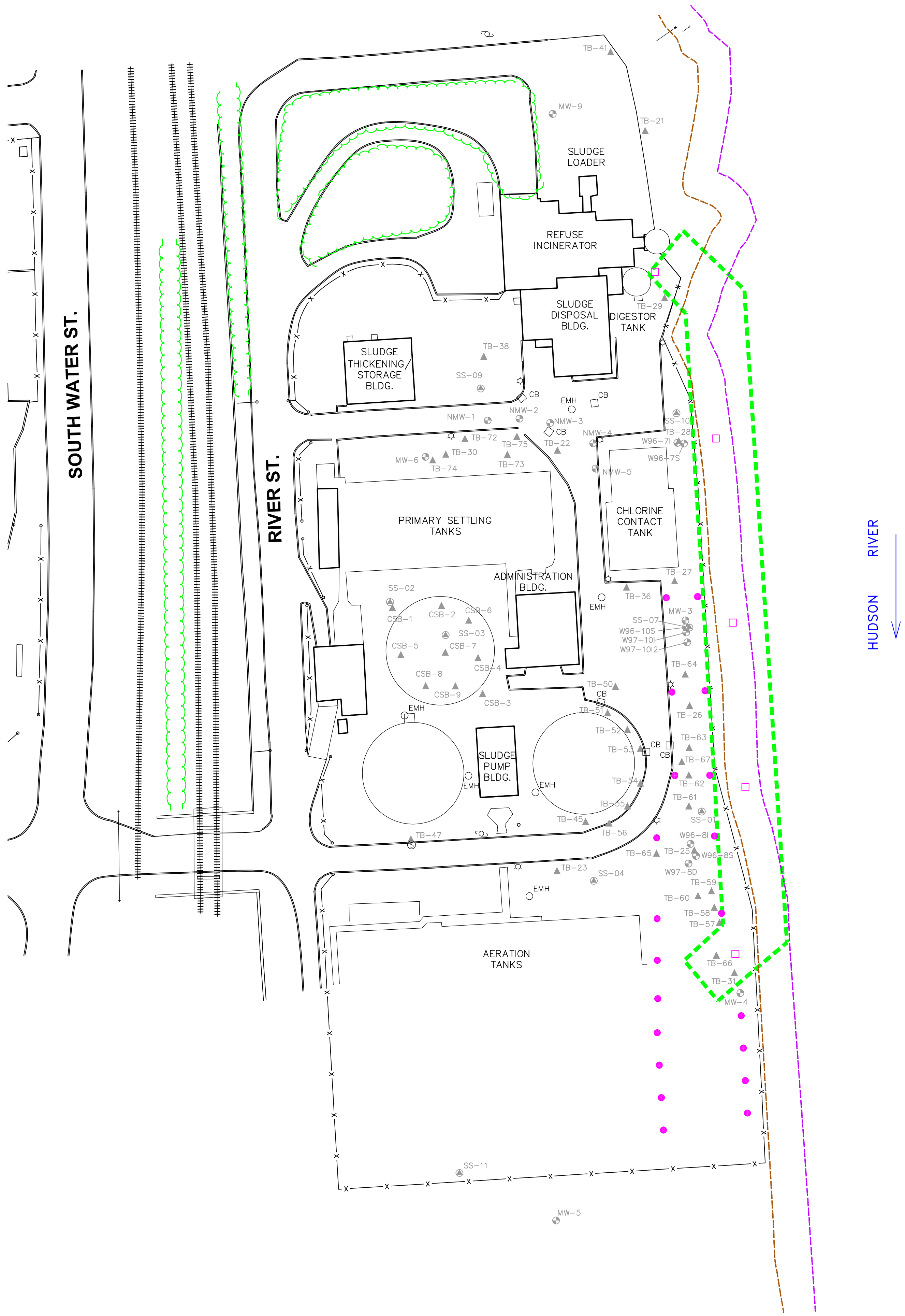
AREA B AND C PRE-DESIGN INVESTIGATION WORK PLAN

SITE PLAN

BBL® an ARCADIS company

FIGURE **2**

[SYR-85-LAF] SYR-85-RCB LAF RCB LAYER: ON=* OFF=*REF*
F:\ACTIVE\~DWG\ACT\20537003\20537G05.DWG SAVED:8/3/2006 2:30 PM LAYOUT:Layout1 PAGESETUP:---- PENTABLE:PLTFULL.CTB PRINTED:8/11/2006 8:13 AM BY:KSARTORI
PROJECTNAME:----
XREFS: IMAGES:
20537X00



LEGEND:

- EXISTING SOIL BORING
- EXISTING SURFACE SOIL SAMPLE
- EXISTING MONITORING WELL (OVERBURDEN)
- PROPOSED TARGOST PROBE/SOIL BORING LOCATION
- PROPOSED GEOTECHNICAL SOIL BORING/PIEZOMETER CLUSTER
- NAPL BARRIER WALL AREA
- APPROXIMATE SHORELINE AT HIGH TIDE
- APPROXIMATE SHORELINE AT LOW TIDE
- LIGHTPOLE
- CATCH BASIN (CB)
- ELECTRICAL MANHOLE (EMH)
- UTILITY POLE

NOTES:

1. BASE MAP DEVELOPED FROM SITE SURVEY CONDUCTED BY BLASLAND, BOUCK AND LEE, INC. BETWEEN DECEMBER 14, 1995 AND JANUARY 5, 1996 WITH DEEP SNOW CONDITIONS. DUE TO THE SNOW CONDITIONS SOME FEATURES MY BE APPROXIMATE.
2. PROPOSED PRE-DESIGN INVESTIGATION LOCATIONS ARE PRELIMINARY AND SUBJECT TO CHANGE IN THE FIELD.
3. CONE PENETROMETER TEST (CPT) WILL BE ADVANCED AT SIX LOCATIONS WITHIN THE BARRIER WALL AREA. CPT PROBING LOCATIONS TO BE DETERMINED IN THE FIELD WITH CONSULTATION BETWEEN FIELD PERSONNEL AND SENIOR GEOTECHNICAL ENGINEERING PERSONNEL IN THE OFFICE.

0 50' 100'
GRAPHIC SCALE

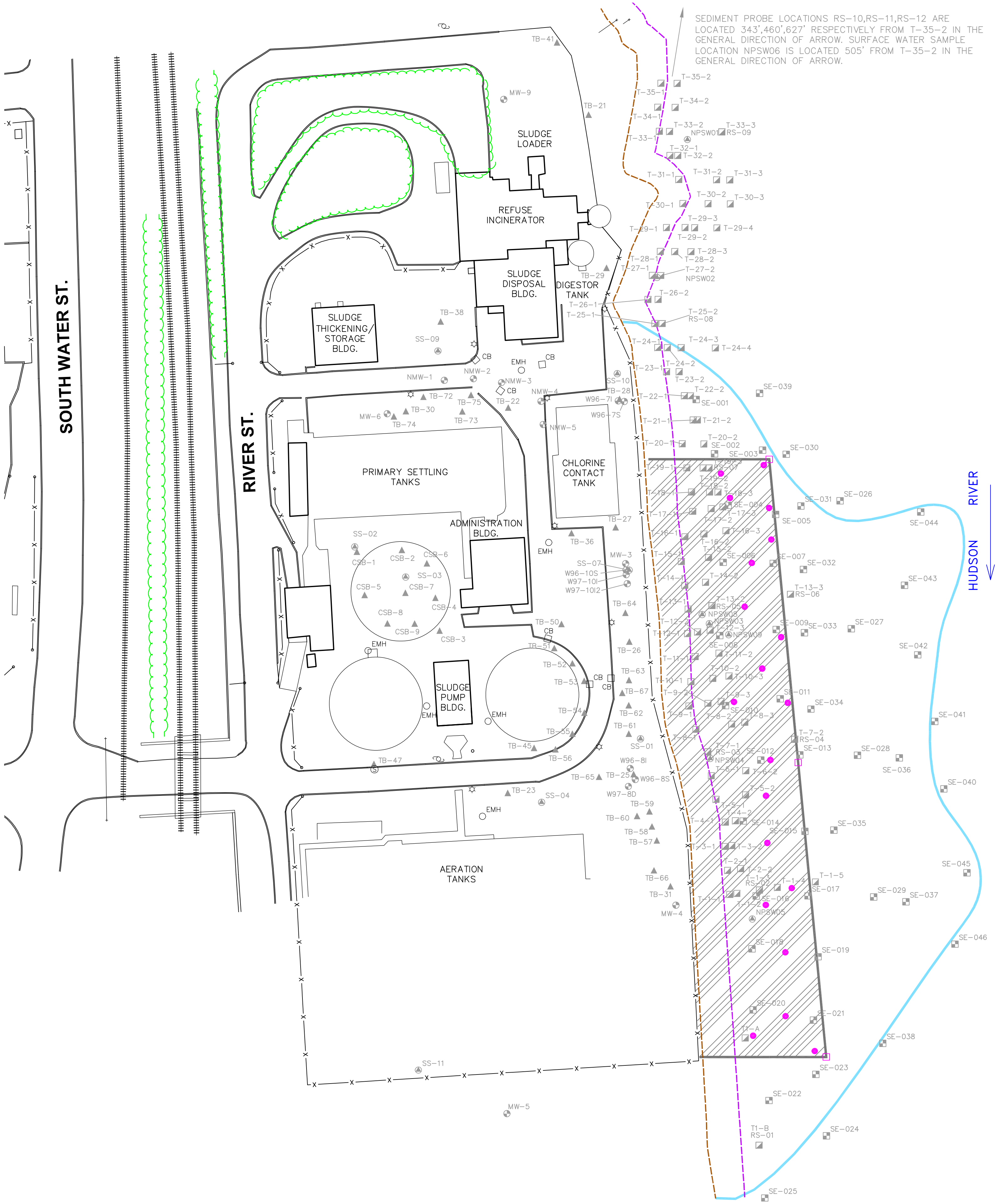
CENTRAL HUDSON GAS AND ELECTRIC CORP.
NEWBURGH, NEW YORK

AREA B AND C PRE-DESIGN INVESTIGATION WORK PLAN

AREA B PRE-DESIGN INVESTIGATION LOCATIONS

BBL an ARCADIS company

FIGURE
3



LEGEND:

- ▲ EXISTING SOIL BORING
- EXISTING SURFACE SOIL SAMPLE
- EXISTING MONITORING WELL (OVERBURDEN)
- EXISTING SEDIMENT SAMPLE
- EXISTING SEDIMENT PROBE
- EXISTING SURFACE WATER SAMPLE
- ● PROPOSED TARGOST PROBE/SEDIMENT BORING LOCATION
- □ PROPOSED GEOTECHNICAL SEDIMENT BORING LOCATION (TO 60')
- PREVIOUSLY IDENTIFIED PAH-IMPACTED SEDIMENT CAPPING LIMITS
- APPROXIMATE SHORELINE AT HIGH TIDE
- APPROXIMATE SHORELINE AT LOW TIDE
- PREVIOUSLY IDENTIFIED NAPL-IMPACTED SEDIMENT DREDGING LIMITS
- LIGHTPOLE
- □ CATCH BASIN (CB)
- ○ ELECTRICAL MANHOLE (EMH)
- UTILITY POLE

NOTES:

1. BASE MAP DEVELOPED FROM SITE SURVEY CONDUCTED BY BLASLAND, BOUCK AND LEE, INC. BETWEEN DECEMBER 14, 1995 AND JANUARY 5, 1996 WITH DEEP SNOW CONDITIONS. DUE TO THE SNOW CONDITIONS SOME FEATURES MY BE APPROXIMATE.
2. PROPOSED PRE-DESIGN INVESTIGATION LOCATIONS ARE PRELIMINARY AND SUBJECT TO CHANGE IN THE FIELD.
3. CONE-PENETROMETER TESTING (CPT) PROBES WILL BE ADVANCED AT UP TO FIVE (5) LOCATIONS OUTSIDE THE PROPOSED LIMITS OF THE NAPL-IMPACTED SEDIMENT DREDGING AREA AND PAH-IMPACTED SEDIMENT CAPPING LIMITS. PROBING LOCATIONS WILL BE DETERMINED IN THE FIELD.
4. LIMITS OF THE PREVIOUSLY IDENTIFIED NAPL-IMPACTED SEDIMENT DREDGING AREA WERE ESTABLISHED TO REMOVE ALL SEDIMENT CONTAINING VISIBLY NAPL-IMPACTED SEDIMENT. THE LIMITS OF THE PREVIOUSLY IDENTIFIED PAH-IMPACTED SEDIMENT CAP COVERS THE EXISTING SEDIMENT SURFACE IN AREAS WHERE SURFICIAL PAH LEVELS EXCEED 20 PPM.

0 50' 100'
GRAPHIC SCALE

CENTRAL HUDSON GAS AND ELECTRIC CORP.
NEWBURGH, NEW YORK

AREA B AND C PRE-DESIGN INVESTIGATION WORK PLAN

AREA C PRE-DESIGN INVESTIGATION LOCATIONS - NAPL-IMPACTED SEDIMENT DELINEATION AND GEOTECHNICAL EVALUATION

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FIGURE
4

[SYR-85-LAF] SYR-85-RCB LAF RCB LAYER: ON=*, OFF=*REF* (TREES*
F:\ACTIVE\~DWG\ACT\20537003\20537G02.DWG SAVED: 8/3/2006 2:31 PM LAYOUT: Layout1 PAGESETUP: ---- PENTABLE: PLTFULL.CTB PRINTED: 8/11/2006 8:13 AM BY: KSARTORI
PROJECTNAME: ----
XREFS: IMAGES:
20537X00
20537X01

SAMPLE ID	DISTANCE NORTH OF SAMPLING LOCATION RS-09 (FEET)	TOTAL PAH CONCENTRATION (PPM)
RS-10	343	14.0
RS-11	460	5.6
RS-12	627	6.2

LEGEND:

- EXISTING SEDIMENT SAMPLE
- 177 TOTAL PAH CONCENTRATION IN SURFICIAL SEDIMENTS (mg/kg)
- PROPOSED INITIAL SEDIMENT SAMPLE LOCATION
- PREVIOUSLY IDENTIFIED PAH-IMPACTED SEDIMENT CAPPING LIMITS
- APPROXIMATE SHORELINE AT HIGH TIDE
- APPROXIMATE SHORELINE AT LOW TIDE
- PREVIOUSLY IDENTIFIED NAPL-IMPACTED SEDIMENT DREDGING LIMITS
- LIGHTPOLE
- CATCH BASIN
- MANHOLE
- UTILITY POLE

NOTES:

1. BASE MAP DEVELOPED FROM SITE SURVEY CONDUCTED BY BLASLAND, BOUCK AND LEE, INC. BETWEEN DECEMBER 14, 1995 AND JANUARY 5, 1996 WITH DEEP SNOW CONDITIONS. DUE TO THE SNOW CONDITIONS SOME FEATURES MAY BE APPROXIMATE.
2. PROPOSED PRE-DESIGN INVESTIGATION LOCATIONS ARE PRELIMINARY AND SUBJECT TO CHANGE IN THE FIELD.
3. LIMITS OF THE PREVIOUSLY IDENTIFIED NAPL-IMPACTED SEDIMENT DREDGING AREA WERE ESTABLISHED TO REMOVE ALL SEDIMENT CONTAINING VISIBLY NAPL-IMPACTED SEDIMENT. THE LIMITS OF THE PREVIOUSLY IDENTIFIED PAH-IMPACTED SEDIMENT CAP COVERS THE EXISTING SEDIMENT SURFACE IN AREAS WHERE SURFICIAL PAH LEVELS EXCEED 20 PPM.

0 50' 100'
GRAPHIC SCALE

CENTRAL HUDSON GAS AND ELECTRIC CORP.
NEWBURGH, NEW YORK

AREA B AND C PRE-DESIGN INVESTIGATION WORK PLAN

AREA C PRE-DESIGN INVESTIGATION LOCATIONS - PAH-IMPACTED SEDIMENT DELINEATION

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FIGURE **5**

[SYR-85-LAF] SYR-85-RCB LAF RCB LAYER: ON=*, OFF=*REF* ,TREES* PENTABLE:PLTFULL.CTB PRINTED:8/11/2006 8:13 AM BY:KSARTORI
F:\ACTIVE\~DWG\ACT\20537003\20537G03.DWG SAVED:8/3/2006 2:32 PM LAYOUT:Layout1 PAGESETUP:----
PROJECTNAME:---- XREFS: 20537X00 20537X01 IMAGES:

Appendices

Appendix A

Standard Operating Procedures

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Soil Boring Installation and Soil Sampling

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Standard Operating Procedure: Soil Boring Installation and Soil Sampling

I. Scope and Application

This Standard Operating Procedure (SOP) describes the field procedures to install soil borings and to collect soil samples. Soil borings will be completed with a truck- or track-mounted hydraulic rotary drill rig using the hollow-stem-auger drilling method or direct-push equipment. Where site features limit access or shallow soil cores are desired, soil borings will be hand driven or completed with a portable power auger, depending on the required depth and subsurface conditions.

II. Personnel Qualifications

Field sampling personnel will have current health and safety training, including 40-hour training in accordance with the Occupational Safety and Health Administration (OSHA) Regulation 29CFR1910.120 (HAZWOPER), site supervisor training, current LPS training, and site-specific training, as needed. In addition, personnel observing soil borings will be experienced in soil boring installation and sampling at MGP sites.

III. Equipment List

The following materials, as required, will be available during install soil borings and to collect soil samples:

- Health and safety equipment (as required in the Health and Safety Plan)
- Drilling or direct push machinery
- Split spoon or macro-core sampler
- Stainless steel hand trowel
- Measuring tape
- Photoionization detector (PID)
- Particulate dust monitor (MIE pDR 1000 Dust Monitor or similar equipment)
- Camera
- Indelible ink pens
- Polyethylene bags (resealable-type)
- Plastic sheeting
- Wooden stakes
- Soil boring log
- Appropriate sample containers, labels, and chain-of-custody forms
- Insulated transport containers with ice or “blue ice” (if sampling is necessary)
- Field notebook

IV. Health and Safety Considerations

Follow health and safety procedures outlined in the Health and Safety Plan. Prior to commencing drilling activities, Underground Facility Protection Organization (UFPO) will be contacted to have appropriate utility representatives mark the location of underground lines at and in the vicinity of the proposed soil boring/monitoring well locations. The drilling subcontractor will survey the project area to determine the presence of known utilities at the project area, especially in those areas where drilling is proposed.

V. Soil Boring Activities

Soil samples will be collected continuously using standard 2-inch by 2-foot split barrels driven by a 140-pound hammer in accordance with ASTM Method D1586 or macro-core samplers. The samplers will be advanced to the depth specified in the project-specific work plan. Samplers will be cleaned between samples and drilling equipment will be cleaned between borings using procedures described in the Equipment Cleaning SOP.

Upon retrieval of each sampler, representative portions of each soil sample will be placed in the appropriate laboratory containers and a container for visual observations and headspace screening. The sample containers will be labeled with: 1) site; 2) boring number; 3) sample interval; 4) date; and 5) initials of sampling personnel. All split-barrel samples will be screened for detectable organic vapors with a PID using the procedures described in Section VI below. In addition, the on-site geologist will be on site during the drilling operations to visually/manually characterize each soil sample including the following:

- Percent recovery;
- Structure and degree of sample disturbance;
- Soil type;
- Principal and minor components;
- Color;
- Moisture and organic content;
- Particle sizes, angularity and shape;
- Density/consistency;
- Plasticity of fines;
- Cohesiveness;
- Discoloration;
- Mottling/staining;
- Weathering;
- Presence/absence of MGP residuals and/or noticeable odors;
- Fill or geologic origin of deposit (local name of deposit, if known);
- Items that may indicate age of deposit (i.e., archaeological artifacts, newspapers, etc.);
- Fill component description (i.e., cinder, clay, metal, tires, etc.); and
- PID headspace screening results.

The descriptions will be recorded in a dedicated field notebook. The on-site geologist will also be responsible for recording the following information in the field notebook:

- Start and finish dates of drilling;
- Name and location of project;
- Project number, client, and project location;
- Sample number and depth;
- Blow counts and recovery;
- Type and size of samples;
- Depth to water;
- Type of drilling equipment;
- Size of casing;
- Documentation of any elevated organic vapor emissions;
- Names of contractor’s drillers, inspectors, or people at the project area; and
- Weather conditions.

The drilling contractor will be responsible for obtaining accurate and representative samples, informing the on-site geologist of changes in drilling pressure and loss of circulation, and keeping a separate general log of soils encountered, including blow counts (i.e., the number of blows from a soil sampling drive weight [140 pounds] required to drive the split-barrel sampler in 6-inch increments).

VI. Field Screening Procedures

Field screening will be conducted on the headspace of soil samples with a PID. A representative portion of the sample will be obtained and placed in either an approximately one pint glass "driller's jar" or a re-sealable Ziploc-type plastic bag. If a driller's jar is used, the top of the jar will be covered with aluminum foil. These samples will be screened as follows:

1. Samples will be taken to a warm workspace and allowed to equilibrate to room temperature for at least one hour.

2. Prior to measuring the soil vapor headspace concentration, the 8-ounce jar will be shaken.

3. The PID probe will be inserted into the headspace of the jar through the aluminum foil covering or into a small opening in the top of the bag.

4. The initial (peak) readings will be recorded in the field note book.

The PID meter will be calibrated to isobutylene at a minimum frequency of once per day prior to collecting readings. The time, date, and calibration procedure must be clearly documented in the field notebook and/or the calibration log book. If at any time the PID results appear erratic or inconsistent with field observations, then the unit will be recalibrated. If calibration is difficult to achieve, then the PIDs lamp should be checked for dirt or moisture and cleaned. During humid or wet conditions, the unit should be calibrated on a more frequent basis as determined by field personnel. In addition, a blank and field duplicate will be performed every 10 samples. Maintenance and calibration records will be kept as part of the field quality assurance program.copied onto test pit logs.

VII. Procedures for Collecting Soil Samples for Laboratory Analysis (If Required)

As discussed in the Work Plan, soil samples collected may be submitted for laboratory analysis. In addition, if any of the samples recovered at a boring location exhibit staining, odors, MGP residuals, or elevated PID readings, then the sample exhibiting the highest PID reading or visible impacts will be submitted for laboratory analysis. Samples designated for laboratory analysis will be placed in the appropriate containers. Sample containers for volatile organic analysis will be filled first. The remaining soil will be homogenized by mixing in a stainless steel bowl with a clean stainless steel trowel, and distributed to the appropriate sample containers.

VIII. Data Recording and Management

Copies of soil boring logs will be maintained in the project file.

IX. References

Blasland, Bouck & Lee, Inc. 2006. *Health and Safety Plan - Newburgh Project.*

Blasland, Bouck & Lee, Inc. 2006. *Newburgh Project Pre-Design Investigation - Area A.*

Monitoring Well Installation

an ARCADIS company

Standard Operating Procedure: Monitoring Well Installation

I. Scope and Application

Monitoring well boreholes are typically drilled using the hollow-stem auger drilling method. Other drilling methods that are also suitable for installing overburden monitoring wells, and are sometimes necessary due to site-specific geologic conditions, include: drive-and-wash, spun casing, Rotasonic, dual-rotary (Barber Rig), and fluid/mud rotary. Direct-push techniques (e.g., Geoprobe or cone penetrometer) and driven well points may also be used in some cases. The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling/well depths, site or regional geologic knowledge, type of monitoring to be conducted using the installed well, and cost.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools). No coated bentonite pellets will be used in the well drilling or construction process. Material safety data sheets (MSDS) and specifications of materials to be installed in the well will be obtained prior to mobilizing onsite, including:

- well casing;
- bentonite;
- sand; and
- grout.

Well materials will be inspected and, if needed, cleaned prior to installation.

II. Personnel Qualifications

Monitoring well installation activities will be performed by persons who have been trained in proper well installation procedures under the guidance of an experienced field geologist, engineer, or technician. Where field sampling is performed for soil characterization, field personnel will have undergone in-field training in terms of soil classification.

III. Equipment List

The following materials will be available during soil boring and monitoring well installation activities, as required:

- Site Plan with proposed soil boring/well locations;
- Work Plan or *Field Sampling Plan* (FSP), and site *Health and Safety Plan* (HASP);
- personal protective equipment (PPE), as required by the HASP;
- drilling equipment required by the American Society of Testing and Materials (ASTM) D 1586, when performing split-spoon sampling;
- disposable plastic liners, when drilling with direct-push equipment;
- appropriate soil sampling equipment (e.g., stainless steel spatulas, knife);
- equipment cleaning materials;
- appropriate sample containers and labels;
- chain-of-custody forms;

- insulated coolers with ice, when collecting samples requiring preservation by chilling;
- photoionization detector (PID) or flame ionization detector (FID);
- keys to wells;
- well construction materials; and
- field notebook.

IV. Cautions

Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be delineated by the drilling contractor or an independent underground utility locator service. See separate SOP for utility clearance.

No coated bentonite pellets will be used in monitoring well construction, as the coating could contaminate the well. Overburden monitoring wells may be installed with Schedule 40 polyvinyl chloride (PVC) to a maximum depth of 200 feet below ground surface (bgs). PVC monitoring wells between 200 and 400 feet total depth will be constructed using Schedule 80 PVC. Monitoring wells deeper than 400 feet will be constructed using steel.

V. Health and Safety Considerations

Field activities associated with monitoring well installation will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

VI. Procedures

The procedures for installing groundwater monitoring wells in soil are presented below:

Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods

1. Locate boring/well location, establish work zone, and set up sampling equipment cleaning area.

2. Advance soil boring to depth. Collect soil samples at appropriate interval as specified in the Work Plan and/or FSP. Collect, document, and store samples for laboratory analysis as specified in the Work Plan and/or FSP. A common sampling method that produces high-quality samples with relatively little soil disturbance is the ASTM D 1586 - *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.* Split-spoon samples are obtained during drilling using hollow-stem auger, drive-and-wash, spun casing, and fluid/mud rotary. Rotasonic drilling produces large-diameter soil cores that tend to be more disturbed than split-spoon samples due to the vibratory action of the drill casing. Dual-rotary removes cuttings by compressed air and allows only a general assessment of geology.

3. Describe each soil sample, including soil type; color; percent recovery; relative moisture content; soil texture; grain-size and shape; consistency; presence of any staining, sheen, or odor; and any other pertinent observations. Record descriptions in the field notebook. During soil boring advancement, document all drilling events in field notebook, including blow counts (number of blows required to advance split-spoon sampler in 6-inch increments) and work stoppages. Blow counts will not be available if Rotasonic, dual-rotary, or direct-push methods are used.

4. Upon completing the borehole to the desired depth, install the monitoring well by lowering the screen and casing assembly with sump through the augers or drill casing. Monitoring wells typically will be constructed of 2-inch-diameter, flush-threaded PVC slotted well screen and blank riser casing. Smaller diameters may be used if wells are installed using direct-push methodology or if multiple wells are to be

installed in a single borehole. The screen length will be specified in the Work Plan or FSP based on regulatory requirements and specific monitoring objectives. Monitoring well screens are usually 5 to 10 feet long, but may be up to 25 feet long in very low permeability, thick geologic formations. The screen length will depend on the purpose for the well and the objectives of the groundwater investigation. Typically, the slot size will be 0.010 inch and the sand pack will be Morie No. 0 or equivalent. In very fine-grained formations where sample turbidity needs to be minimized, it may be preferred to use a 0.006-inch slot size and Morie No. 00 or equivalent sand pack. Alternatively, where monitoring wells are installed in coarse-grained deposits and higher well yield is required, a 0.020-inch slot size and Morie No. 1 or equivalent sand pack may be preferred. To the extent practicable, the slot size and sand pack gradation will be predetermined in the Work Plan or FSP based on site-specific grain-size analysis or other geologic considerations or monitoring objectives. A blank sump may be attached below the well screen if the well is being installed for dense non-aqueous phase liquid (DNAPL) recovery/monitoring purposes. If so, the annular space around the sump will be backfilled with neat cement grout to the bottom of the well screen prior to placing the sand pack around the screen. A blank riser will extend from the top of the screen to approximately 2.5 feet above grade or, if necessary, just below grade where conditions warrant a flush-mounted monitoring well.

5. When the monitoring well assembly has been set in place and the grout has been placed around the sump (if any), place a washed silica sand pack in the annular space from the bottom of the boring to a height of 1 to 2 feet above the top of the well screen. The sand pack is placed and drilling equipment extracted in increments until the top of the sand pack is at the appropriate depth. The sand pack will be consistent with the screen slot size and the soil particle size in the screened interval, as specified in the Work Plan or FSP. A hydrated bentonite seal (a minimum of 2 feet thick) will then be placed in the annular space above the sand pack. If non-hydrated bentonite is used, the bentonite should be permitted to hydrate in place for a minimum of 30 minutes before proceeding. No coated bentonite pellets will be used in monitoring well drilling or construction. Potable water may be added to hydrate the bentonite if the seal is above the water table. Monitor the placement of the sand pack and bentonite with a weighted tape measure. During the extraction of the augers or casing, a cement/bentonite grout will be placed in the annular space from the bentonite seal to a depth approximately 2 feet bgs.

6. Place a locking, steel protective casing (extended at least 1.5 feet below grade and 2 feet above grade) over the riser casing and secure with a neat Portland Cement seal. Alternatively, for flush-mount completions, place a steel curb box with a bolt-down lid over the riser casing and secure with a neat Portland Cement seal. In either case, the cement seal will extend approximately 1.5 to 2.0 feet below grade and laterally at least 1 foot in all directions from the protective casing, and should slope gently away to promote drainage away from the well. Monitoring wells will be labeled with the appropriate designation on both the inner and outer well casings or inside of the curb box lid.

   When an above-grade completion is used, the PVC riser will be sealed using an expandable locking plug and the top of the well will be vented by drilling a small-diameter (1/8 inch) hole near the top of the well casing or through the locking plug, or by cutting a vertical slot in the top of the well casing. When a flush-mount installation is used, the PVC riser will be sealed using an unvented, expandable locking plug.

7. During well installation, record construction details and actual measurements relayed by the drilling contractor and tabulate materials used (e.g., screen and riser footages; bags of bentonite, cement, and sand) in the field notebook.

8. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section VII below.

Direct-Push Method

The direct-push drilling method may also be used to complete soil borings and monitoring wells. Examples of this technique include the Diedrich ESP vibratory probe system or AMS Power Probe® dual-tube system. Environmental probe systems typically use a hydraulically operated percussion hammer. Depending on the equipment used, the hammer delivers 140- to 350-foot pounds of energy with each blow. The hammer provides the force needed to penetrate very stiff/medium dense soil formations. The hammer simultaneously advances an outer steel casing that contains a dual-tube liner for sampling soil. The outside diameter (OD) of the outer casing ranges from 1.75 to 2.4 inches and the OD of the inner sampling tube ranges from 1.1 to 1.8 inches. The outer casing isolates shallow layers and permits the unit to continue to probe at depth. The double-rod system provides a borehole that may be tremie-grouted from the bottom up. Alternatively, the inside diameter (ID) of the steel casing provides clearance for the installation of small-diameter (e.g., 0.75- to 1-inch ID) micro-wells. The procedures for installing monitoring wells in soil using the direct-push method are described below.

1. Locate boring/well location, establish work zone, and set up sample equipment cleaning area.

2. Advance soil boring to designated depth, collecting samples at intervals specified in the Work Plan. Samples will be collected using dedicated, disposable, plastic liners. Describe samples in accordance with the procedures outlined in Step 2 above. Collect samples for laboratory analysis as specified in the Work Plan and/or FSP.

3. Upon advancing the borehole to the desired depth, install the micro-well through the inner drill casing. The micro-well will consist of approximately 1-inch ID PVC slotted screen and blank riser. The sand pack, bentonite seal, and cement/bentonite grout will be installed as described, where applicable, in Step 4 above.

4. Install protective steel casing or flush-mount, as appropriate, as described in Step 5 above. During well installation, record construction details and tabulate materials used.

5. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section VII below.

Driven Well Point Installation

Well points will be installed by pushing or driving using a drilling rig or direct-push rig, or hand-driven where possible. The well point construction materials will consist of a 1- to 2-inch-diameter threaded steel casing with either 0.010- or 0.020-inch slotted stainless steel screen. The screen length will vary depending on the hydrogeologic conditions of the site. The casings will be joined together with threaded couplings and the terminal end will consist of a steel well point. Because they are driven or pushed to the desired depth, well points do not have annular backfill materials such as sand pack or grout.

VII. Waste Management

Investigation-derived wastes, including soil cuttings and excess drilling fluids (if used), decontamination liquids, and disposable materials (well material packages, PPE, etc.), will be placed in clearly labeled, appropriate containers, or managed as otherwise specified in the Work Plan or FSP.

VIII. Data Recording and Management

Drilling activities will be documented in a proper field notebook. Pertinent information will include personnel present on site, times of arrival and departure, significant weather conditions, timing of well installation activities, soil descriptions, well construction specifications (screen and riser material and diameter, sump length, screen length and slot size, riser length, sand pack type), and quantities of materials used.

A field survey control program will be conducted using standard instrument survey techniques to document well or piezometer location, ground, and inner and outer casing elevations. Generally, a local baseline control will be set up. This local baseline control can then be tied into the appropriate vertical and horizontal datum, such as the National Geodetic Vertical Datum of 1929 and the State Plane Coordinate System. At a minimum, the elevation of the top of the inner casing used for water-level measurements should be measured to the nearest 0.01 foot. Elevations will be established in relation to the National Geodetic Vertical Datum of 1929. A permanent mark will be placed on top of the inner casing to mark the point for water-level measurements.

IX. Quality Assurance

All drilling equipment and associated tools (including augers, drill rods, sampling equipment, wrenches, and any other equipment or tools) that may have come in contact with soil will be cleaned in accordance with the procedures outlined in the Field Equipment Cleaning-Decontamination SOP. Well materials will also be cleaned prior to well installation.

X. References

American Society of Testing and Materials (ASTM) D 1586 - *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.*

Monitoring Well Development

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Standard Operating Procedure: Monitoring Well Development

I. Scope and Application

This Standard Operating Procedure (SOP) describes the procedures to be used to develop monitoring wells. Monitoring wells will be developed following installation to promote hydraulic connectivity with the surrounding formation. Prior to monitoring well development, each monitoring well will be checked for the presence of a floating non-aqueous phase liquid (NAPL) by checking the water table surface with an oil/water interface probe or a translucent bailer. If a separate phase is present, an attempt will be made to remove the NAPL prior to development. In addition, if a separate phase is present, efforts will be made to avoid significantly drawing the water table down in the well (and, thus avoid redistributing the separate phase to locations below the water table). These efforts will be contingent on the capacity of the formation to yield water to the monitoring well.

II. Personnel Qualifications

Field sampling personnel will have current health and safety training, including 40-hour training in accordance with the Occupational Safety and Health Administration (OSHA) Regulation 29CFR1910.120 (HAZWOPER), site supervisor training, current LPS training, and site-specific training, as needed.

III. Equipment List

The following materials, as required, will be available during monitoring well installation and development:

- Appropriate PPE (as required by the Health and Safety Plan)
- Well log form
- Appropriate Cleaning Equipment
- Bottom Loading Bailer
- Polypropylene Rope
- Plastic Sheeting
- Buckets to measure purge water
- Conductivity/temperature meter
- pH meter
- Turbidity meter
- DO meter
- Disposable Gloves
- Keys to wells
- Photoionization detector (PID)
- Pump/tubing/foot valve/surge block
- Power Source (generator or battery)
- Field book

IV. Health and Safety Considerations

Follow health and safety procedures outlined in the Health and Safety Plan.

V. Procedures

Development can be accomplished by evacuating water by bailing, however, development using an inertial-type pump (Watera pump) is recommended. The well will be developed until turbidity is reduced to the goal of 50 nephelometric turbidity units (NTUs) or less, or until relatively constant pH and conductivity measurements are obtained. A turbidity meter with a scale of 0-1000 NTUs will be used to monitor improvement in well development with respect to turbidity.

1. Review materials check list (Part II) to ensure the appropriate equipment has been acquired. Test all equipment prior to mobilizing to the Site to verify it is working.

2. Identify the site name and well ID, along with date, arrival time, and weather conditions in the field book. Identify the personnel and equipment utilized and other pertinent data requested on the groundwater sampling field book.

3. Don safety equipment, as required in the Health and Safety Plan.

4. Place plastic sheeting adjacent to well to use as a clean work area.

5. Establish the background reading with the PID and record the reading on the groundwater sampling field log. If the well headspace reading is less than 5 ppm, proceed; if the well headspace reading is greater than 5 ppm, screen the air within the breathing zone. If the PID reading in the breathing zone is below 5 ppm, proceed. If the PID reading is above 5 ppm, move upwind from the well for 5 minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 ppm, don appropriate respiratory protection in accordance with the requirements of the HASP.

6. Begin removing water from the well by pumping or bailing. Continue pumping until the turbidity is reduced to 50 NTUs or less, or until relatively constant (within 10 percent) pH and conductivity measurements are obtained.

7. If well runs dry, shut off pump and allow well to recover.

8. Contain all water in appropriate containers.

9. When complete, secure the lid back on the well.

10. Place plastic sheeting and tubing in plastic bags for appropriate disposal and clean pump.

The procedures for developing a well using the bailer method are outlined below:

1. Don appropriate PPE (as required by the HASP).

2. Place plastic sheeting around the well.

3. Clean bailers and new rope.

4. Open the well cover while standing upwind of the well. Remove well cap and place on the plastic sheeting. Insert PID probe approximately 4 to 6 inches into the casing or the well headspace and cover with gloved hand. Record the PID reading in the field notebook. If the well headspace reading is less than 5 ppm,

proceed; if the headspace reading is greater than 5 ppm, screen the air within the breathing zone. If the breathing zone reading is less than 5 ppm, proceed. If the PID reading in the breathing zone is above 5 ppm, move upwind from well for 5 minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 ppm, don appropriate respiratory protection in accordance with the requirements of the site HASP. Record all PID readings. For wells that are part of the regular weekly monitoring program and prior PID measurements have not resulted in a breathing zone reading above 5 PID units, PID measurements will be taken monthly.

5. Determine depth of well by examining drilling log data and measuring a length of rope at least 10 feet greater than the total depth of the well.

6. Secure one end of the rope to the well casing and secure the other end to the bailer. Test the knots and make sure the rope will not loosen. Check bailers to be sure all parts are intact and will not be lost in the well.

7. Lower bailer into well until bailer reaches the bottom of the well.

8. Surge/purge by raising and lowering the bailer at 2-foot intervals at least 10 times.

9. Contain all water in appropriate containers.

10. Lower bailer back into the well and repeat surging/purging at an interval 2 feet above the previous interval.

11. Repeat Steps 8 and 9 until entire screen has been surged/purged and the purge water is relatively clear of silt.

12. Upon completing well surging, remove bailer and remove the rope from the bailer and the well.

13. Secure lid on well.

14. Place plastic sheeting and polypropylene rope in plastic bags for appropriate disposal and clean bailer.

VI. Data Recording and Management

Copies of all groundwater sampling logs will be maintained in the project file.

VII. References

Blasland, Bouck & Lee, Inc. 2006. *Health and Safety Plan - Newburgh Project.*

Blasland, Bouck & Lee, Inc. 2006. *Newburgh Project Pre-Design Investigation - Area A.*

Fluid Level Measurement and Sampling for Monitoring Wells

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Standard Operating Procedure: Fluid Level Measurement and Sampling for Monitoring Wells

I. Scope and Application

This Standard Operating Procedure (SOP) describes the procedures to be used to measure water levels in monitoring wells and collect groundwater samples. No wells will be sampled until well development has been performed in accordance with Monitoring Well Development SOP. During precipitation events, groundwater sampling will be discontinued until precipitation ceases. When a round of water levels is taken for the purpose of generating water elevation data, the water levels will be taken consecutively at one time prior to sampling or other activities.

II. Personnel Qualifications

Field sampling personnel will have current health and safety training, including 40-hour training in accordance with the Occupational Safety and Health Administration (OSHA) Regulation 29CFR1910.120 (HAZWOPER), site supervisor training, current LPS training, and site-specific training, as needed.

III. Equipment List

The following materials, as required, will be available during fluid level measurement and sampling:

- Sample pump
- Sample tubing
- Power source (i.e. generator)
- Photoionization detector (PID)
- Appropriate PPE (as required by the Health and Safety Plan)
- Plastic sheeting
- Dedicated or disposable bailers
- Polypropylene rope
- Buckets to measure purge water
- Oil-water level indicator
- 6' rule with gradation in hundredths of a foot
- Conductivity/temperature meter
- pH meter
- Turbidity meter
- DO meter
- Hacksaw
- Appropriate water sample containers
- Appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials
- Groundwater sampling logs
- Chain-of-Custody forms
- Indelible ink pens
- Site map with well locations and groundwater contours maps
- Peristaltic pump and dedicated tubing
- Keys to locks on well protective cover
- Field notebook

IV. Health and Safety Considerations

Follow health and safety procedures outlined in the Health and Safety Plan.

V. Procedures

1. Review materials check list (Part II) to ensure the appropriate equipment has been acquired. Test all equipment prior to mobilizing to the Site to verify it is working.

2. Identify the site name and well ID on sampling log sheets, along with date, arrival time, and weather conditions. Identify the personnel and equipment utilized and other pertinent data requested on the groundwater sampling field log.

3. Label the sample containers as described in the Work Plan. Cover the sample label with clear packaging tape to secure the label to the container.

4. Don safety equipment, as required in the Health and Safety Plan.

5. Place plastic sheeting adjacent to well to use as a clean work area.

6. Establish the background reading with the PID and record the reading on the groundwater sampling field log. If the well headspace reading is less than 5 ppm, proceed; if the well headspace reading is greater than 5 ppm, screen the air within the breathing zone. If the PID reading in the breathing zone is below 5 ppm, proceed. If the PID reading is above 5 ppm, move upwind from the well for 5 minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 ppm, don appropriate respiratory protection in accordance with the requirements of the HASP.

7. Remove lock from well and if rusted or broken replace with a new brass lock (with similar key).

8. Unlock and open the well cover while standing upwind of the well. Remove well cap and place on the plastic sheeting. Insert PID probe in the breathing zone above the well casing following instructions in the Health and Safety Plan.

9. Set out on plastic sheeting the dedicated or disposable sampling device and meters.

10. refer to Equipment Cleaning SOP).

11. Prior to sampling, measure the depth to groundwater in each monitoring well and the depth to the bottom of each monitoring well. The depth to groundwater (and depth to the bottom of the well) will be determined using an oil-water level probe. If a reference point on the well casing is not found, initiate a reference point by notching the inner casing (or outer if necessary) with a hacksaw. All downhole measurements will be taken from one reference point established at each well. Measurements will be recorded to the nearest hundredth of a foot, along with the height of the inner and outer casings from the reference point to ground level. The measurements and reference point will be recorded on a sampling log sheet. Clean the well probe before and after each use with a soapy (Alconox) water wash and a tap water rinse (refer to Equipment Cleaning SOP). [Note: water levels will be measured at all wells prior to initiating any sampling activities].

12. When checking the depth to groundwater in each well, check the water level probe for evidence of LNAPL.

13. Pump, safety cable, tubing, and electrical lines will be lowered slowly into the well to a depth corresponding to the center of the saturated screen section of the well, or at a location determined to either be a preferential flow path, or zone where contamination is present. The pump intake must be kept at least two feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.

14. Measure the water level again with the pump in well before starting the pump. Start pumping the well at 200 to 500 milliliters per minute. Ideally, the pump rate should cause little or no water level drawdown in the well (less than 0.3 feet and the water level should stabilize). The water level should be monitored every three to five minutes (or as appropriate) during pumping. Care should be taken not to cause pump suction to be broken or entrainment of air in the sample. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If the recharge rate of the well is very low, purging should be interrupted so as not to cause the drawdown within the well to advance below the pump. However, a steady flow rate should be maintained to the extent practicable. Sampling should commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.

15. During purging of the well, monitor the field indicator parameters (pH, conductivity, dissolved oxygen, temperature, turbidity, etc.) every three to five minutes (or as appropriate). Groundwater samples will be collected for laboratory analysis following the stabilization of field parameters and the reduction of turbidity levels in the groundwater to less than 50 nephelometric turbidity units (NTUs). For the purpose of the RI, the field parameters will be considered to have stabilized after three consecutive readings are within the following values:

    - pH: ± 0.1;
    - Conductivity: ± 3%;
    - Oxidation/Reduction Potential (ORP): ± 10 mV;
    - Dissolved Oxygen: ± 10%; and
    - Turbidity: less than 50 NTU.

    If the field parameters have not stabilized after a reasonable effort has been made during the well purging, a sample will be collected based on the judgment of the field personnel. If the field parameters have stabilized, but the turbidity of the groundwater is not less than the 50 NTU goal, the pump flow rate will be decreased to no more than 100 mL/min, and additional purging will be conducted. The purging will continue until the 50 NTU turbidity goal is achieved or, if not possible, until reasonable effort has been made to reduce the turbidity to less than 50 NTUs.

16. After the appropriate purge volume of groundwater in the well has been removed, obtain the groundwater sample for analysis from the sampling device. Groundwater samples will be placed directly into the appropriate containers. When sampling for volatiles, collect water samples directly from a bottom-loading bailer into 40-mL vials with Teflon-lined septa. The bailer will be slowly lowered into the screened portion of the well to retrieve a filled bailer from the well causing minimal disturbance to the water and any sediments in the well. Groundwater sample containers will be collected in the following order:

    a. VOCs
    b. TOC (if sampled)
    c. SVOCs
    d. metals and cyanide
    e. others

17. Secure the caps on the sample containers. Place the sample containers on ice in an insulated transport container provided by the laboratory.

18. After all sampling containers have been filled, remove an additional volume of groundwater. Check the calibration of the meters and then measure and record on the field log physical appearance, pH, conductivity, dissolved oxygen, temperature, and turbidity.

19. If using a dedicated bailer, replace dedicated bailer in the well and replace the well cap and lock well.

20. Record the time sampling procedures were completed on the field logs.

21. Place all disposable sampling materials (plastic sheeting, disposable bailers, and health and safety equipment) in appropriately labeled containers.

22. Complete the procedures for packaging, shipping, and handling.

23. If new locks were installed, forward copies of the keys to the Project Manager (PM) at the end of the sampling activities.

VI. Data Recording and Management

Copies of all groundwater sampling logs will be maintained in the project file.

VII. References

Blasland, Bouck & Lee, Inc. 2006. *Health and Safety Plan - Newburgh Project.*

Blasland, Bouck & Lee, Inc. 2006. *Newburgh Project Pre-Design Investigation - Area A.*

Pump Testing

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Standard Operating Procedure: Pumping Test Procedures

I. Scope and Application

The purpose of conducting a pumping test is to quantify the bulk hydrogeologic parameters (e.g., transmissivity and storativity) of the saturated zone in the vicinity of a pumping well. A pumping test entails removing groundwater from a pumping well and measuring the change in fluid levels in the pumping well and, if possible, in one or more other (observation) wells proximal to the pumping well. Pumping rate and fluid-level data gathered during a test are used to characterize the aquifer parameters to evaluate the potential for contaminant transport and help design a remedial measure, if applicable.

A preliminary step-drawdown test of limited duration is implemented to identify a suitable pumping rate for the drawdown portion of the actual pumping test.

II. Personnel Qualifications

Pump test will be performed by persons who have been trained in proper pumping test procedures under the guidance of an experienced field geologist, engineer, or technician.

III. Equipment List

The following materials and equipment will be available, as needed, for use during completion of the pumping test:

- Submersible pump equipped with check valve and discharge line;
- In-line totalizing flow meter or calibrated bucket;
- Generator (if electric power source is not available);
- Supply of fuel for generator;
- Several water level probes (number depending on site);
- Oil-water interface probe(s) for separated-phase hydrocarbon (SPH) sites;
- Pressure transducers;
- Laptop computer, communication cable, and software to download and process transducer data;
- Aquifer test data sheets;
- Field notebook;
- Flashlights;
- Stopwatches;
- Engineer's scale rulers;
- Suitable protective clothing and gear, as specified in the Health & Safety Plan (HASP);
- Extension cords;
- Equipment cleaning supplies; and
- Clean 55-gallon steel drums, other suitable containers, or groundwater treatment system (if needed).

IV. Health and Safety Considerations

Field activities associated with pumping test will be performed in accordance with a site-specific HASP, a copy of which will be present onsite during such activities.

V. Procedure

Preliminary Step-Drawdown Testing

Preliminary step-drawdown testing will be conducted to determine the pumping rate required to stress the aquifer without causing the pumping well to go dry. The preliminary step-drawdown test is implemented by pumping the well at several successively higher pumping rates (pumping rate will be increased after water level at well reaches approximately steady state), and recording the increased depth to water (drawdown) inside the pumping well. The preliminary step-drawdown test typically lasts several hours depending on site conditions. From the preliminary step-drawdown test, general aquifer properties can be estimated and used to identify an appropriate pumping rate for the subsequent pumping test.

Pumping Test Procedures

1. Select an array of observation wells at various distances from the pumping well, including one or more wells distant from the pumping well. These distant wells indicate the "background" fluctuations of the aquifer during the test. Alternately, if only wells proximal to the pumping well are available, water-level data may be obtained several times per day for a few days prior to the pumping test to determine the background trend of water-level changes.

2. Decontaminate all equipment prior to the test.

3. Measure water levels in all of the wells in pumping test monitoring array, including the pumping well, immediately before pumping according to the water-level monitoring procedures.

4. Prepare water-level monitoring equipment to be operational before pumping is initiated. The following water level recording frequency will apply if manual, electronic water-level probes are utilized:

Time Interval	Recording Frequency
0 to 10 minutes	every 30 seconds
10 to 20 minutes	every minute
20 to 30 minutes	every 2 minutes
30 to 100 minutes	every 5 minutes
100 to 200 minutes	every 10 minutes
200 to 400 minutes	every 30 minutes
400 + minutes	every 1 hour

5. If automatic transducers are used to record water levels, data can be recorded more frequently. Transducers should be matched with wells appropriately, such that the full range of potential drawdown can be monitored without placing the transducer at an inappropriate initial depth. The depth of a transducer below the top of fluid in the well should be less than 2.31 times the transducer PSI rating, in feet. Following transducer installation, obtain a transducer reading using the program from the transducer rental company/manufacture installed in a laptop computer to ensure proper transducer connection and installation depth, plus a manual water-level measurement for cross-referencing water-level fluctuations recorded by the

transducer during the pumping test. This and other pertinent information should be recorded on the data logger form. Synchronize all transducers by using the same laptop computer and prepare the data logger to initiate data acquisition from all transducers at the instant pumping begins. Make sure all timing devices including computer, stop watch, and personal watch are synchronized before pumping test starts.

6. A pumping test typically consists of a pumping (or drawdown) phase and a recovery phase. Initiate the drawdown phase of the pumping test by starting the pump at the pumping test discharge rate (Q) identified based on the preliminary step-drawdown testing results. Monitor the discharge rate according to the same schedule listed above for manual water-level measurements. Adjust the pumping rate as needed to maintain as constant a discharge rate as possible. Record all pumping rate data and adjustments on the pumping rate data form.

7. For each well monitored using a manual water-level indicator, record the following data on the data sheet: clock time, depth to water, depth to water (water level) and SPH if applicable, and initials of person taking measurement.

8. At wells monitored using transducers, several manual water-level measurements should also be obtained daily to verify proper calibration of the transducers.

9. Terminate the drawdown phase after sufficient data have been acquired to adequately characterize the aquifer parameters and boundary conditions, typically after 24 hours to one week of pumping. For confined aquifer, pumping will usually take less than a day. For unconfined aquifer, pumping may take 24 to 48 hours or even longer. Transducer data from pumping well and surrounding observation wells should be downloaded and reviewed consistently to determine the final pumping duration.

10. At the instant the pump is shut off, commence the recovery phase data acquisition by recording water-level data according to the same measurement frequency used during the drawdown phase. The recovery phase should continue until the water level in the pumping well has recovered approximately 75% of the drawdown incurred during pumping. Use of transducers is recommended as manual measurements are only for checking accuracy of transducer readings.

11. Decontaminate all equipment at the end of the testing.

VI. Waste Management

Materials generated during pumping tests will be placed into appropriate containers. Containerized waste will be disposed of by the client.

VII. Data Recording and Management

Several methods of data interpretation may be used to estimate aquifer properties from a pumping test. The assumptions and limitations pertaining to each method of data analysis and the site-specific geology must be carefully considered to select an appropriate method of analysis. Prior to use in parameter calculations, drawdown and recovery data should be corrected for background water-level changes. Background fluctuations data may be obtained from a distant observation well or deduced from a period of water-level monitoring prior to the initiation of the pumping test. Barometric pressure data may be obtained from the weather station nearest the site (or measure it by placing a barologger at one of the background wells and the barologger has to be above water table all the time during the pumping test) so that data corrections can be applied to drawdown and recovery data as appropriate.

Water-level data obtained from a test in an unconfined aquifer may be used to estimate the aquifer transmissivity and short-term storativity by the Neuman (1975) method. Alternately, the drawdown data may be modified by the Jacob (1944) correction for plotting and analysis according to the methods listed below for confined aquifers. Long-term storativity (or specific yield) of an unconfined aquifer may be underestimated using the Neuman method or the confined-aquifer methods. The specific yield of an unconfined aquifer is best evaluated, therefore, by calculating the ratio of the total volume of water pumped during the drawdown phase to the total volume of aquifer material dewatered, or the "cone of depression" (Nwankwor et al., 1984).

Data from a pumping test in a confined aquifer may be plotted and analyzed according to the methods of Theis (1935) or Cooper & Jacob (1946) to calculate the transmissivity and storativity of the aquifer. Data from a test in a leaky-confined aquifer may be plotted and analyzed according to the Walton (1962) or Hantush-Jacob (1955) method. Aquifer analysis may be used to calculate the aquifer transmissivity and storativity, as well as the aquitard leakance.

VIII. Quality Assurance

All reused, non-disposable, downhole pump test equipment will be cleaned in accordance with the procedures described in the Equipment Cleaning SOP.

IX. References

Cooper, H.H., and C.E. Jacob (1946). "A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well Field History," Transactions, American Geophysical Union, Vol. 27, pp. 526 - 534.

Hantush, M.S., and C.E. Jacob (1955). "Non-Steady Radial Flow on an Infinite Leaky Aquifer," Transactions, American Geophysical Union, Vol. 36, pp. 95 - 100.

Jacob, C.E. (1944). "Notes on Determining Permeability by Pumping Tests Under Watertable Conditions," U.S.G.S. Open File Report.

Nwankwor, G.I., Cherry, J.A., and R.W. Gillham (1984). "A Comparative Study of Specific Yield Determinations for a Shallow Sand Aquifer," Ground Water, Vol. 22, pp. 764-772.

Neuman, S.P. (1975). "Analysis of Pumping Test Data from Anisotropic Unconfined Aquifers Considering Delayed Gravity Response," Water Resources Research, Vol. 11, No. 2, pp. 309 - 312.

Theis, V.C. (1935). "The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Groundwater Storage," American Geophysical Union Transactions, Vol.16, pp. 519 - 524.

Walton, W.C. (1962). "Selected Analytical Methods for Well and Aquifer Evaluation," Illinois State Water Survey Bulletin, No. 49, 81 p.

Specific Capacity Testing

Standard Operating Procedure: Specific Capacity Testing

I. Scope and Application

Specific capacity tests will be conducted to estimate the transmissivity of the geologic formation immediately surrounding the screened or open interval of monitoring wells. This test consists of pumping water from a well at a constant rate and quantifying the pumping rate and the magnitude of groundwater drawdown inside the well after a known pumping duration.

The transmissivity of the geologic formation is calculated based on the following:

- Observed test pumping rates;
- Drawdown measured immediately before the end of pumping;
- Pumping duration;
- The effective radius of the monitoring well; and
- The estimated storativity of the aquifer.

II. Personnel Qualifications

Field sampling personnel will have current health and safety training, including 40-hour training in accordance with the Occupational Safety and Health Administration (OSHA) Regulation 29CFR1910.120 (HAZWOPER), site supervisor training, current LPS training, and site-specific training, as needed.

III. Equipment List

The following materials, as required, will be available during specific capacity testing:

- Health and safety equipment (as required in the Health and Safety Plan)
- Appropriate PPE (as required by the Health and Safety Plan)
- A pump (preferably submersible) equipped with a discharge line capable of pumping at a controlled rate between less than one gallon and 10 gallons per minute
- A power source for the pump
- A calibrated in-line totalizing flow meter or two graduated buckets
- An electronic water-level indicator and extra batteries
- Waterproof marker
- Engineers rule
- Cleaning supplies including non-phosphate laboratory grade detergent (Alconox or equivalent), solvents (pesticide grade methanol or hexane), brushes, buckets, tap water, aluminum foil, plastic sheeting, etc
- Garbage bags
- Disposable gloves
- Flashlight
- Stopwatch
- Field notebook

IV. Health and Safety Considerations

Follow health and safety procedures outlined in the Health and Safety Plan.

V. Procedures

1. Identify the site name and well ID in the field notebook along with the date, time, personnel, and weather conditions.

2. Make sure that all equipment that enters the well is cleaned before use (i.e., pump, cable, water level probe, etc.). Use new, clean materials when cleaning is not appropriate (polypropylene rope, disposable gloves, etc.). Document cleaning procedures in field notebook.

3. Place cleaned equipment and instruments on plastic sheeting near the well.

4. Measure the static water level of the well with a water level indicator to the nearest 0.01 feet relative to a specified datum at the top of the well casing. Record the water level and the time of measurement in the field notebook.

5. Calculate the depth to water corresponding to a drawdown of two feet. Ideally, the drawdown during a specific capacity test should not exceed three feet. Excessive drawdown may cause inefficient flow to the well and may cause an error to the transmissivity calculation.

6. Lower the pump to approximately five feet below the static water level, or within no less than one foot of the bottom of the well (to minimize sediment mobilization). Once the pump is in place, the water level in the well should be monitored until it has returned to within 0.01 feet of the static water level.

7. Hold the water level probe in the well just above the surface of the static water level. If an in-line totalizing flow meter is used, record the pre-test volume measurement in the field notebook. If no in-line flow meter is available, place the end of the discharge line from the pump in one of the two calibrated buckets. Record the total capacity of each bucket.

8. Simultaneously start the pump and the stop watch. Record the start time.

9. Immediately begin monitoring the water level in each well. If the drawdown rapidly approaches or passes the maximum suggested drawdown of two feet, reduce the pumping rate until the drawdown is approximately 0.5 to 1.0 feet. All pumping rate adjustments should be completed within one or two minutes of the beginning of pumping, after which, no adjustment should be made other than minor adjustments that may be necessary to maintain a steady pumping rate.

10. Continue to pump for at least 20 minutes, recording the water level every two minutes and field parameters every five minutes throughout the test. If an in-line flow meter is used, record the volume measurement on the totalizer gauge approximately every two minutes during the test. If calibrated buckets are used to measure the pumping rate, record the time which the bucket reaches its known, recorded volumetric capacity. Transfer the discharge line to the other empty bucket and record the time when it becomes full. Repeat this process for the duration of the test.

11. Pumping should continue for no less than 20 minutes. A longer pumping period may provide a slightly more reliable transmissivity estimate. Immediately prior to termination of pumping, record the final water level measurement plus the time of measurement.
12. Calculate and record the total volume of groundwater removed from the well during the test, and the total duration of the test. Divide the total volume (in gallons) by the total pumping duration (in minutes) to calculate and record the average test pumping rate (in gallons per minute).

13. Reduce the data obtained from the specific capacity test using the specific capacity test reduction spreadsheet program (QSTRANS) developed by BBL. QSTRANS iteratively solves for the value of transmissivity in the equation (Walton 1962):

    Q/s = T / [264 log(Tt/2693rw2S) - 65.5]

    where:
    Q = Average test pumping rate in gallons per minute;
    s = Groundwater drawdown (in feet) within well after a known duration of pumping (t);
    (Q/s = Specific capacity of the well in gallons per minute per foot;)
    T = Transmissivity of the geologic formation surrounding the intake of the well (in square feet per minute);
    S = Estimated storativity of the aquifer (unitless);
    rw = Effective radius of the well (feet); and
    t = Time between the start of pumping and the time when drawdown is measured (minutes).

    For confined aquifers an estimated storativity of 0.0001 should be used. For a specific capacity test of less than one hour duration within an unconfined aquifer, an estimated storativity of 0.01 should be used.

    To calculate the estimated hydraulic conductivity for the formation surrounding the well, the estimated transmissivity is divided by the thickness of the water-bearing zone adjacent to the intake of the monitoring well. All calculations must be reviewed by a qualified hydrogeologist. Calculations will be provided with backup documentation such as raw data and graphs of the data.

VI. Data Recording and Management

Copies of field notes will be maintained in the project file.

VII. References

Blasland, Bouck & Lee, Inc. 2006. *Health and Safety Plan - Newburgh Project.*

Blasland, Bouck & Lee, Inc. 2006. *Newburgh Project Pre-Design Investigation - Area A.*

Sediment Sampling

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Standard Operating Procedure: Sediment Sampling (with Dewatering)

I. Scope and Application

The general procedures to be utilized when obtaining sediment samples are outlined below. Lexan® tubing will be the primary method used to collect sediment cores. The tubing may be replaced with a calibrated rod if only probing is needed. If the creek bed cannot be penetrated by the Lexan® tubing due to large cobbles, boulders, or bedrock, an attempt may be made using a standard split-spoon sampler or a stainless steel bucket auger. If no sample is obtained, work will proceed to the next location.

Surface sediment sampling will be conducted using a hand-held dredge (e.g., Ponar Dredge) or an Ekman grab sampler. Surface sediment is defined as the upper 6 inches of the sediment column.

II. Personnel Qualifications

BBL field personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervision training, and site-specific health and safety training. In addition, personnel overseeing, directing, or supervising sediment collection will be versed in the applicable SOPs to successfully complete the sampling activities. Supervising personnel will be trained in swift-water rescue for rivers with flow rates greater than 2 feet per second.

III. Equipment List

The following equipment or materials will be available, as required, during sediment sampling activities:

- Personal protective equipment (PPE), as specified by the site *Health and Safety Plan* (HASP);
- Chest waders;
- Cleaning supplies and equipment;
- Boat;
- Aluminum or stainless steel tray (do not use aluminum if sediment samples will be analyzed for metals);
- Clear tape;
- Indelible marker;
- Lexan® tubing with end caps, stainless steel bucket auger, and/or stainless steel sediment corer;
- Stainless steel core driver;
- Hand-held dredge with rope;
- Calibrated rod for sediment depth measurement;
- Stainless steel spatula;
- Handsaw;
- Brass push rod;
- Hacksaw;
- Vacuum pump;
- Stainless steel Ekman grab sampler (0.25 ft^2) with handle (or equivalent);

- Teflon® or polyethylene siphon;
- Stainless steel or plastic ruler;
- Stainless steel spoons;
- Stainless steel mixing bowl;
- Camera (if permitted);
- Transport container with ice;
- Appropriate sample containers and forms;
- Field notebook;
- Whatman #4 filter paper (or equivalent); and
- Stainless steel colander.

IV. Cautions

If heavy precipitation occurs and there is no cover over the sampling area, sampling must be discontinued until adequate cover is provided. Rain water could contaminate sediment samples.

Do not use permanent marker or felt-tip pens for labels on sample container or sample coolers – use indelible ink. The permanent markers could introduce volatile constituents into the samples.

Store and/or stage empty and full sample containers and coolers out of direct sunlight.

To mitigate potential cross-contamination, sediment samples are to be collected in a pre-determined order downstream to upstream.

Be careful not to over-tighten lids with Teflon® liners or septa (e.g., 40-mL vials). Over-tightening can impair the integrity of the seal.

Be careful not to spill laboratory-prepared containers that may contain preservatives. Reduction of the preservative in the container may impact the integrity of the sample and analytical results.

V. Health and Safety Considerations

Be careful not to spill laboratory-prepared containers that may contain preservatives on hands or clothing. Wear appropriate gloves and PPE when handling containers containing preservatives, as per the HASP.

If thunder or lightning is present, discontinue sampling until 30 minutes have passed after the last occurrence of thunder or lightning.

Pay attention to the vegetation type along shorelines, as poisonous plants (such as poison ivy) thrive along the banks of water bodies.

Consult the site-specific HASP.

VI. Procedures

Sediment Probing

Use the calibration rod to probe sediment depths along the sediment characterization transects. At each probe location record:

- sediment type;
- sediment river bed grain sizes in percentages of fine sand, gravel, cobbles, boulders;
- an estimated percentage of organics/peat;
- condition of sediment water interface; and
- an evaluation of whether the river bed is consolidated versed non-consolidated.

Note measurements made of location, depth, time, and field samples in the field notebook.

Sediment Collection

a. Procedures for Lexan® Tube Sampling

1. Identify the proposed sample location in the field notebook, along with other appropriate information collected during sediment sampling activities.

2. Don PPE, as required by the HASP.

3. Position boat (if used) or sampling device over the sampling location and record station position.

4. At each sample location, lower a section of Lexan® tube until it just reaches the top of sediment. Measure the depth of water. (It may be necessary to splice sections of Lexan® tube together in deep water locations.)

5. Push the Lexan® tube into the sediment by hand until refusal. Measure the depth of sediment. If the procedure is being performed to determine sediment depth (probing), a calibrated rod may be used in place of the Lexan® tube. If the procedure is being performed to collect samples for laboratory analysis, continue with Step 6.

6. Drive the tube several more inches using a stainless steel core driver and measure the distance. This procedure is performed to obtain a "plug" at the bottom of the core and prevent the loose sediment from escaping.

7. Place a vacuum pump on the top end of the Lexan® tube and create a vacuum to prevent the sediments/plug from escaping.

8. Slowly pull the tube from the sediment, twisting it slightly as it is removed (if necessary).

9. Before the tube is fully removed from the water, place a cap on the bottom end of the tube while it is still submerged.

10. Keeping the tube upright, wipe the bottom end dry and seal the cap with tape. Measure the length of sediment recovered and evaluate the integrity of the core. If the core is not suitably intact, repeat the coring procedure at a point adjacent to the first location attempted.

11. While still keeping the core upright, use a handsaw to make a horizontal cut in the tube approximately 1 inch above the sediment.

12. Re-cap the cut end of the tube, seal the cap with tape, and mark this end as “TOP” with indelible marker.

13. Wipe the tube dry.

14. Place a completed sample label on the tube.

15. Record the following sediment characteristics in the field notebook:
    - texture;
    - color;
    - presence of debris;
    - presence of an oily sheen;
    - biological structures; and
    - odor (e.g., hydrogen sulfide).

16. Record the following information on both the tube and the cap:
    - sample number;
    - sampling date; and
    - sampling time.

17. If the core is to be photographed, photograph the core along with a calibrated measuring ruler and note the location and soil description in the field notebook.

18. Place the core sample upright in a container with ice.

19. Extrude sediment cores from the Lexan® tubing onto an aluminum or stainless steel tray. Section cores into the 0- to 6-inch and 6- to 12-inch depth increments and thereafter into increments corresponding to visible vertical strata in the core, if any. If the sediment is homogeneous throughout and there are no distinguishable strata, split the remainder of the core into predetermined increments to the bottom of the core. Individually package each increment. Describe and record sample descriptions.

20. Core sections may be frozen to facilitate sectioning when sediment is extremely loose.

21. For cores that require sectioning into thin intervals (2 cm), extruding can be accomplished using a mechanical extruder that pushes the core material out through the top of the core tube. Cut sediment samples into the desired section thickness. Discard sediment touching the inner sides of the tube. Individually place each section into sample containers.

22. Store samples in coolers on ice until transfer to the laboratory (within 48 hours of sample collection).

23. Decontaminate the handsaw or knife used to section the core between each cut.

24. Label sample containers with: 1) site, 2) project number, 3) location number, 4) sample interval, 5) date, 6) time of core collection, and 7) names of sampling personnel. Record appropriate information in the field notebook.

25. Fill out chain-of-custody form and handle, pack, and ship the samples in accordance with Attachment B-1.

b. Procedures for Hand-Held Dredge Sampling

1. Identify the proposed sample location and the appropriate information collected during sediment sampling activities in the field notebook.

2. Don PPE, as required by the HASP.

3. At each sample location, drop the opened dredge from the side of the boat, making sure that the end of the rope is maintained at all times inside the boat.

4. Once the dredge has been allowed to settle into the bottom sediments, maintain a hard pull on the rope inside the boat.

5. Retrieve the dredge into the boat.

6. Open the dredge to allow the sediments to empty onto a stainless steel tray.

7. Describe and record sample descriptions.

8. Distribute a portion of the sample to the containers for VOC analysis, if required in the Work Plan for chemical analyses.

9. For sediment collected for non-VOC analysis, dewater the sediment samples. After allowing the sample to settle, gently pour out the sediment-free standing water from the mixing bowl container. This step should be repeated at least once. Mix sample with decontaminated stainless steel spoon and let sample re-settle. Decant standing water after all sediment has had time to settle. Assess the sample for moisture content.

10. Place two or more sheets (as needed) of Whatman #4 filter paper into the bottom of a stainless steel colander. Place the sediment sample or portion of the sample on the filter paper in the colander and spread into a 1-inch thick (or less) layer. Allow the water to be absorbed. If standing water collects on the surface of the sediment layer, place a piece of filter paper on top of the sediment. Additional sheets of filter paper should be exchanged and patted on upper surface until excess standing water is absorbed. The sediment should remain in the colander for up to 10 minutes, but no less than 5 minutes. When the surface of the sediment is relatively dry, remove the top layer of the filter paper and quickly invert the colander over a decontaminated stainless steel mixing bowl. Remove the bottom layer of filter paper. Repeat until enough dewatered sediment fills all sample containers. Remix sample with stainless steel spoon and fill containers with uniform sample.

11. Place into appropriate sample containers with stainless steel spatula.

12. Label sample containers with: 1) site, 2) project number, 3) location, 4) sample interval, 5) date, 6) time of sample collection, and 7) names of sampling personnel.

13. Handle, pack, and ship the samples in accordance with Attachment B-1.

c. Procedures for Ekman Grab Sampling

Grab Sampler Deployment

1. Identify the proposed sample location in the field notebook, along with other appropriate information collected during sediment sampling activities.

2. Don PPE, as required by the HASP.

3. Before each station is sampled, decontaminate the inner surfaces of the grab sampler and all stainless steel sampling utensils.

4. If the water depth is less than 9 feet, attach the grab sampler to the metal handles.

5. Place the grab sampler on a decontaminated surface and open it.

6. Verify that the two release wires are securely placed around the release pins.

7. Lower the sampler through the water column at a slow and steady speed.

8. Allow the grab sampler to contact the bottom gently, with only its weight being used to force it into the sediment. The sampler should not be allowed to "free fall" to the bottom because this may result in premature triggering, an excessive wake, or improper orientation upon contact with the bottom.

9. Deploy trigger weight to release the doors on the bottom of the grab sampler.

Grab Retrieval

1. After the grab sampler has rested on the bottom for approximately 5 seconds, begin retrieving it at a slow and steady rate.

2. After the grab sampler breaks the water surface, gently lower it onto a decontaminated surface while maintaining the grab sampler in an upright position.

3. Open the doors on the top of the grab sampler and inspect the sample for acceptability. The following acceptability criteria should be satisfied:

   - Sampler is not overfilled with sample to the point that the sediment surface presses against the top of the sampler or is extruded through the top of the sampler.

   - Overlying water is present (indicates minimal leakage).

   - Overlying water is not excessively turbid (indicates minimal disturbance or winnowing).

- Desired penetration depth is achieved (i.e., 4 to 5 cm for a 2-cm deep surficial sample).

4. Determine penetration depth by placing a ruler against the center of the inside edge of the opening on top of one side of the grab sampler and extending it into the grab sampler until it contacts the top of the sample. The penetration depth is determined by the difference between that measurement and the total depth of the grab sampler.

Sample Removal and Processing

1. For acceptable samples, remove the overlying water by slowly siphoning it off near one or more sides of the grab sampler. Take care that the siphon does not contact the sediment or that fine-grained suspended sediment is not siphoned off. If sediment is suspended in the overlying water, do not proceed with siphoning until the sediment is allowed sufficient time to settle.

2. After the overlying water is removed, characterize the sample as specified in the study design. Characteristics that are often recorded include:
    - texture;
    - color;
    - biological structures (e.g., shells, tubes, macrophytes);
    - presence of debris (e.g., twigs, leaves);
    - presence of an oily sheen; and
    - odor (e.g., hydrogen sulfide, oil).

3. After the sample is characterized, remove the top 2 inches using a stainless steel spatula. Unrepresentative material (e.g., large shells, stones, leaves, twigs, root mass) should be removed and noted on the field log sheet.

4. Transfer the surface sediment to a stainless steel mixing bowl for homogenization (see SOP for Compositing Samples - Attachment B-7). Additional grab samples may be required to collect the volume of sediment specified in the study design. The mixing bowl should be covered with aluminum foil while additional samples are being collected to prevent sample contamination (e.g., from precipitation, splashing water).

5. After a sufficient volume of sediment is transferred to the mixing bowl, homogenize the contents of the bowl using stainless steel spoons until the texture and color of the sediment appear to be uniform.

6. After the sample is homogenized, distribute a portion of the subsamples to the various containers for VOC analysis, if required in the Work Plan.

7. For sediment collected for non-VOC analysis, dewater the sediment samples. After allowing the sample to settle, gently pour out the sediment-free standing water from the mixing bowl container. This step should be repeated at least once. Mix sample with decontaminated stainless steel spoon and let sample re-settle. Decant standing water after all sediment has had time to settle. Assess the sample for moisture content.

8. Place two or more sheets (as needed) of Whatman #4 filter paper into the bottom of a stainless steel colander. Place the sediment sample or portion of the sample on the filter paper in the colander and spread into a 1-inch thick (or less) layer. Allow the water to be absorbed. If standing water collects on the surface of the sediment layer, place a piece of filter paper on top of the sediment. Additional sheets

of filter paper should be exchanged and patted on the upper surface until excess standing water is absorbed. The sediment should remain in the colander for up to 10 minutes, but not less than 5 minutes. When the surface of the sediment is relatively dry, remove the top layer of filter paper and quickly invert the colander over a decontaminated stainless steel mixing bowl. Remove the bottom layer of filter paper. Repeat until enough dewatered sediment fills all sample containers. Remix sample with stainless steel spoon and fill containers with uniform sample.

VII. Waste Management

Dispose of remaining sediment in accordance with project requirements and applicable regulations.

VIII. Data Recording and Management

Sampling activities will be recorded in the field notebook. Copies of the field notebook will be forwarded at the end of each day to the Project Manager or designee. Upon completion of the field activities, field notebooks will be maintained in the project files.

IX. Quality Assurance

Field-derived quality assurance blanks will be collected as specified in the Work Plan, depending on the project quality objectives. Typically, field rinse blanks will be collected when non-dedicated equipment is used during groundwater sampling. Field rinse blanks will be used to confirm that decontamination procedures are sufficient and samples are representative of site conditions. Trip blanks for VOCs, which aid in the detection of contaminants from other media, sources, or the container itself, will be kept with the coolers and the sample containers throughout the sampling activities.

X. References

None.

Benthic Community Sampling

Standard Operating Procedure: Benthic Macroinvertebrate Survey

I. Scope and Application

The following procedures describe the general methodologies that will be used in the field to sample the benthic macroinvertebrate community.

II. Personnel Qualifications

Field personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervision training, and site-specific health and safety training. In addition, personnel overseeing, directing, or supervising sediment characterization will be versed in the applicable SOPs to successfully complete the activities. Supervising personnel will be trained in swift-water rescue for rivers with flow rates greater than 2 feet per second.

III. Equipment List

The following collection equipment and materials will be available, as required, during benthic sampling:

- Health and safety equipment (as required by the site Health and Safety Plan [HASP]);
- Water body name and Site maps;
- Boat, engine, life jackets, anchors, buoys, and rigging;
- Sediment dredge (standard ponar dredge);
- Winch;
- Mesh or sieve screen (500 um);
- Sample jars, vials, and preservative (70% alcohol solution);
- Forceps and magnifying glass;
- Stainless steel mixing bowl, tray, and scoop;
- Cleaning and decontamination materials;
- Insulated coolers with ice;
- Plastic sealable bags and indelible ink markers;
- Camera;
- Hand-held GPS unit;
- Physical characterization/water quality field data sheet; and
- Field notebook.

IV. Cautions

Cautions include typical hazards associated with working around water (e.g., drowning, falling on slippery surfaces, etc.).

V. Health and Safety Considerations

Personnel will wear life jackets when working around water. Isopropyl alcohol will be labeled and stored appropriately.

VI. Procedure

Benthic macroinvertebrate samples will be collected using approved sampling techniques. The following procedures describe the use of a sediment dredge to collect benthic macroinvertebrates:

1. The field crew will identify the proposed sample location using GPS or topographic landmarks and will anchor the boat securely so that it will not drift due to water or wind currents.

2. Water quality data (i.e., temperature, dissolved oxygen, pH, specific conductance, turbidity, and water velocity) will be collected within 1 meter of the substrate surface. If sample locations are close together, this data will be recorded once for each general area.

3. At each sample location, the opened dredge will be lowered over the side of the boat with the winch and allowed to settle into bottom sediments. Close the sediments inside the dredge by either a hard pull on the rope.

4. Retrieve the dredge into the boat using the winch and empty dredge contents into a 5-gallon bucket. Repeat this process until approximately 1 gallon of sediment has been collected (approximately 3 dredges).

5. Sieve the benthic samples to isolate the benthic organisms. Hand transfer organisms and sediment matrix from the sieve to a labeled sample jar, and preserve in the field using 70% alcohol.

VII. Sample Handling

The following identifies the temporary storage procedures that will be used to preserve benthic community samples in the field prior to shipment to the laboratory:

1. Benthic organisms, and the remaining sediment matrix that is isolated after sieving, will be preserved in the field using 70% isopropyl alcohol.

2. Each sample will be labeled with sampling date and collection location and will be counted to ensure that the correct number of samples has been taken

VIII. Waste Management

All disposable equipment will be bagged and appropriately handled based on Site-specific requirements (if applicable).

IX. Data Recording and Management

Field notes will be recorded during sampling activities, and at a minimum, will include the following:

- Names of field crew and oversight personnel;
- General weather conditions;

- Date, time, and sample location (GPS, if specified);
- Sampling technique and duration;
- General observations of benthic abundance and diversity;
- Substrate characterization and water quality; and
- Photograph number when pictures are taken (if necessary).

Copies of the field notebook will be forwarded at the end of each day to the Project Manager or designee. Upon completion of the field activities, field notebooks will be maintained in the project files.

X. Quality Assurance

The benthic macroinvertebrate survey will be conducted consistent with the procedures outlined in this SOP. Deviations from the SOP will be discussed with the project manager prior to changing any field procedures.

XI. References

None.

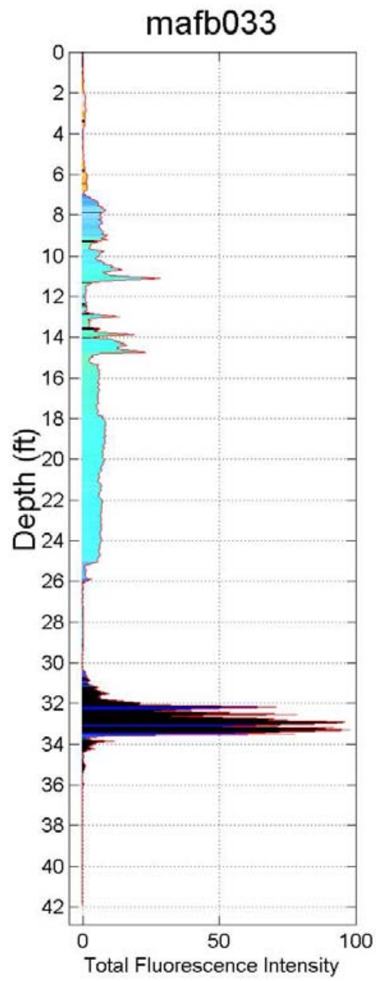
TarGOST™ Probing

BBL®

an ARCADIS company

Dakota Technologies, Inc. Laser Induced Fluorescence
Standard Operating Procedure

Prepared: September 3, 1999



Soil Logging with Laser Induced Fluorescence

1.0 OBJECTIVE

The objective of this procedure is to collect an *in-situ* real-time soil log to identify soil/water contamination by POLs.

2.0 BACKGROUND

2.1 Definitions

SPOC Shock Protected Optical Cylinder
POL petroleum, oils and lubricants
ppm parts per million
DCAM Depth Control and Acquisition Module
LIF Laser Induced Fluorescence
M1 Fluorescence Signal Standard
UV Ultraviolet (wavelength 308nm in this case)
Bgs Below ground surface
TPH Total petroleum hydrocarbon
Geoprobe a registered trademark of Kejr Engineering, Salina, KS

2.2 Discussion

Fluorescence is a property of some compounds where-by absorbed ultraviolet light stimulates the release of photons (light) of a longer wavelength, often in the visible range. Since many aromatic hydrocarbons fluorescence, this property can be used to detect small amounts of a substance in/on a much larger matrix, gasoline in soil, for example.

The method has been used in the laboratory for decades, but only recently, because of the availability of high power light sources and optical fibers, has this technology been taken to the field.

The system developed by DTI sends UV light through optical fibers that are strung through Geoprobe rods. The light exits the probe through a sapphire window on the side of the probe tip. As the probe is advanced, soil sliding past the window is exposed to UV light, if fluorescent compounds exist light is emitted. The "signal" light is then transmitted through a fiber to be analyzed. Responses are indicated, in real-time, on a graph of signal vs. depth. The graph can also display false color logs or three dimensional "fingerprints" which correlate to the type of contaminant present.

This technology is useful for the detection of POLs including; gasoline, diesel fuel, kerosene, motor oil, creosote, etc. Even small amounts of neat product can be detected in the vadose and saturated zones. However, this method can not detect chlorinated solvents or pesticides and does not detect dissolved phase BTEX.

Signal intensities are calibrated before each push to a known standard. The horizontal axis represents the signal intensity relative to that standard. The concentration of contaminant is directly related to the signal intensity but because of soil matrix effects, degradation of fuels and other factors, approximate concentration values (ppm) can only be assigned by comparison to adjacent soil sample data. The instrument limit of detection varies with soil matrix and contamination type.

3.0 REQUIRED EQUIPMENT

List of standard Geoprobe equipment specific to LIF, including part numbers:

48" x 1.25" probe rods	AT1248(enough for intended probing depth)
24" x 1.25" probe rod	AT1224
rod to SPOC drive head	GW1512
slotted drive cap	AT1202
slotted pull cap	AT1203
rod wiper	AT1255

LIF system equipment

- Instrument cabinet
  - Pentium I, color LCD, harsh environment computer
  - MPB excimer laser – PSX-100
  - Tectronix oscilloscope – TDS220
  - Acton monochromator
  - Hamamatsu photomultiplier tube and housing
- Color printer – HP model 722C
- 50 meter optical cable
- SPOC components
  - SPOC assembly
  - drive point
  - sapphire window
  - tool kit (window tool, silicone tube, o-rings, swage ferrules, etc.)
- M1 Reference standard in magnetic holder
- DCAM and associated cables (encoder, valve, serial, power)
- Encoder – Unimeasure model # HX-EP-80
- Electronic hydraulic control valve assembly (valve, block, coil, DIN)
- Manual bypass valve

4.0 SAFETY

Laser safety.

Don't look directly into the sapphire window of the SPOC, UV light can damage skin and eyes. Only qualified individuals should have the front panel of the instrument cabinet removed to access the launch end of the optical fiber.

The excimer gas contains low levels of HCl. When recharging, exhaust all gas through the chemical scrubbing cylinder.

Site hazards

Make sure the area has been cleared for **underground utilities!** A natural gas line or high voltage electric can kill. Be aware of aerial hazards that may catch the probe or top of truck. Uneven terrain poses a tipping hazard during of the truck. If terrain is unknown, walk the intended route before driving to look for hidden holes, rocks, wires, pipes, muddy areas, etc.

Operational hazards

Beyond the utility hazard, the next greatest risk to the operator is crushing. The operator must not allow any untrained individuals in the immediate area around the probe and must not allow others to operate hydraulic controls. Never put hands or fingers between the drive cap and the hammer. **Gloves** should be worn since sharp metal filings are sometimes produced by the hammer. Rubber gloves may be required where chemical hazards exist. Never put your foot or hand under the foot of the probe. Probing through resistant material will tend to lift the probe foot and can fall unexpectedly when the probe tip encounters softer sediments. **Steel toe boots** must be worn by the operator and helper, they will protect against dropped rods or tools. Hearing protection is a must. The hammer is very loud. Operator and helper **must have hearing protection** as well as any clients or bystanders in close proximity to the probe. For extended projects that require a lot of hammering the operator may choose to use ear plugs <u>and</u> ear muffs. A **hardhat is required** for operator and helper to protect from falling objects. The operator works in very close proximity to the probe and probe tools, often under the hammer, head protection can prevent painful contusions. The greatest eye hazard is from the fine metal filings that are produced by the hammer. The operator and helper should be wearing **eye protection**. The level of chemical protection will depend on the chemical hazards of the site. Often the site owner, environmental consulting company or regulating agency will define the type of **personal chemical protection** required. If not, it is up to the operator to make sure that personnel are protected for potential chemical hazards.

Site Safety Plan

Often the environmental consulting company will have a site safety plan in place. If not, it is up to the operator to make sure that all relevant aspects of a generic site safety plan have been modified to fit the current work site and conditions.

5.0 OPERATION

<u>Collecting an LIF log</u>

1) Start the electric generator and wait for a minute or two for the rpms to stabilize.

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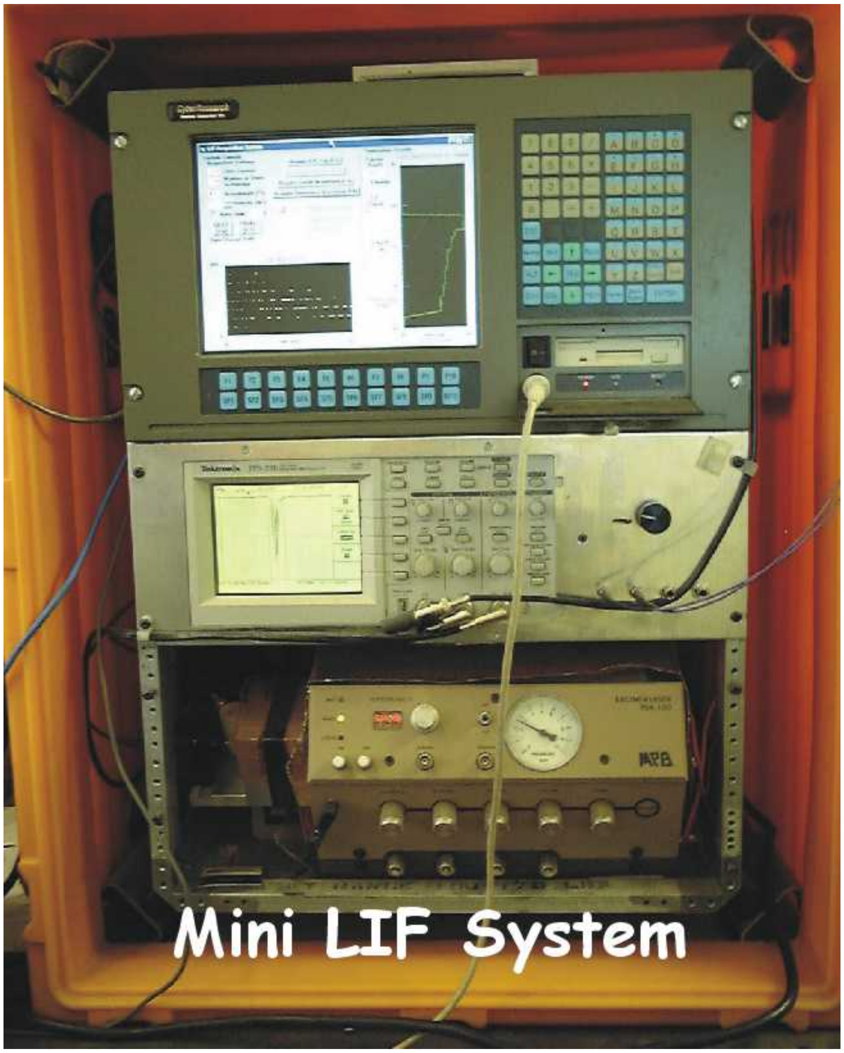
2) Turn on system power.
The excimer laser will require some time to warm up under cool/cold conditions. With nighttime temperatures below 40F it may be prudent to plug in the laboratory to an electrical outlet and run the lab heater overnight to maintain a 60F temperature. Once the power is turned on, the laser will take several minutes before the "READY" indicator light is illuminated. It will take another 30 seconds or so for the laser to actually start after pushing the "ON" button, this is normal. From initial start the

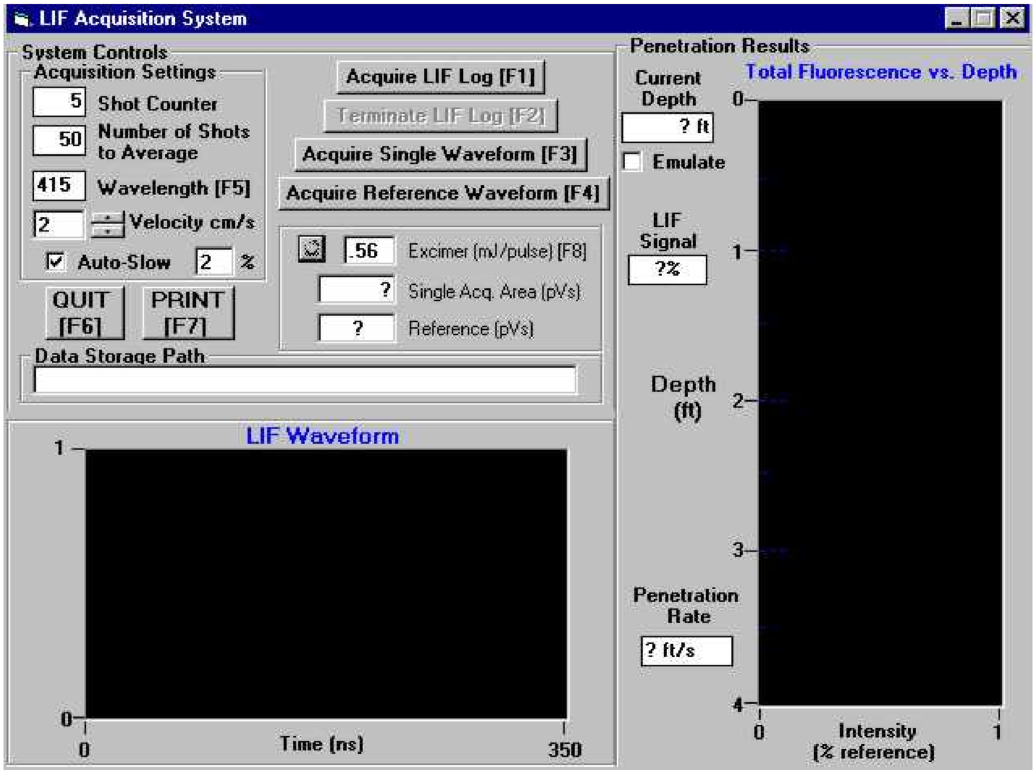
laser may take 15 to 30 minutes to reach a steady-state power output, factor this into your start time.



3) To log-on to the computer, type password "minilif" and "enter". Windows 95 will open and display program icons. Open the visual basic icon and select "Run" – "Start". This will open the logging software.

The prompt will ask if you want the DCAM operational. Switch on the DCAM at the back of the truck at this time. Go back to the computer and click "Retry".

The software should start, and the following screen should appear.



4) Check the laser output by selecting F8 or click on the button to the left of the "Excimer" field. The output should be 0.5mJ/pulse or greater. If the output is less, the laser will need to be recharged. See the laser manual for recharging the system.

5) The area under the waveform should now be checked by putting the M1 reference on the window. Position the M1 over the window in such a way to optimize the signal as viewed on the oscilloscope. Now click on "Aquire Reference Waveform" or F4 and check the measured area in pVs. This number should be between 40,000 and 18,000. If not, see the section below regarding alignment of optics.

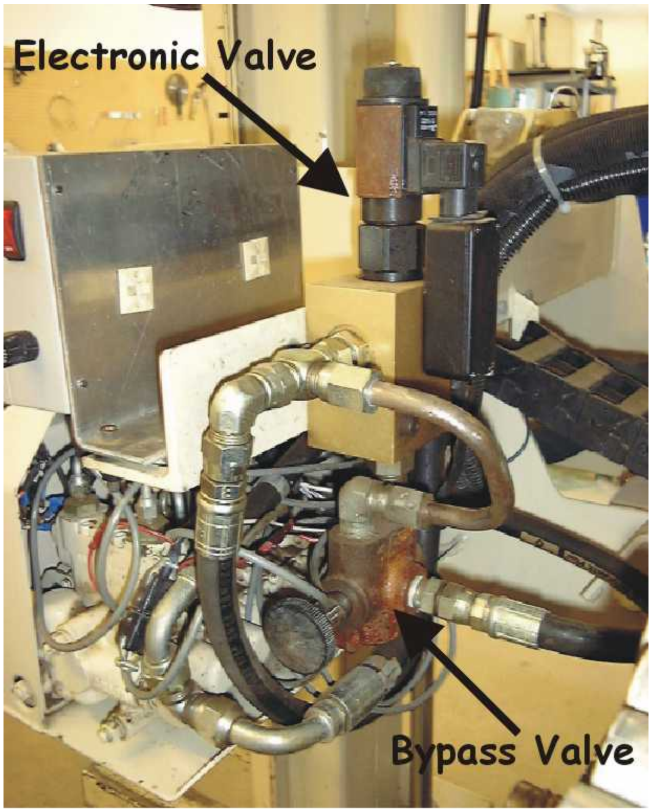
6) The rubber rod wiper should be on the ground and the probe foot should be on to the peg and the clip removed so that the peg "floats" with probe movement. the wiper at the desired hole location. The encoder cable should be hooked (show photo of peg and cable)

7) To begin collecting an LIF log, click on "Aquire LIF Log" or press F1. The logging protocol will begin by asking for a file name. Type in the path and file name or select the appropriate directory and type a file name and press enter. The software will ask if you want to do a reference standard. Indicate "yes".

8) The M1 standard should now be placed over the sapphire window of the probe (window and cuvette should be clean).

After acquiring the reference waveform, the software will ask if you want to zero the DCAM. Remove the M1 and place the probe under the hammer. Push the probe into the ground until the window is at ground level, this will be zero feet or ground surface. Now start the logging software by confirming that the window is at zero and data acquisition can begin. DCAM should beep, indicating that the push can begin.

9) The probe operator should push in, or close the hydraulic bypass valve, to divert all oil through the electronic valve (see photo below).



The operator can now hold down the leftmost probe control lever. The default probe rate is 2cm/sec. **The operator should be prepared at any time to begin hammering to prevent the probe from lifting too far off of the ground**. Continue probing to desired depth by cycling the probe up, adding a rod and pushing it at a controlled rate.

10) At the end of the push the logging should be terminated by clicking on “Terminate LIF Log” or F2. The DCAM should beep indicating that data collection has been teminated.

11) The log just recorded can be printed immediately by clicking on “PRINT” or F7. Scale parameters should be selected based on the depth probed and the signal levels. Mini waveforms can be selected at specific depths to look at the “fingerprint” of the contamination in question. Click on “OK” to send the job to the printer (or go to “File” – “Print” when the graph is displayed).

12) While the log is printing the rods can be pulled out of the ground. To expedite the rod pulling process, pull out the bypass valve. This will send unrestricted oil flow to the push/pull ram.

13) Grout the hole by pouring bentonite crumbles (#8) into the hole. Some states may require tremie grouting (see Geoprobe manual for this procedure).

Oscilloscope

Upon initialization of the software, the proper oscilloscope settings should be automatically set. However, to set it manually, the setup should be as follows:

Channel 1 – signal

Horizontal scale - 250ns/division

Vertical scale – set to 50mV/division (should autoscale with widely ranging signal intensity levels. The operator should zoom in to 2mV/division when observing the background signal of a clean window.)

Width between measurement cursors is 350ns

Aquire menu should be in average mode with 64 samples

Channel 2 – laser energy meter

Horizontal scale - 500us/division

Vertical scale – 50mV/division

Width between measurement cursors is 700us

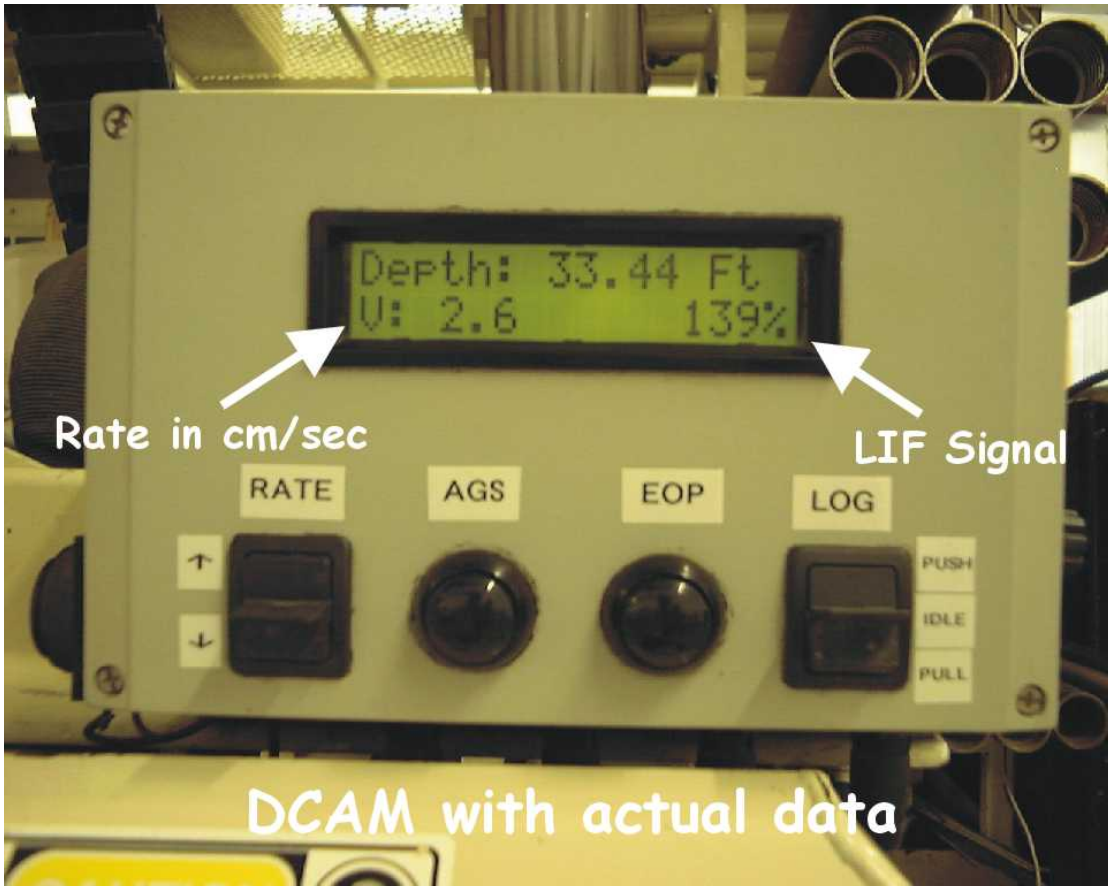
Trigger – external trigger photo diode

Set the trigger level to ride in the center of the rising slope of the photo diode signal.

See the oscilloscope manual for additional operating instructions.

DCAM

The DCAM was designed as a multifunction device that is used as a intermediary between encoding or detecting devices and a serial output. It is also the interface between the probe operator and the logging software. **When used with the LIF system all functions are normally controlled from the LIF logging software**. However, the probe operator can control all functions at the DCAM. These controls include: Probe rate increase or decrease, **A**t **G**round **S**urface/begin push, **E**nd **O**f **P**ush, and Log while pushing/idle/log while pulling.



Hydraulic Valve

For probing activities other than LIF the bypass valve should be opened (pulled out) to optimize probing speed. For LIF pushes the bypass should be closed (pushed in) so oil is diverted through the rate controlling valve. After an LIF push the operator should open the bypass to expedite rod removal. Technical information regarding the electronic hydraulic valve are available in the valve manual.

Fiber Cable

Two 400um optical fibers are enclosed in a stripwound stainless steel cable covered with a thick polyurethane coating. In general the cable is quite robust and can be handled constantly and stepped on, however, **care should be practiced during rod handling and probing to prevent crushing or kinking of the cable**. Do not drop rods on their end, since fiber damage could occur. The probe operator must never let the cable get crushed under the probe foot or near the hammer. When adding or removing slotted drive or pull caps care should be taken to prevent twists or crushing by the hammer. Don't slam the side door of the truck on the cable and do not move the truck with the cable dragging. Be aware of the cable and prevent damage.

SPOC

See maintenance section for SPOC adjustments. Make sure window and M1 are clean. Position M1 over window in a manner that illuminates the standard best – it may be offset slightly from center.

Probe

Probing through **hard surfaces**.
Concrete – see Geoprobe manual for procedure (5-14 to 5-22).
Asphalt and rubble - preprobing. When penetrating asphalt or near-surface rubble, employ a preprobing technique to prevent damage to the SPOC and cable. Use a 1.5 inch "dummy" probe to penetrate asphalt pavement and/or rubble and compacted aggregate (usually less than 2 feet). Remove the preprobe, lift the probe foot and place rod wiper over hole and proceed as usual. Note, reliable LIF data will not be collected to the preprobed hole depth
Frost – see Geoprobe manual for procedure (5-14 to 5-22).

Placing the rubber **rod wiper** under the probe "foot".
If no hard surface conditions exist, simply place rubber rod wiper under the foot of the probe with one of the holes in a position that is optimized for straight penetration of the probe. For hard surfaced situations, do preprobing or drilling first, then place rubber wiper under the foot.

Probe operation during an LIF push.
The key to good data collection is smooth penetration of the probe. The hydraulic rate controller, typically set at 2cm/sec, maintains a uniform penetration rate through soft sediments. The operator simply holds the vertical hydraulic control in the fully down position and lets the electronic valve keep the rate steady. When resistance is encountered and the foot of the probe machine lifts off of the ground the probe operator may have to respond with blows of the hydraulic hammer. Often a partial opening of the hammer valve (a light hammering) is all that is necessary to keep the foot on or near the ground. **CAUTION:** The probe **will** pick the truck off of the ground, creating a dangerous situation. Never put anything under the probe foot when it has been lifted off of the ground. A good rule of thumb is – don't let the sliding peg of the encoder line ever leave the ground. This gives approximately 8" of vertical travel, plenty for all probing activities.

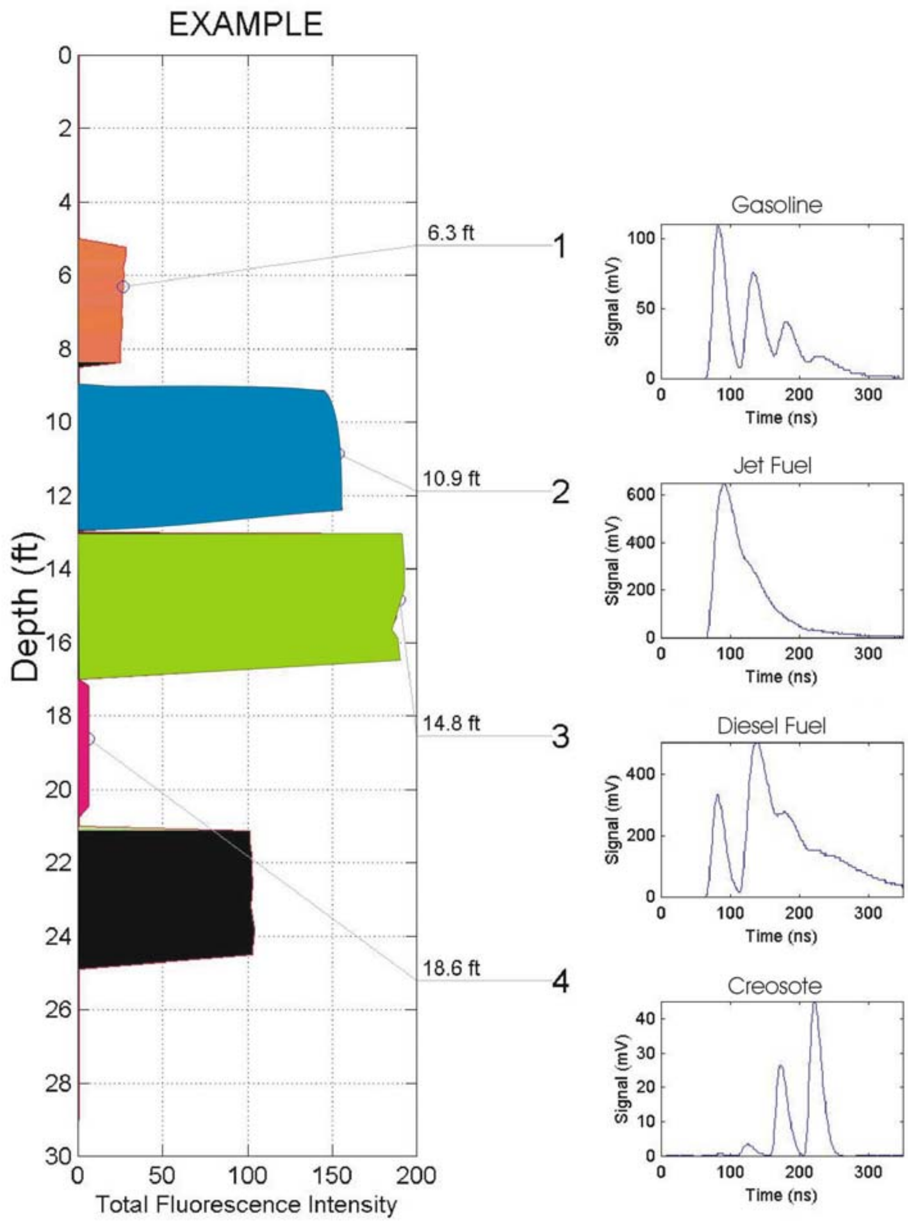
Data output

Typically the client is provided with 1) a line graph of fluorescence intensity vs. depth, 2) a color log of fluorescence intensity vs. depth with color code of fuel type, 3) a JPG file of the color graph and 4) optional, an asci tab delineated data set. Waveform graphs are often included at specific vertical locations to provide a "fingerprint" of the contaminant. The color log is actually derived from the "fingerprint" waveforms, assigning a color code to specific peak ratio ranges. An activity log for the LIF work done on each day is available in the C:/vb/LogFiles directory. Open the file in notepad or similar program and print. The activity log lists start times on pushes, file names, max depth, max signal intensity, depth of max signal, end time of push and laser energy levels.

6.0 DATA INTERPRETATION

Qualitative Information

The LIF system is very good at detecting soil contaminated by a variety of petroleum products. Even small amounts of contaminant produce a signal with a characteristic waveform or "fingerprint".   The example plot below shows three different common fuels and creosote.   Color codes are assigned by calculating the peak intensity ratios, each fuel type has it's own color (colors below may not match current system color assignments).



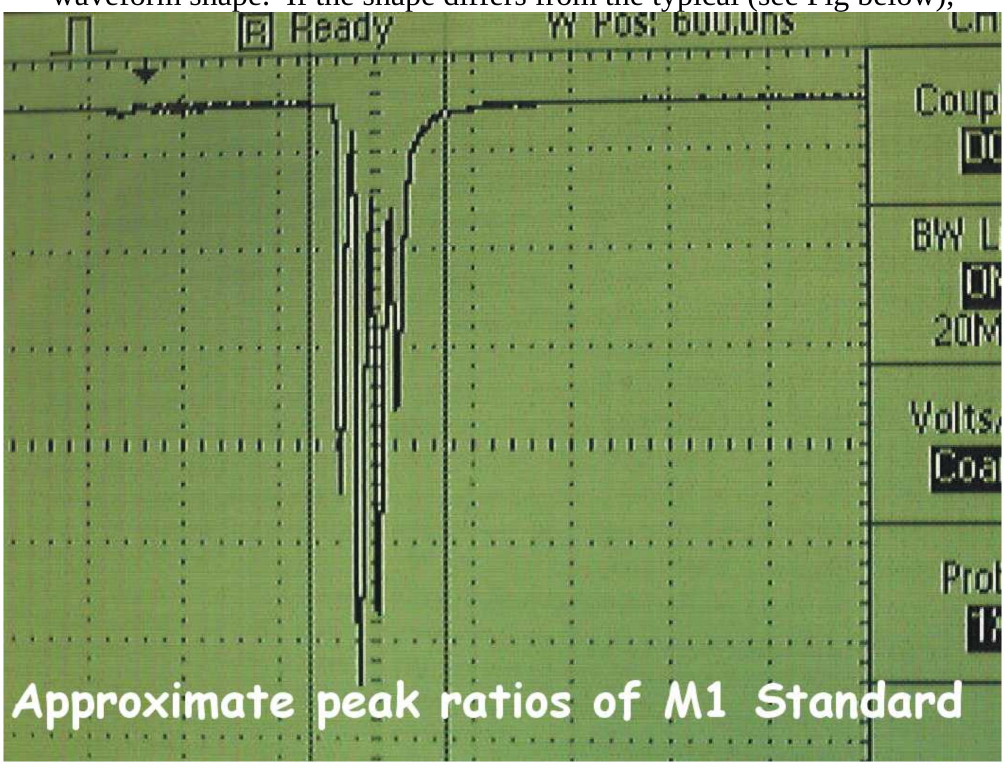
Quantitative Information

Data produced by the LIF system is accurate, reliable and repeatable under ideal conditions. However, the LIF signal intensity of 500 ppm diesel fuel on sand will be much greater than that of a 500 ppm diesel fuel on clay. Particle size has a significant effect on the scattering and absorbance of light just outside the sapphire window. Since soil conditions are often quite heterogeneous it can be difficult to assign a concentration value to the signal intensity. Below is a method that can be done in the field to make this a semi-quantitative tool.

Collecting a comparison sample of soil adjacent to an LIF probe is a good way to correlate signal to concentration. A core should be taken close to the LIF hole but in undisturbed soil. Referring to the LIF log, one should select a particularly outstanding zone and submit a sample from this zone. This should be done for high and low contamination concentration levels to create a 2 point calibration line.   It should be noted that variability of the soil over a few inches can lead to suspect or erroneous data. The best method still is the up-hole analysis by LIF of a sample, then the submission of the **same sample** for quantitative laboratory analysis. It should be noted however that volatile constituents will be lost during handling.

7.0 QA/QC

The M1 reference emitter is used before every LIF push to check system performance and to obtain a value that can be used for log to log comparison. A low overall intensity, resulting in a small integrated area under the curve is an indication of low laser energy or a launch fiber that is out of adjustment. A good range for the integrated area in pVsec is 18,000 to 40,000. See the maintenance section for adjustment of the launch fiber. The M1 exhibits a characteristic waveform shape. If the shape differs from the typical (see Fig below),



then some parameter of the system in not adjusted properly. If the parabolic mirror in the SPOC is out of adjustment, too much laser light is reflected back into the signal fiber and causes a signal addition to the baseline. See the maintenance section for adjustment of the parabolic mirror.

Comparison samples, addressed earlier in the Data Interpretation section, is a good QA/QC practice. Collecting a physical sample very close to the LIF probe should provide validation

Another good QA/QC field practice is to check the window when it is withdrawn from the ground. The window should be free of scratches, cracks or chips. No dust, mud or water should be seen inside the window. Mud/water usually is an indication of a leaking o-ring and the window should be removed, cleaned and replaced with a new o-ring. Condensation on the inside of the window will have a undesirable affect on the signal. Condensation will attenuate the light getting out of the window and cause reflection of laser light behind the window, adding to the intensity of the background signal.

A rod wiper is used to wipe contaminated soil and water off of the probe rods. The method is quite effective and in most cases is all that is needed to prevent cross contamination of holes. The operator may choose to wipe the probe with a paper towel if contamination remains on the point after being removed from the rod wiper. If any minor contamination has remained on the probe from the previous hole, it is rubbed away as soon as the probe enters the soil.

8.0 MAINTENANCE

Optical fiber cable

Periodically check for abrasions/cuts in polyurethane cover, replace or repair as necessary. Also, look for or pinched or unwound squarelock tubing. Replace or repair as necessary. Fiber terminations may need occasional cleaning or repolishing. A field optical fiber kit should be stored in the truck for field repairs or reterminations. A portable microscope is in the field kit and can be used to inspect the fiber surfaces. Polished fibers surfaces should be free of dirt, dust and scratches. If dust is present try wiping the surface with a optical grade tissue and blowing off with canned air. If imperfections remain, it will be necessary to repolish the surface. See the polishing procedure afixed to the field kit.

Launch alignment

Remove the front panel of the laser to gain access to the launch adjustment. As the UV light exits the laser, it is focused, then sent into the polished end of a bare optical fiber. The proximity of the fiber to the focal point depends on the intensity of the light coming from the laser. Example, if the energy is high (2.0mJ/pulse) the fiber will have to be pulled away from the focus so as not to damage the fiber, if the energy is low (0.5mJ/pulse) the fiber will have to be very close to the focus to get the necessary light into the fiber. Note, before starting the laser after a recharge, pull the fiber away from the focal point to prevent fiber damage. The fiber is held in a mount that can be adjusted in the X, Y and Z axis. With a signal emitter on the sapphire window (M1 will work), the X and Y thumb screws can be adjusted while watching the signal intensity on the oscilloscope.

Adjust the thumb screws until the signal is maximized. The Z axis can be grossly adjusted by moving the brass fiber holder in the mount and fine adjusted by turning the large thumb nut on the back side of the mount. Replace the front panel when adjustments are done.

SPOC

Assuming the fiber cable has been previously strung through the necessary probe rods. Remember to put the two foot rod and the drive head (GW1512) on the fiber cable before it is attached to the SPOC. Make sure the SPOC is clean inside and out. Remove the swagenuts with the sockets provided in the tool kit. Slide a swagenut onto the termination of the fiber cable, then slide on a teflon ferrule pair. Make sure there is a good o-ring on the termination. Put a tiny amount of grease on the o-ring to help it slide into the brass center tube of the SPOC easily. Insert the termination as far as it will go and finger tighten the swagenut. On the other end (orientation doesn't matter) insert a parabolic mirror with extension shaft in the same manner as the fiber termination. Be careful so as not to push the mirror into the fiber termination. Temporary install a sapphire window in the window port. Turn on the system to send light through the fiber. The goal now, is to get the largest signal possible with the M1 reference emitter but the smallest background (or reflected light) signal as possible. You will have to adjust the oscilloscope frequently to see the baseline signal levels and the maximum reference signal intensities. Through trial and error, turning and pulling/pushing the mirror and fiber termination, it is possible to get a nearly smooth baseline (at 2mV scale) but a strong M1 signal (at 100mV scale). Hint, the "hot spot" of light needs to be off to the edge of the window, not centered. Once you have determined the "sweet spot" the swagenuts should be moderately tightened and the mirror/fiber readjusted back to optimum. Tighten more and check alignment. Note, to really tighten the swagenuts you need to put a socket on both ends and tighten both at the same time. Turning too hard on just one end of the SPOC will tear the rubber loose from the tube wall.

Window

After alignment of the optics is complete the window can be removed from the SPOC. Now it is necessary to flush the interior of the SPOC of any air containing moisture. It is good to do the assembly on a day with low humidity, however a good dry air flush will be adequate. Using canned air, flush the SPOC interior with ample gas. Insert a 5/16" long piece of silicon tube through the window hole until it is seated on the nipple of the brass inner-tube. Prepare a window by making sure it is clean, install a new o-ring and lubricate it with a tiny amount of grease. Now blow canned air into the window port, holding the window at the hole so the canned air is flushing the port and the backside of the window. Withdrawl the canned air and immediately screw in the window. The window should be as tight as possible without tearing out the tiny prongs of the window tool or the holes in the window.

Waterproofing

Make sure a good o-ring is on the screw-in point. Wrap the threads with teflon tape and tighten securely into SPOC. On the drive head end do the same thing to prevent groundwater from leaking into the SPOC. At the 1.25” rod end of the drive head a low density extruded teflon packing can be used to seal around the fiber cable. It can be wrapped around the cable, then jammed into the annulus with a screwdriver. A rubber stopper or o-ring seal may also be used on some cables.

Tool kits
Tool kits should always be available in the field to perform necessary repairs. Consumable items should be checked and replenished as needed. Typically 3 tool kits accompany the LIF system: The SPOC tool kit, the optical fiber kit and a miscellaneous electronics kit.

Laser recharge
Consult laser manual. Recharge when energy level as indicated on logging software is 0.5mJ/pulse or less. Make sure gas cylinders accompany the

Encoder
Replacing encoder cable. See installation instruction provided with new cables.

Field Documentation

Standard Operating Procedure: Field Documentation

I. Scope and Application

Field documentation consists of field logbooks, field reconnaissance logs, field chain-of-custody forms, and photographs. The objective of field documentation and is to assure that samples are properly collected, appropriately classified, and labeled according to protocol.

II. Field Logbooks and Logs

Field logbooks and other Logs will provide the means of documenting the data collection activities performed. As such, entries will be described in as much detail as possible so that persons going to the site could re-construct a particular situation without reliance on memory.

Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in a secure location when not in use. Each logbook will be identified by the project-specific document number. The title page of each logbook will contain the following:

- person to whom the logbook is assigned;
- logbook number;
- project name;
- project start date; and
- end date.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather conditions, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the site, field sampling or investigation team personnel and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark and initialed. Whenever a sample is collected or a measurement is made, a detailed description of the location will be recorded. The number of the photographs taken, if any, will also be noted. All equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in the appropriate SOP. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume and number of containers. The sample identification number will be assigned prior to sample collection. Field duplicate samples, which will receive an entirely separate sample identification number (so that the location from which the duplicate sample was collected is only determined through use of the field notes), will be noted under sample description.

III. Field Chain-of-Custody Forms

Completed chain-of-custody forms will be required for all samples to be analyzed. Chain-of-custody forms will be initiated by the sampling crew in the field. The chain-of-custody forms will contain the sample's unique identification number, sample date and time, sample description, sample type, preservation (if any), and analyses required. The original chain-of-custody form will accompany the samples to the laboratory. Copies of the chain-of-custody forms will be made prior to shipment (or multiple copy forms used) for field documentation. The chain-of-custody forms will remain with the samples at all times. The samples and signed chain-of-custody forms will remain in the possession of the sampling crew until the samples are delivered to the express carrier (i.e., UPS) or courier, or hand delivered to a mobile or permanent laboratory, or placed in secure storage.

Whenever samples are split with another party or a government agency, a separate Sample Receipt will be prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the other party or agency should request the representative's signature acknowledging sample receipt. If the representative is unavailable or refuses to sign, this should be noted in the "Received By" space.

Chain-of-Custody, Handling, Packing, and Shipping

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Standard Operating Procedure: Chain-of-Custody, Handling, Packing, and Shipping

I. Scope and Application

This Standard Operating Procedure (SOP) describes the chain-of-custody, handling, packing, and shipping procedures for the delivery of samples that are protected from cross-contamination, tampering, misidentification, and breakage, and are maintained in a controlled environment from the time of collection until receipt by the analytical laboratory.

II. Personnel Qualifications

Field sampling personnel will have current health and safety training, including 40-hour training in accordance with the Occupational Safety and Health Administration (OSHA) Regulation 29CFR1910.120 (HAZWOPER), site supervisor training, current LPS training, and site-specific training, as needed. In addition, field sampling personnel will be versed in the relevant SOPs and possess the skills and experience necessary to successfully complete the desired field work.

III. Equipment List

The following materials, as required, will be available during chain-of-custody, handling, packing, and shipping procedures:

- indelible ink pens;
- polyethylene bags (resealable-type);
- clear packing tape, strapping tape, duct tape;
- custody seal evidence tape;
- appropriate sample containers, labels, and chain-of-custody forms;
- large (e.g., 30 to 40 gallon) insulated coolers;
- ice;
- cushioning and absorbent material (e.g., vermiculite);
- thermometer; and
- field notebook.

IV. Health and Safety Considerations

Follow health and safety procedures outlined in the Health and Safety Plan.

V. Chain-of-Custody Procedures

1. Prior to collecting samples, complete the chain-of-custody form header information by filling in the project number, project name, and the name(s) of the sampling technician(s). (Note: it is important that chain-of-custody information is printed legibly using indelible ink).

2. After sample collection, enter the individual sample information by filling in the following chain-of-custody fields:

A. STA. NO. - Indicates the station number or location that the sample was collected. Appropriate values for this field are described in the Work Plan.

B. Date - Indicates the date that the sample was collected. The date format to be followed should be mm/dd/yyyy (e.g., 03/07/2000).

C. Time - Indicates the time at which the sample was collected. The time value should be presented using the military format. For example, 3:15 P.M. should be entered as 15:15.

D. Comp - This field should be marked with an "X" if the sample was collected as a composite.

E. Grab - This field should be marked with an "X" if the sample was collected as an individual grab sample.

F. Station Location - This field should represent the complete sample name; although, in some instances it may be similar to the STA. NO. field. Please note that it is very important that the use of hyphens in sample names and the depth units (i.e., feet or inches) remain consistent for all samples entered on the chain-of-custody form. Sample names may also use the abbreviations "MS/MSD", "FB", "TB", and "DUP" as prefixes or suffixes to indicate that the sample is a matrix spike/matrix spike duplicate, field blank, trip blank, or field duplicate, respectively.

G. Number of Containers - This field represents the number of containers that were collected at the sampling location to be submitted for analysis.

H. Analytical Parameters - The analytical parameters that the samples are being analyzed for should be written legibly on the diagonal lines to the right of the "number of containers" column. As much detail as possible should be presented to allow the analytical laboratory to properly analyze the samples. Multiple methods and/or analytical parameters may be combined for each column. These columns should also be used to present project specific parameter lists. Quality Assurance/Quality Control (QA/QC) information may also be entered in a separate column for each parameter (e.g., MS/MSD) to identify a sample that the laboratory is to use for a specific QA/QC requirement. Each sample that requires a particular parameter analysis will be identified by placing an "X" in the appropriate analytical parameter column.

I. Remarks - The remarks field should be used to communicate special analytical requirements to the laboratory. These requirements may be on a per sample basis such as "extract and hold sample until notified" or may be used to inform the laboratory of special reporting requirements for the entire sample delivery group (SDG). Reporting requirements that should be specified in the remarks column include: 1) turn around time, 2) contact and address where data reports should be sent, 3) name of laboratory project manager, and 4) type of sample preservation that was utilized.

J. Relinquished By - This field should contain the signature of the sampling technician that relinquished custody of the samples to the shipping courier or the analytical laboratory.

K. Date - Indicates the date that the samples were relinquished. The date format should be mm/dd/yyyy (e.g., 03/07/2000).

L. Time - Indicates the time that the samples were relinquished. The time value should be presented using the military format. For example, 3:15 P.M. should be entered as 15:15.

M. Received By - This field should contain the signature of the sample courier or laboratory representative that received the samples from the sampling technician.

3. Complete as many chain-of-custody forms as necessary to properly document the collection and transfer of the samples to the analytical laboratory.

4. Upon completion of the chain-of-custody forms, forward two copies to the analytical laboratory and retain one for the field records.

VI. Sample Handling Procedures

1. After completing the sample collection procedures, record the following information in the field notebook with indelible ink:

   - project number and site name;
   - sample identification code and other sample identification information, if appropriate;
   - sampling method;
   - date;
   - name of sampler(s);
   - time;
   - location (project reference); and
   - any comments.

2. Fill in sample label with the following information in indelible ink:

   - sample type (e.g., surface water);
   - project number and site name;
   - sample identification code and other sample identification information, if applicable;
   - analysis required;
   - date;
   - time sampled;
   - initials of sampling personnel;
   - sample type (composite or discrete); and
   - preservative added, if applicable.

3. Cover the label with clear packing tape to secure the label onto the container.

4. Check the caps on the sample containers to ensure that they are tightly sealed.

5. Wrap the sample container cap with clear packing tape to prevent it from becoming loose.

6. Place a signed custody seal label over the cap such that the cap cannot be removed without breaking the custody seal. Alternatively, if shipping several containers in a cooler, custody seal evidence tape may be placed on the shipping container as described below.

VII. Packing Procedures

1. Using duct tape, secure the outside and inside of the drain plug at the bottom of the cooler that is used for sample transport.
2. Place each container or package in individual polyethylene bags (resealable-type) and seal. If a cooler temperature blank is supplied by the laboratory, it should be packaged following the same procedures as the samples. If the laboratory did not include a temperature blank, do not add one, since the sample temperature will be determined by the laboratory using a calibrated infrared thermometer.

3. Place 1 to 2 inches of cushioning material (e.g., vermiculite) at the bottom of the cooler.

4. Place the sealed sample containers upright in the cooler.

5. Package ice or blue ice in small resealable-type plastic bags and place loosely in the cooler. Do not pack ice so tightly that it may prevent addition of sufficient cushioning material. Samples placed on ice will be cooled to and maintained at a temperature of approximately 4°C.

6. Fill the remaining space in the cooler with cushioning material.

7. Place the completed chain-of-custody forms in a large resealable-type bag and tape the bag to the inside of the cooler lid.

8. Close the lid of the cooler and fasten with packing tape.

9. Wrap strapping tape around both ends of the cooler.

10. Mark the cooler on the outside with the following information: shipping address, return address, “Fragile” labels on the top and on one side, and arrows indicating “This Side Up” (Attachment D-4) on two adjacent sides.

11. Place custody seal label over front right and back left of the cooler lid and cover with clear plastic tape.

(Note: Procedure numbers 2, 3, 5, and 6 may be modified in cases where laboratories provide customized shipping coolers. These coolers are designed so the sample bottles and ice packs fit snugly within preformed styrofoam cushioning and insulating packing material.)

VIII. Shipping Procedures

All samples will be delivered by within 48 hours of sample collection. Alternatively, a laboratory courier may be used for sample pickup. If parameters with short holding times are being analyzed, sampling personnel will take precautions to assure that the maximum holding times for these parameters will not be exceeded.

The following chain-of-custody procedures will apply to sample shipping:

- Relinquish the sample containers to the laboratory via express carrier (FedEx or UPS) or laboratory courier. The signed and dated forms should be included in the cooler. The express carrier will not be required to sign the chain-of-custody forms.

- When the samples are received by the laboratory, the laboratory personnel shall complete the chain-of-custody by recording the data and time of receipt of samples, measure and record the internal temperature of the shipping container, and then check the sample identification numbers on the containers to ensure that they correspond to the chain-of-custody forms.

IX. Data Recording and Management

Copies of chain-of-custody forms will be maintained in the project file.

X. References

Blasland, Bouck & Lee, Inc. 2006. *Health and Safety Plan - Newburgh Project*.

Blasland, Bouck & Lee, Inc. 2006. *Newburgh Project Pre-Design Investigation - Area A.*

Equipment Cleaning

Standard Operating Procedure: Equipment Cleaning

I. Scope and Application

The equipment cleaning procedures described herein include pre-field, in the field, and post-field cleaning of sampling equipment which will be conducted on site, as appropriate. Sampling equipment consists of soil sampling equipment and other activity specific sampling equipment. Non-disposable equipment will be cleaned after completing each sampling event, between sampling events, and prior to leaving the site. Cleaning procedures will be monitored through collection of rinsate blank samples as specified in the Work Plan.

II. Equipment List

The following materials, as required, will be available during field cleaning procedures:

- health and safety equipment (as required in the Health and Safety Plan);
- distilled/deionized water;
- non-phosphate soap;
- appropriate cleaning solvent (i.e., CitruSolv);
- rinsate collection containers;
- brushes;
- plastic sheeting;
- large heavy-duty garbage bags;
- spray bottles;
- resealable-type bags;
- handiwipes; and
- field notebook.

III. Field Cleaning Procedures

As practicable, a designated area will be established to conduct cleaning of sampling equipment in the field prior to and following sample collection. Equipment cleaning areas between sampling locations will be set up within or adjacent to the specific work areas. Equipment to be cleaned in the field may include stainless steel bowls, spatulas, etc.

<u>Cleaning of Sampling Equivalent when Analyzing for Organic Constituents</u>

1. Non-phosphate detergent and water wash to remove all visible particulate matter and any residuals.

2. Water rinse to remove the detergent solution.

3. Solvent rinse.

4. Distilled/deionized water rinse.

5. Repeat solvent and water rinse two more times (i.e., triple rinse) and allow to air dry.

IV. Disposal Methods

Rinse water, personal protective equipment, and other residuals generated during the equipment cleaning procedures will be placed in appropriate containers for subsequent management.

V. References

Blasland, Bouck & Lee, Inc. 2006. *Health and Safety Plan - Newburgh Project.*

Blasland, Bouck & Lee, Inc. 2006. **Newburgh Project Pre-Design Investigation - Area A.**

Handling and Storage of Investigation-Derived Waste

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Standard Operating Procedure: Handling and Storage of Investigation-Derived Waste

I. Scope and Application

The objective of this Standard Operating Procedure (SOP) is to describe the procedures to manage investigation-derived wastes (IDW) generated during drilling, well sampling, and decontamination procedures. IDW may include soil, groundwater, drilling fluids, decontamination liquids, personal protective equipment (PPE), and disposable sampling materials that may have come in contact with potentially impacted materials. All IDW will be collected at the point of generation and taken to a storage area onsite or to a disposal facility. Soil and water will be containerized in DOT-approved drums and analyzed for constituents of concern to evaluate proper disposal methods. PPE and disposable sampling equipment will be placed in DOT-approved drums prior to disposal. This SOP describes the necessary equipment, field procedures, materials, and documentation procedures necessary to do so, as well as the handling of these materials up to the time they are properly disposed. The procedures for handling IDW are based on the United States Environmental Protection Agency's Guide to Management of Investigation Derived Wastes (USEPA, 1992) and IDW is assumed to be hazardous waste unless analytical evidence indicates otherwise.

Pending characterization, IDW will be stored appropriately at a designated location at the Site. Under RCRA, "storage" is defined as "the holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere" (40 CFR 2690.10). The onsite waste staging area will be in a secure and controlled area. Waste characterization involves sending composite samples for each media to a laboratory for analysis.

II. Personnel Qualifications

Field sampling personnel will have current health and safety training, including 40-hour training in accordance with the Occupational Safety and Health Administration (OSHA) Regulation 29CFR1910.120 (HAZWOPER), site supervisor training, current LPS training, and site-specific training, as needed.

III. Equipment List

The following materials, as required, will be available for handling and storage IDW:

- Appropriate PPE (as required by the Health and Safety Plan)
- 55-gallon steel drums, DOT 1A2 or equivalent
- ¾-inch socket wrench
- Hammer
- Leather gloves
- Drum dolly
- Appropriate drum labels (outdoor waterproof self-adhesive)
- Polyethylene storage tank
- Appropriate labeling, packing, chain-of-custody forms, and shipping materials as specified in the Field Sampling Handling, Packing, and Shipping SOP
- Indelible ink and/or permanent marking pens
- Plastic sheeting
- Appropriate sample containers, labels, and forms

- Stainless steel bucket auger
- Stainless steel spatula or knife
- Stainless steel hand spade
- Stainless steel scoop
- Field book

IV. Health and Safety Considerations

Follow health and safety procedures outlined in the Health and Safety Plan.

V. Procedures

Waste storage and handling procedures to be used depend on the type of generated waste. For this reason, IDW can be stored in a secure location onsite in separate 55-gallon storage drums, soil can be stockpiled onsite, and purge water may be stored in polyethylene tanks. Waste materials, such as broken sample bottles or equipment containers and wrappings, will be included in the 55-gallon drums unless they were not in contact with sample media.

Management of IDW

Minimization of IDW should be considered by the Project Manager during all phases of the project. Site Managers may want to consider techniques such as replacing solvent-based cleaners with aqueous-based cleaners for decontamination of equipment, reuse of equipment (where it can be decontaminated), limitation of traffic between exclusion and support zones, and drilling methods and sampling techniques that generate little waste. Alternative drilling and subsurface sampling methods may include the use of small diameter boreholes, as well as borehole testing methods such as a direct-push technique, instead of coring (EPA 1993).

Drum Labeling

IDW drums will be labeled on both the side and lid of the drum using a permanent marking pen. Old drum labels must be removed to the extent possible, descriptions crossed out should any information remain, and new labels affixed on top of the old labels. IDW drums will be labeled as follows:

- Appropriate waste characterization label;
- Waste generator’s name (e.g., BBL);
- Project name (e.g., Newburgh Project Pre-Design Investigation - Area A);
- Name and telephone number of BBL Project Manager;
- Composition of contents (e.g., used oil, acetone 40%, toluene 60%);
- Media (e.g., solid, liquid);
- Accumulation start date; and
- Drum number of total drums.

Drill Soil Cuttings and Muds

Drill soil cuttings are solid to semi-solid soils generated during trenching activities, subsurface soil sampling, or installation of monitoring wells. Depending on the drilling method, drilling fluids known as “muds” may be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Soil cuttings will be labeled and stored in 55-gallon drums with bolt-sealed lids. All 55-gallon steel drums will have a containment system that can contain at least 10% of the volume of the largest container, be closed during storage, and be in good condition in accordance with the *Guide to Management of Investigation-Derived Wastes* (USEPA, 1992).

Decontamination Solutions

Decontamination solutions are generated during decontamination of PPE and sampling equipment. Decontamination solutions may range from detergents, organic solvents, and acids used to decontaminate small field sampling equipment to steam cleaning rinsate used to wash heavy field equipment. These solutions are to be labeled and stored in 55-gallon drums with bolt-sealed lids.

Decontamination Equipment

Disposable equipment includes PPE and disposable sampling equipment such as trowels or disposable bailers. If the media sampled exhibits hazardous characteristics per results of waste characterization sampling, disposable equipment will also be disposed of as a hazardous waste. These materials will be stored onsite in labeled 55-gallon drums pending analytical results for waste characterization.

Purge Water

Purge water includes groundwater generated during well development, groundwater sampling, or aquifer testing. The volume of groundwater generated will dictate the appropriate storage procedure. Monitoring well development and groundwater sampling may generate three well volumes of groundwater or more. This volume will be stored in labeled 55-gallon drums. Aquifer tests may generate significantly greater volumes of groundwater depending on the well yield and the duration of the test. Therefore, large-volume portable polyethylene tanks will be considered for temporary storage pending groundwater-waste characterization.

VI. Waste Characterization Sampling

The need for characterization sampling will be determined based upon the selected disposal facility. Chain-of-custody and sample labels for wastes characterization samples will be filled out in accordance with Field Sampling Handling, Packing, and Shipping SOP.

VII. Data Recording and Management

Waste characterization sample handling, packing, and shipping procedures will be documented. Copies of chain-of-custody forms will be maintained in the project file.

VIII. References

Blasland, Bouck & Lee, Inc. 2006. *Health and Safety Plan - Newburgh Project.*

Blasland, Bouck & Lee, Inc. 2006. *Newburgh Project Pre-Design Investigation - Area A.*

Appendix B

RETEC – Sediment Sample Collection and Analysis Work Plan for Evaluating Bioavailability

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