SOURCE CONTROL DATA GAPS WORK PLAN

NW NATURAL GASCO SITE
7900 NW ST. HELENS ROAD
PORTLAND, OREGON

Prepared for
NW Natural
Portland, Oregon

Prepared by
Anchor Environmental, L.L.C.
1423 Third Avenue, Suite 300
Seattle, Washington 98101

and

Hahn and Associates, Inc.
434 NW Sixth Avenue, Suite 203
Portland, Oregon 97209

July 2007

Table of Contents

1 INTRODUCTION 1

2 STORMWATER SAMPLING SCOPE 3
2.1 Background and Context 3
2.2 Sampling Approach 3
2.3 Sample Locations, Types, and Numbers 4
2.3.1 Catch Basin Samples 4
2.3.2 Stormwater Grab Samples 5
2.4 Sample Analysis 6
2.4.1 Catch Basin Sediments 6
2.4.2 Stormwater Samples 7

3 SOURCE CONTROL SEGMENT 2 MONITORING WELL INSTALLATION SCOPE 8
3.1 Background and Context 8
3.2 Approach and Objectives 8
3.3 Locations and Methods 9

4 DNAPL-TARGETED LASER-INDUCED FLUORESCENCE SCOPE 10
4.1 Background and Context 10
4.2 Approach and Objectives 10
4.3 Locations and Methods 10

5 GEOPHYSICAL PILOT INVESTIGATION SCOPE 13
5.1 Background and Context 13
5.2 Approach 13
5.3 Location and Methods 14

6 REFERENCES 16

List of Tables

Table 1 Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits – Catch Basin Sediment
Table 2 Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits – Stormwater
Table 3 Station Locations and Sample Matrix Summary for Catch Basin Sediment and Stormwater Samples

List of Figures

Figure 1 Outfall and Drainage Basins within NW Natural "Gasco" Site
Figure 2 Stormwater Conveyance Schematic and Proposed Catch Basin Locations
Figure 3 Stormwater Conveyance Schematic and Proposed Stormwater Sampling Locations
Figure 4 Proposed Monitoring Wells – Source Control Segment 2
Figure 5 Cross Section B-B', Proposed Monitoring Wells – Source Control Segment 2
Figure 6 Proposed LIF-TarGOST Boring Locations with Estimated Tar and DNAPL within the Fill
Figure 7 Proposed LIF-TarGOST Boring Locations with Estimated DNAPL within the Alluvial – Above 100 feet bgs
Figure 8 Proposed LIF-TarGOST Boring Locations with Estimated DNAPL within the Alluvial – Below 100 feet bgs
Figure 9 Proposed Geophysical Pilot Investigation Area

Appendix

A Catch Basin Sediment and Stormwater Sample Collection, Processing, and Analysis Procedures, NW Natural "Gasco" Site

1 INTRODUCTION

This Work Plan presents the approach and procedures to implement upland source control-related investigation activities in conjunction with the ongoing NW Natural "Gasco" Remedial Investigation and Feasibility Study (RI/FS) under a Voluntary Agreement with Oregon Department of Environmental Quality (DEQ). The RI has been completed and the RI Report (HAI 2007) has been submitted to DEQ for review. The investigation activities proposed here are focused on filling final data gaps specifically related to evaluating the site as a potential source of pollutants to the Willamette River. This Work Plan describes the general scope and approach to the field sampling.

This Work Plan describes activities proposed to resolve source-control related data gaps at the Gasco property as determined by DEQ. The Siltronic RI Work Plan (prepared by Hahn and Associates, Inc. [HAI]) is being submitted under separate cover to address RI data needs for that property. Sampling activities for the Siltronic RI and Gasco Source Control Data Gaps Work Plans will be conducted on the same schedule, and DEQ has requested that one document be submitted with detailed procedures in cases where the same sampling methodologies are proposed for use on both properties. As such, this Gasco Source Control Data Gaps Work Plan provides an overview of the sampling scope unique to the Gasco portion of the work, while much of the detailed sampling procedures are referenced within the Siltronic RI Work Plan.

This document was prepared consistent with DEQ's May 2, 2007, comment letter on the *Siltronic RI Proposal* (HAI 2006) and the *Gasco Source Control Data Gaps Evaluation* (Anchor 2006), which requested the following investigation activities be conducted relative to the Gasco property:

- Stormwater and catch basin sampling consistent with the Joint Source Control Strategy (JSCS) for Portland Harbor (DEQ and EPA 2005);
- Additional monitoring well installations within the portion of the Gasco site designated as Shoreline Source Control "Segment 2";
- Additional Evaluation of DNAPL presence and distribution within Shoreline Source Control "Segment 1" using Laser Induced Fluorescence (LIF);
- Geophysical evaluation of the nature of the contact between fill material and the underlying alluvial material (the silt unit surface).

The following types of data collection are proposed to fill final source control data gaps as laid out in the *Gasco Source Control Data Gaps Evaluation* document and as identified by DEQ in their May 2, 2007 letter:

- Catch basin sediment chemistry
- Stormwater chemistry, total suspended solids (TSS), and associated conventionals
- Groundwater chemistry and soil description within the alluvial water-bearing zone from new Segment 2 borings/wells

- Down-hole laser-induced fluorescence response and physical cone penetrometer response data within Segment 1
- Ground penetrating radar and earth resistivity geophysical profile data.

The field study sampling procedures, methods, and analyses for catch basin and stormwater are described herein as Appendix A. The remainder of the field study investigation procedures are described in the Siltronic RI Work Plan document since all of these sampling procedures are similarly proposed for completion on the Siltronic property as part of RI activities on that property.

The purpose of this Work Plan is to provide guidance along with the Siltronic RI Work Plan for all aspects of the fieldwork and laboratory analysis to address data gaps identified by DEQ and consistent with the *Gasco Source Control Data Gaps Evaluation* (Anchor 2006).

It is NW Natural's understanding that with the stormwater sampling; the additional well installation and groundwater monitoring in Segment 2; the laser-induced fluorescence/cone penetrometer work in Segment 1, and the implementation of geophysical techniques, as deemed appropriate, then source control data gaps will be filled for the site and source control evaluations and designs can proceed and be completed for the project.

2 STORMWATER SAMPLING SCOPE

2.1 Background and Context

A general description of the site and site features is provided in the recently submitted Final Gasco RI (HAI 2007). Figure 1 shows the general site layout and stormwater drainage areas. Surface water sampling was conducted in 1996 and some discharge permit sampling data also exists. No catch basin sediment data are available from the Gasco site. The surface water information available includes mainly historic data from now-abandoned surface water conveyances, or surface water bodies that do not discharge to the Willamette River. The National Pollutant Discharge Elimination System (NPDES) permit requires sampling for representative parameters but does not require analysis for the full JSCS list of parameters. The NPDES permit sample detection limits are in many instances higher than JSCS screening levels. (Note that for a number of chemicals, laboratories cannot routinely provide detection limits lower than the JSCS criteria).

Section 5.3 of the JSCS states stormwater sediment (e.g., catch basin, conveyance line) and stormwater discharge (i.e., whole water) sampling may be required at upland sites to characterize and evaluate the stormwater pathway and to determine if source control measures are required to prevent contaminants from impacting the river and its sediments (DEQ and EPA 2005).

In addition, the Lower Willamette Group (LWG) is collecting stormwater and sediment trap samples from the WR-107 outfall (Figure 1; draining areas of the LNG and FAMM facilities) as part of the Portland Harbor RI/FS to understand the general nature and extent of stormwater sources to the river. DEQ has indicated that this sampling is inadequate for JSCS screening purposes because it does not include stormwater discharges from Koppers area to Doane's Creek (Figure 1) and does not follow the JSCS catch basin screening procedure for selecting analytes to examine in stormwater samples.

Given these data sets and DEQ's requirements, it appears that additional stormwater and catch basin data is a data gap for the site.

2.2 Sampling Approach

The purpose of this sampling and analysis effort is to provide data for evaluating the Gasco site as a potential source of unacceptable levels of stormwater chemicals to the river. In summary, the sampling approach involves:

- Collection of representative catch basin sediments.
- If necessary, the collection of stormwater grab samples from four storm events, as specified in the JSCS.

Key objectives and sampling and analysis activities proposed to address the stormwater data gaps identified and agreed to by DEQ in their May 2, 2007, comment letter are:

- Collection of catch basin sediments, analysis of JSCS chemicals, and the assessment of the potential impacts to surface sediment quality from the potential transport of solids from the site to the Willamette River. Catch basin sediment screening will precede the stormwater screening so that analytical results can be used to refine the site-specific stormwater analytical suite.
- If catch basin sediments exceed JSCS chemical screening levels, the collection of stormwater from the two active outfalls will be performed to confirm that current site activities are not impacting stormwater. Samples will be analyzed for JSCS chemicals and storm characteristics will be recorded to assist with the evaluation.

2.3 Sample Locations, Types, and Numbers

Sample types and their locations are presented in Figures 2 and 3. All catch basin sediments will be analyzed for the full suite of JSCS parameters, including total solids, total organic carbon, and grain size. Tables 1 and 2 present the proposed analytes, the analytical methods to be used, and the targeted detection limits for the evaluation of catch basin sediments, stormwater outfall discharge, and field Quality Assurance/Quality Control (QA/QC) samples. Table 3 summarizes the sample locations, analytes for each sample type, and the approximate sample volumes that will be needed for these analyses. Note that for stormwater, the analyte list cannot be determined until the catch basin sediment screening is completed. A list of potential analytes is shown in Table 3 for now.

2.3.1 Catch Basin Samples

Sediment samples will be collected by hand from sumps shown on Figure 2 that have been identified as representative of catch basins that potentially contain chemicals of interest (COIs). Sampling methods will be consistent with Catch Basin Solid Sampling Standard Operating Procedure in Appendix A (Attachment C of Appendix D of the Framework for Portland Harbor Storm Water Screening Evaluations) (DEQ and EPA 2005).

Four sediment samples (SS-1 through SS-4) (Figure 2) were located to represent each of the four primary drainage areas within the Gasco site. All stormwater discharged from the site first flows through either an oil/water separator or carbon treatment facility prior to discharge, with the exception of stormwater from the NW Natural LNG Plant office area, which is pumped directly to the river through Outfall WR-107 without treatment via the sump indicated by SS-3 (Figure 2).

Note that in the case of SS-2, water moving from this catch basin is either treated (historically) prior to discharge or is (currently) discharged to sanitary sewer.

Consequently, catch basin sediments sampled at SS-2 may not be representative of any chemicals currently discharged to the Willamette River. However, there are no other catch basins within this basin from which to sample and therefore, SS-2 was selected. It should also be noted that LWG is collecting sediment trap data from the mouth of outfall WR-107, and this is likely a much more representative sample of actual sediments discharged to the river and should be used in lieu of SS-2 when those data become available.

2.3.2 Stormwater Grab Samples

Drainage areas on the site are outlined on an aerial photo presentation of the site (Figure 1). Much of the site (Area C on Figure 1) consists of unpaved soils where stormwater infiltrates and/or small ponds are created in the rainy season that dissipate over the summer.

NW Natural has one combined stormwater/process water outfall (WR-107) that discharges to the river embankment (Figure 1). Water from Areas D and E discharge to this outfall. As noted above, stormwater and any groundwater that seeps into the LNG containment basin (Area B) is removed and treated in an on-site carbon adsorption system (a permitted wastewater treatment system) prior to discharge into the City of Portland sanitary sewer system (Figure 3). Stormwater from remaining areas of the LNG facility (Area E) is collected through a series of catch basins and is discharged directly to the river through WR-107 (Figure 3).

In Area D, (FAMM), stormwater also drains to WR-107 (Figure 1). Of the 10 acres in this area, approximately 3.4 acres from within two tank berms and stormwater collected in a sump on the fuel loading dock is collected and treated by an oil/water separator prior to being discharged via WR-107 under the FAMM NPDES permit. Stormwater from the remaining 6.6 acres of Area D mostly infiltrates into the soil.

Stormwater from Area A (KI lease area) drains to Doane Creek and discharges to the river via City Outfall 22C, which is upriver of the Gasco site. Stormwater from the 6.4-acre Area A is collected within a series of catch basins or sumps (Figure 3). With the exception of several catch basins in the gate entry area, this stormwater is treated by an oil/water separator and then stored in six stormwater storage tanks that have a total capacity of 220,000 gallons. This water is tested and batch discharged at the KI outfall located immediately south of the property through a culvert leading to Doane Creek under the KI NPDES permit.

If catch basin sediment screening indicates any chemicals above JSCS Screening Level Values (shown in Table 2), then stormwater sampling will be conducted for analyses of the chemicals exceeding the sediment screening. Under these circumstances, discrete

stormwater "grab" samples will be collected during four storm events. Samples will be collected from either one or both of the two outfall locations depending on the results of the screening of catch basins that drain to these outfalls.

Stormwater grab sampling procedures will follow those procedures described in Attachment D to Appendix D of the Framework for Portland Harbor Storm Water Screening Evaluations (contained in Appendix A).

Appendix D of the JSCS recommends that at least four separate storm events be sampled for screening purposes. Two of the four sampling events will be representative of "first flush" conditions (within the first 30 minutes of stormwater discharge). The remaining two events will be collected within the first three hours of stormwater discharge, to the extent practicable.

Storm event criteria for the screening evaluation are as follows:

- Antecedent dry period of a least 24 hours (as defined by less than 0.1-inch of precipitation over the previous 24 hours)
- Minimum predicted rainfall volume of greater than 0.2-inch per storm event
- Expected duration of storm event of at least 3 hours

The above target storm conditions should be considered goals. Each event sampled will be evaluated relative to these goals, but circumstances may arise where all of these goals cannot be met. In that event, DEQ will be contacted to discuss sampling or storm conditions that substantially do not meet the target storm conditions prior to analyzing the samples. The justification for accepting samples that deviate from these target storm conditions will be provided in the data report.

2.4 Sample Analysis

Catch basin sediments and stormwater will be analyzed as described below. Tables 1 and 2 summarize the analytes and methods of analysis for each analyte group for each sample type (catch basin sediment and stormwater).

2.4.1 Catch Basin Sediments

Catch basin sediments will be analyzed at Columbia Analytical Services (CAS) in Kelso, Washington, for conventionals, metal, and organic parameters as summarized in Table 1. If sufficient mass (as shown in Appendix A) is not available to complete all analyses, the analyses will be conducted by the laboratory in the priority order identified in this table. Any additional mass available will be used for laboratory quality control analyses (i.e., matrix spike samples, laboratory duplicate samples, matrix spike duplicate samples).

2.4.2 Stormwater Samples

The stormwater samples will be analyzed for pH, conductivity, and temperature in the field. Stormwater samples will be analyzed at CAS for conventionals and those chemicals that exceeded the catch basin sediment screening and may potentially include metals and organic parameters as summarized in Table 2. It is anticipated that sufficient sample volume will be collected during each stormwater event to conduct all analyses listed in Table 2.

3 SOURCE CONTROL SEGMENT 2 MONITORING WELL INSTALLATION SCOPE

3.1 Background and Context

A source control data gap along the Gasco shoreline "Segment 2" (running from approximately the shoreline docks to the downstream boundary of the Site) was identified by DEQ in their May 2, 2007 correspondence. Specifically, DEQ requested that additional monitoring wells be installed in the surficial fill WBZ and at multiple depth intervals within the alluvial WBZ to evaluate groundwater contamination and support source control measures evaluations relative to Shoreline Source Control Segment 2.

In order to maintain the project schedule for the Groundwater Focused Feasibility Study (GWFFS), the Segment 2 monitoring well installation work has been proposed and described in earlier memos ("Proposal for Segment 2 Shoreline Monitoring Wells, Gasco Site, Portland, Oregon," dated June 8, 2007, and "DEQ Requested Changes to the Segment 2 Shoreline Monitoring Well Plan, Gasco Site, Portland, Oregon," dated June 22, 2007). This work has been approved by DEQ in a June 25, 2007 letter, "Gasco Site, Revised Segment 2 Shoreline Monitoring Wells Proposal", with installation activities occurring in late June and early July 2007. Consequently, the following subsections summarize work that is already underway.

3.2 Approach and Objectives

The purpose of the well installation and sampling effort is to provide additional data for the full evaluation of groundwater within Segment 2 as a potential source of unacceptable levels of chemicals to the river.

The specific sampling approach and objectives well installation and sampling effort are as follows:

- Installation of monitoring wells within Segment 2 to enable a level of detailed evaluation of potential groundwater sources to the river that are representative of conditions in Segment 2.
- Provide a well spacing and screen elevation that is similar to, and complimentary of, that currently afforded by wells in Segment 1.
- Incorporation of all new wells into the existing quarterly groundwater monitoring program and well network for the site with sample collection and testing for contaminants of interest (COIs) in accordance with the approved monitoring program. The first round of such samples will be collected in a timely manner such that data may be incorporated into the GWFFS.

3.3 Locations and Methods

Monitoring wells are being installed at the Gasco site as shown on Figures 4 and 5. Figure 4 is a map of the Site showing locations of the proposed wells. Figure 5 is a subsurface profile showing the approximate screen depths of the proposed wells. New monitoring wells are being installed:

- Near the existing MW-1 well location, with screened zones within the alluvial WBZ from approximately 60 to 70 feet bgs (MW-1-70) and 100 to 110 feet bgs (MW-1-110);
- Near the existing MW-2 well cluster location, with screened zones within the alluvial WBZ from approximately 80 to 90 feet bgs (MW-2-90) and 115 to 125 feet bgs (MW-2-125);
- At a new location within the FAMM containment basin approximately midway between the current MW-2 and MW-3 well cluster locations with four new wells proposed. Proposed wells are to be screened within the fill WBZ from 5 to 15 feet bgs (MW-21-15); and within the alluvial WBZ from 65 to 75 feet bgs (MW-21-75); from 105 to 115 feet bgs (MW-21-115); and from 155 to 165 feet bgs (MW-21-165).

Actual screen intervals will be based on depth to bedrock at each location as well as identified subsurface conditions. Well installation (via Rotosonic drilling), design, development, and sampling methods are as described in DEQ correspondence dated June 19, 2007 "*Gasco Site, Segment 2 Shoreline Monitoring Wells*". The same methods are also reiterated within the Sampling and Analysis Plan as included with the Siltronic RI Work Plan. Samples will be analyzed for all analytes as identified within the June 1, 2007 letter "*Groundwater Monitoring Program*" as approved by DEQ in correspondence dated June 14, 2007 "*June 2007 Groundwater Monitoring Event*".

4 DNAPL-TARGETED LASER-INDUCED FLUORESCENCE SCOPE

4.1 Background and Context

A DNAPL-related source control data gap along the Gasco and Siltronic Shoreline "Segment 1" (running from approximately the shoreline docks at Gasco upstream across the approximate northern 400 feet of the Siltronic shoreline) was identified by DEQ in their May 2, 2007 correspondence. Specifically, DEQ has required that NW Natural utilize subsurface logging tools as an alternative to direct visual identification and screening of retrieved soil core to identify the presence and distribution of DNAPL along Shoreline Segment 1. Specifically, DEQ has required that cone penetrometer (CPT) and laser-induced fluorescence (LIF) logging systems (i.e., "tar-specific green optical screening tool" [TarGOST]) be used at Segment 1 to support source control measures evaluations relative to Segment 1. A description of the CPT and TarGOST logging system, including fundamental principals and known and possible limitations of the technology are described within the Siltronic RI Work Plan and are therefore not repeated herein.

4.2 Approach and Objectives

The approach and objectives of the TarGOST sampling effort are:

- Conduct bench scale testing of the TarGOST system using available DNAPL and soil samples of various level of impact to ascertain TarGOST response and evaluate applicability to site contaminant conditions.
- As appropriate, advance the CPT/TarGOST system into the subsurface at selected shoreline area locations to evaluate
    1) subsurface material types and the presence of DNAPL to evaluate potential geologic influences on DNAPL distribution and potential movement within the Alluvial WBZ and
    2) confirmation of the vertical extent of DNAPL in the alluvial WBZ.

4.3 Locations and Methods

It is proposed that the TarGOST technology be evaluated as a pilot investigation to determine its applicability to use within the alluvial WBZ. If the technology works as the developer intends, this technology may be useful for discerning lenses or ganglia of DNAPL present at depth within the alluvial unit. Elements of the proposed TarGOST pilot investigation including the completion of bench scale testing of the TarGOST system and installation of Primary and Secondary borings, as appropriate, are provided in the Siltronic RI Work Plan.

With regard to the pre-field bench-scale testing, samples of DNAPL from various locations on the adjacent Gasco property as well as numerous blind soil samples containing various levels of impact (DNAPL, solid tar, solid pitch, odor, no odor) will be provided to the

technology developer for bench scale testing of TarGOST response. The technology developer will provide NW Natural with the output for each sample so that an evaluation of the TarGOST capability to distinguish between DNAPL and non-DNAPL related PAH impacts. Results of the bench scale testing will be evaluated and provided to DEQ in a brief letter with recommendations concerning moving forward with the on-site testing phase of the pilot investigation.

Assuming the TarGOST pilot investigation moves into the field, then additional pilot work is proposed to evaluate response relative to locations where additional data concerning presence and depth of DNAPL may be useful and that have also been previously cored and directly screened for the presence of DNAPL. This will allow a comparison of TarGOST results to previous DNAPL conventional observations. For the initial pilot testing work, the TarGOST unit will be advanced on the Gasco property using CPT methods at "Primary Locations" identified on Figures 6 through 8 (borings TG-1 through TG-5). These locations correlate to areas where a good lithological and visual field screening description already exist, and are also areas of interest with regard to potential additional information on the distribution and depth of DNAPL adjacent to the Gasco shoreline.

To date, the maximum depth for the deployment of the TarGOST unit by the developer (Dakota Technologies, Inc.) is 60 feet bgs. For the Gasco source control data gap work, an attempt to advance the CPT with the TarGOST attachment to a depth of 150 feet bgs or to refusal, whichever occurs first, will be made. As DNAPL is not suspected of being present at depths greater than approximately 100 to 125 feet bgs at the Gasco or Siltronic properties, a maximum depth of 150 feet is deemed sufficient. Further, the depth of 150 feet also corresponds to the approximate depth limitation of the unit based on fiber optic cable length limitations.

TarGOST will be evaluated in real-time during the push with the TarGOST response being compared to known conditions as identified at nearby borings. Responses across known zones of tar and pitch within the fill will be noted, as will responses across known or inferred zones containing DNAPL. A comparison of TarGOST response with inferences regarding subsurface lithological conditions as interpreted from the CPT friction sleeve data will similarly be evaluated to determine if there is a correlation between possible DNAPL conditions and possible layering of silt lenses.

DEQ will be consulted during and at the completion of the installation of the Primary TarGOST locations and NW Natural will provide an assessment (on-site meeting / technical briefing) of the effectiveness and suitability of the TarGOST application to site conditions. If NW Natural deems the technology to be effective, and DEQ concurs, then the TarGOST will be deployed for the full scope of work at those pre-determined locations depicted on Figures 6 through 8 as being "Secondary". Secondary locations would be

similarly installed primary locations TG-1 through TG-5. Secondary locations were selected to further enhance the understanding of the distribution and potential migration pathways of DNAPL at the site by evaluating conditions upland of the primary locations within the former effluent pond area. Additionally, one secondary location has been placed near the FAMM containment basin to verify the absence of DNAPL within the alluvial WBZ in the area of a former well seal breach (MW-13-61) – since remedied by abandonment and replacement.

The flexibility and real-time nature of the method may permit deviation from planned locations or depths, in which case DEQ will be consulted prior to modifying the proposed plan.

CPT boring installation and abandonment procedures and TarGOST sampling methods are described within the Sampling and Analysis Plan included with the Siltronic RI Work Plan.

5 GEOPHYSICAL PILOT INVESTIGATION SCOPE

5.1 Background and Context

DEQ has required that NW Natural employ geophysical methods (e.g., ground-penetrating radar) in conjunction with CPT and LIF logging systems (TarGOST), as described above, at the Gasco Site. Specifically, as provided in their May 2, 2007 correspondence, DEQ envisions geophysical methods being useful for further assessing the thickness of the surficial fill and the configuration of the top of the silt which has been shown previously to affect or control DNAPL migration.

Due to the thickness and variable nature of the fill unit at the Gasco site, it is unclear that geophysical methods will be adequate to discern the nature of the silt surface with sufficient detail to be useful or to enhance the understanding of this surface as determined from physical soil boring data across the property. As such, a pilot investigation has been proposed to test the suitability of the most promising geophysical methods to site conditions. Pilot testing activities have been selected for both the Siltronic property (see the Siltronic RI Work Plan) and at an area located at the Gasco property, described herein.

5.2 Approach

The approach and objectives of the geophysical pilot investigation activities are:

- Conduct a geophysical investigation including ground penetrating radar (GPR) and earth resistivity methods at a limited portion of the Gasco property to ascertain geophysical response and to evaluate applicability of these methods to site conditions.
- Using GPR and earth resistivity geophysical methods within the selected test area, determine the approximate depth and configuration of the interface between the fill unit and the alluvial unit and compare to silt elevation data from historical conventional soil borings and DNAPL distribution observations in the same area.

Results of the pilot investigation will be evaluated to ascertain whether unique geophysical interpretive data are provided that would enhance the current understanding of the morphology of the native silt unit – which is presently well understood and delineated based on a significant number physical soil boring observations.

The geophysical pilot investigation will be deemed successful if it demonstrates that it can effectively and accurately identify surface elevations or subtle morphological features of the silt unit over a large area and in a way that is more cost effective than direct observational data afforded by conventional soil boring methods.

If the pilot is evaluated as successful and the geophysical methods appear cost effective, the potential for expanding surface geophysics to other portions of the site will be proposed to DEQ in a brief scoping document based on the results of the pilot work.

5.3 Location and Methods

Two surface geophysical methodologies will be pilot tested at the north central portion of the Gasco property (Figure 9). The pilot investigation is designed to evaluate the ability of geophysical techniques to map the top of the silt unit beneath 20-25 feet of fill material on the site, and – as practical – extend the geophysical survey into the LNG containment basin (Figure 9), where the fill is expected to be only 5 to 10 feet thick.

The north central portion of the Gasco property was selected for the testing of geophysical technologies since it corresponds to an area of potentially mobile DNAPL within the fill (MW-6 and MW-13 area) and corresponds to the location of the estimated location of the former channel feature within the silt – as observed from soil boring data.

Two parts are proposed for the pilot investigation program, as follows:

- Ground penetrating radar (GPR), using low frequency antenna, to achieve the desired depth of investigation,

- Earth resistivity profiling using a multi electrode dipole-dipole survey.

<u>Ground Penetrating Radar</u>
Ground penetrating radar (GPR) is often used to image subsurface geologic features and horizons. However, radar depth of exploration is generally limited to 5 to 8 feet in the conductive (clayey) soils of the Willamette Valley. Lower frequency antennas can increase the depth of exploration. Also the fill material on the site, dredge spoils and other placed materials, is expected to be widely variable. Hence, the desired depth of exploration may be obtained over some areas, while the method may be unable to do so over other areas. Methods to be used for the GPR pilot investigation are identical to those proposed for the pilot area at the Siltronic property and are described within the Siltronic RI Work Plan.

<u>Earth Resistivity</u>
Multi-electrode earth electrical resistivity systems provide a two dimensional image of the electrical conductivity structure of the ground, the geoelectric section. The fill material at the site is expected to have a great deal of variation in its electrical resistivity, with the silt generally being more conductive. Areas where resistivity surveys can be run are limited by the numerous utilities, buildings, and fences at the property. These features interfere with the ground electrical currents and preclude collecting reliable data. Methods to be used for

the earth resistivity pilot investigation are identical to those proposed for the pilot area at the Siltronic property and are described within the Siltronic RI Work Plan.

6 REFERENCES

Anchor. 2006. Gasco Source Control Data Gaps Evaluation, NW Natural "Gasco" Site. Prepared for NW Natural. Anchor Environmental, L.L.C., Seattle, WA. November 2006.

DEQ and EPA. 2005. Portland Harbor Joint Source Control Strategy – Final. Prepared by State of Oregon Department of Environmental Quality and U.S. Environmental Protection Agency. December 2005.

HAI. 1998. Phase I Remedial Investigation Summary Report. Prepared for NW Natural Gasco Facility. Hahn and Associates, Inc., Portland, OR. October 9, 1998.

HAI. 2005. Updated Phase I Site Characterization Summary Report, Siltronic Corporation Property, Siltronic Corporation Property, Portland, Oregon. July 22, 2005.

HAI. 2006. Remedial Investigation Proposal, Historical Manufactured Gas Plant Activities, Siltronic Corporation Property, Siltronic Corporation Property, Portland, Oregon. November 17, 2006.

HAI. 2007. Remedial Investigation Report, NW Natural Gasco Facility, Prepared for NW Natural Gasco Facility. Hahn and Associates, Inc., Portland, OR. April 30, 2007.

TABLES

Table 1
Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits—Catch Basin Sediment

Parameter	Unit	MacDonald PECs and other SQVs[c]	DEQ 2001 Bioaccumulative Sediment SLVs[c]	Analytical Method	Practical Quantitation Limit
Conventional Parameters					
Gravel	%	---	---	PSEP	0.1
Sand	%	---	---	PSEP	0.1
Silt	%	---	---	PSEP	0.1
Clay	%	---	---	PSEP	0.1
Fines	%	---	---	PSEP	0.1
Total solids	%	---	---	PSEP	0.1
Total organic carbon	%	---	---	PSEP	0.1
Metals					
Antimony	µg/kg dry	64,000	10,000	6020	50 µg/kg
Arsenic	µg/kg dry	33,000	---	6020	500 µg/kg
Cadmium	µg/kg dry	4,980	3	6020	50 µg/kg
Chromium	µg/kg dry	---	---	6020	200 µg/kg
Copper	µg/kg dry	149,000	10,000	6020	100 µg/kg
Cyanide	µg/kg dry	---	---	9014	500 µg/kg
Lead	µg/kg dry	128,000	128,000	6020	50 µg/kg
Mercury	µg/kg dry	1,060	---	1631	1 µg/kg
Nickel	µg/kg dry	48,600	316,000	6020	200 µg/kg
Silver	µg/kg dry	5,000	---	6020	20 µg/kg
Zinc	µg/kg dry	459,000	3,000	6020	500 µg/kg
Aromatic Hydrocarbons					
Naphthalene	µg/kg dry	561	---	8270C	20 µg/kg
2-Methylnaphthalene	µg/kg dry	200	---	8270C	20 µg/kg
Acenaphthylene	µg/kg dry	200	---	8270C	20 µg/kg
Acenaphthene	µg/kg dry	300	---	8270C	20 µg/kg
Fluorene	µg/kg dry	536	---	8270C	20 µg/kg
Phenanthrene	µg/kg dry	1170	---	8270C	20 µg/kg
Anthracene	µg/kg dry	845	---	8270C	20 µg/kg
Fluoranthene	µg/kg dry	2230	---	8270C	20 µg/kg
Pyrene	µg/kg dry	1,520	---	8270C	20 µg/kg
Benz[a]anthracene	µg/kg dry	1050	---	8270C	20 µg/kg
Chrysene	µg/kg dry	1290	---	8270C	20 µg/kg
Total benzofluoranthenes[b]	µg/kg dry	13000	---	8270C	40 µg/kg
Benzo[a]pyrene	µg/kg dry	1450	---	8270C	20 µg/kg
indeno[1,2,3-c,d]pyrene	µg/kg dry	100	---	8270C	20 µg/kg
Dibenz[a,h]anthracene	µg/kg dry	1300	---	8270C	20 µg/kg
Benzo[g,h,i]perylene	µg/kg dry	300	---	8270C	20 µg/kg
Phthalate Esters					
Dimethyl phthalate	µg/kg dry	---	---	8270C	100 µg/kg
Diethyl phthalate	µg/kg dry	600	---	8270C	200 µg/kg
Di-n-butyl phthalate	µg/kg dry	100	---	8270C	200 µg/kg
Butyl benzyl phthalate	µg/kg dry	---	---	8270C	200 µg/kg
Di-n-octyl phthalate	µg/kg dry	---	---	8270C	200 µg/kg
Bis[2-ethylhexyl]phthalate	µg/kg dry	800	330	8270C	200 µg/kg
Miscellaneous Semivolatile Organic Compounds (SVOCs)					
Dibenzofuran	µg/kg dry	---	---	8270C	50 µg/kg
Carbazole	µg/kg dry	1600	---	8270C	50 µg/kg

Table 1
Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits—Catch Basin Sediment

Parameter	Unit	MacDonald PECs and other SQVs[c]	DEQ 2001 Bioaccumulative Sediment SLVs[c]	Analytical Method	Practical Quantitation Limit
Volatile Organic Compounds					
Benzene	µg/kg dry	---	---	8260B	5.0 µg/kg
Toluene	µg/kg dry	---	---	8260B	5.0 µg/kg
Ethylbenzene	µg/kg dry	---	---	8260B	5.0 µg/kg
m,p-Xylene	µg/kg dry	---	---	8260B	5.0 µg/kg
o-Xylene	µg/kg dry	---	---	8260B	5.0 µg/kg
Total Xylenes	µg/kg dry	---	---	8260B	5.0 µg/kg
Polychlorinated Biphenyls (PCBs)					
Aroclor 1016	µg/kg dry	530	420	8082[a]	10 µg/kg
Aroclor 1221	µg/kg dry	---	---	8082[a]	10 µg/kg
Aroclor 1232	µg/kg dry	---	---	8082[a]	10 µg/kg
Aroclor 1242	µg/kg dry	---	2	8082[a]	10 µg/kg
Aroclor 1248	µg/kg dry	1500	4	8082[a]	10 µg/kg
Aroclor 1254	µg/kg dry	300	10	8082[a]	10 µg/kg
Aroclor 1260	µg/kg dry	200	---	8082[a]	10 µg/kg
Aroclor 1262	µg/kg dry	---	---	8082[a]	10 µg/kg
Aroclor 1268	µg/kg dry	---	---	8082[a]	10 µg/kg
Total PCB	µg/kg dry	676	---	8082[a]	10 µg/kg

Notes:

a All aroclors detected above the reporting limit must be confirmed by gas chromatograph mass spectrometer (GCMS).

b The total benzofluoranthenes criterion represents the sum of the concentrations of the b, j, and k isomers of benzofluoranthene.

c MacDonald PEC and DEQ 2001 Bioaccumulative Sediment SLVs taken from Table 3-1 Portland Harbor JSCS, December 2005
µg/kg dry wt = micrograms per kilogram, dry weight basis
PSEP = Puget Sound Estuary Program

Table 2
Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits—Stormwater

Parameter	Unit	Portland Harbor Specific Fish Consumption Rate	Analytical Method	Practical Quantitation Limit
Conventional Parameters				
Total suspended solids	mg/L	-	160.2	5 mg/L
Total organic carbon	mg/L	-	415.1,9060	1.5 mg/L
Metals				
Arsenic	µg/L	0.014	200.8,6020	2 µg/L
Cadmium	µg/L	-	200.8,6020	2 µg/L
Chromium	µg/L	-	200.8,6020	2 µg/L
Copper	µg/L	-	200.8,6020	2 µg/L
Cyanide		-		
Lead	µg/L	-	200.8,6020	2 µg/L
Mercury	µg/L	0.0146	1,631	0.001 µg/L
Nickel	µg/L	460	200.8,6020	2 µg/L
Selenium	µg/L	420	200.8,6020	2 µg/L
Silver	µg/L	-	200.8,6020	2 µg/L
Zinc	µg/L	2600	200.8,6020	5 µg/L
Aromatic Hydrocarbons				
Naphthalene	µg/L	-	8270C	2 µg/L
2-Methylnaphthalene	µg/L	-	8270C	1.0 µg/L
Acenaphthylene	µg/L	-	8270C	1.0 µg/L
Acenaphthene	µg/L	99	8270C	1.0 µg/L
Fluorene	µg/L	530	8270C	1.0 µg/L
Phenanthrene	µg/L	-	8270C	1.0 µg/L
Anthracene	µg/L	4,000	8270C	1.0 µg/L
Fluoranthene	µg/L	14	8270C	1.0 µg/L
Pyrene	µg/L	400	8270C	1.0 µg/L
Benz[a] anthracene	µg/L	0.0018	8270C-UL	0.003 µg/L
Chrysene	µg/L	0.0018	8270C-UL	0.003 µg/L
Total benzofluoranthenes	µg/L	0.0018	8270C-UL	0.003 µg/L
Benzo[a]pyrene	µg/L	0.0018	8270C-UL	0.003 µg/L
indeno[1,2,3-c,d]pyrene	µg/L	0.0018	8270C-UL	0.003 µg/L
Dibenzo[a,h]anthracene	µg/L	0.0018	8270C-UL	0.003 µg/L
Benzo[g,h,i]perylene	µg/L	-	8270C-UL	0.003 µg/L
Phthalate Esters				
Dimethyl phthalate	µg/L	110000	8270C	2.0 µg/L
Diethyl phthalate	µg/L	4400	8270C	2.0 µg/L
Di-n-butyl phthalate	µg/L	450	8270C	2.0 µg/L
Butyl benzyl phthalate	µg/L	190	8270C	3.0 µg/L
Di-n-octyl phthalate	µg/L	-	8270C	2.0 µg/L
Bis[2-ethylhexyl]phthalate	µg/L	0.22	8270C	15 µg/L
Miscellaneous semivolatile organic compounds (SVOCs)				
Dibenzofuran	µg/L	-	8270C	2.0 µg/L
Carbazole	µg/L	-	8270C	2.0 µg/L
Volatile Organic Compounds				
Benzene	µg/L	5.1	8260B	0.5 µg/L
Toluene	µg/L	1500	8260B	0.5 µg/L
Ethylbenzene	µg/L	210	8260B	0.5 µg/L
m,p-Xylene	µg/L	-	8260B	0.5 µg/L

Table 2
Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits—Stormwater

Parameter	Unit	Portland Harbor Specific Fish Consumption Rate	Analytical Method	Practical Quantitation Limit
o-Xylene	µg/L	-	8260B	0.5 µg/L
Total Xylenes	µg/L	-	8260B	0.5 µg/L
Polychlorinated biphenyls (PCBs)				
Aroclor 1016	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1221	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1232	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1242	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1248	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1254	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1260	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1262	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1268	µg/L	-	8082[a]	0.5 µg/L
Total PCB	µg/L	-	8082[a]	0.5 µg/L

Notes:

a All aroclors detected above the reporting limit must be confirmed by gas chromatograph mass spectrometer (GCMS).

WQC = Water Quality Criteria
µg/L = micrograms per liter
mg/L = milligrams per liter

Table 3
Station Locations and Sample Matrix Summary for Catch Basin Sediment and Stormwater Samples

Station ID	Parameter Container Preservative Laboratory Sample Id[a]	Metals 8-oz WM-G NA	PCBs 8-oz WM-G NA	SVOCs 8-oz WM-G NA	TS, TOC 8-oz WM-G NA	Grain Size 16-oz Plastic NA	Total Metals 250-ml Poly HNO_3	Dissolved Metals 250-ml Poly HNO_3	PCBs 2x1-L Amber glass NA	SVOCs 1-L Amber Glass NA	TSS 1-L Poly NA
Catch Basin Sediments											
SS-1	GSW-01CB-YYMMDD	X	X	X	X	X					
SS-2	GSW-02CB-YYMMDD	X	X	X	X	X					
SS-3	GSW-03CB-YYMMDD	X	X	X	X	X					
SS-4	GSW-04CB-YYMMDD	X	X	X	X	X					
Field Homogenization Duplicate	GWS-(+50)CB-YYMMDD	X	X	X	X	X					
Filter Wipe	GWS-SSEB-YYMMDD	X	X	X							
Filter Blank	GWS-SSFB-YYMMDD										
Stormwater Samples											
WR-107 Outfall	GWS-ST01-YYMMDD						X	X	X	X	X
Doane Creek Outfall	GWS-ST02-YYMMDD						X	X	X	X	X
Equipment Rinsate	GWS-STRB-YYMMDD						X		X	X	
Equipment Rinsate-Filtered	GWS-STRBF-YYMMDD							X			

Note:

[a] Labortory IDs are defined below:
ST = stormwater
CB = pipe or catch basin solids
WM-G = wide mouth glass jar
PCB = polychlorinated biphenyls
SVOC = semivolatile organic compounds
TS = total solids

FIGURES

Legend

A Koppers Lease
Batch discharge to Doane Creek/Outfall 22C

B Containment Basin
Activated carbon treatment 6" effluent pipe to city sanitary sewer

C Infiltration

D FAMM Lease
3" supply line to new buried 8" pipe to Outfall 107

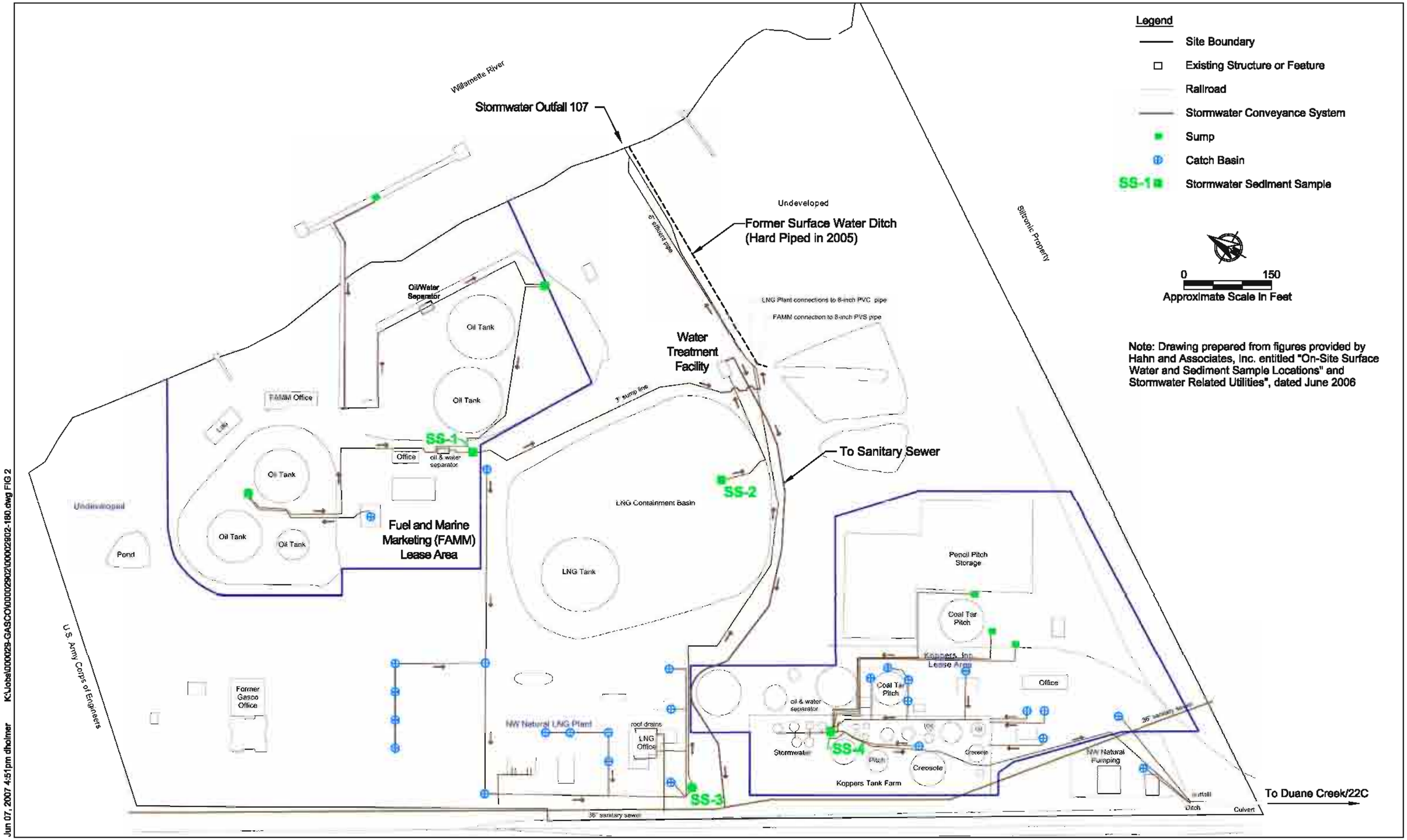
E LNG Plant
2" supply/catch basin lines to new buried 8" pipe to Outfall 107

0 200
Scale in Feet

Jun 07, 2007 10:24am dholmer K:\Jobs\000029-GASCO\00002902\00002902-179.dwg FIG 1

ANCHOR ENVIRONMENTAL, L.L.C.

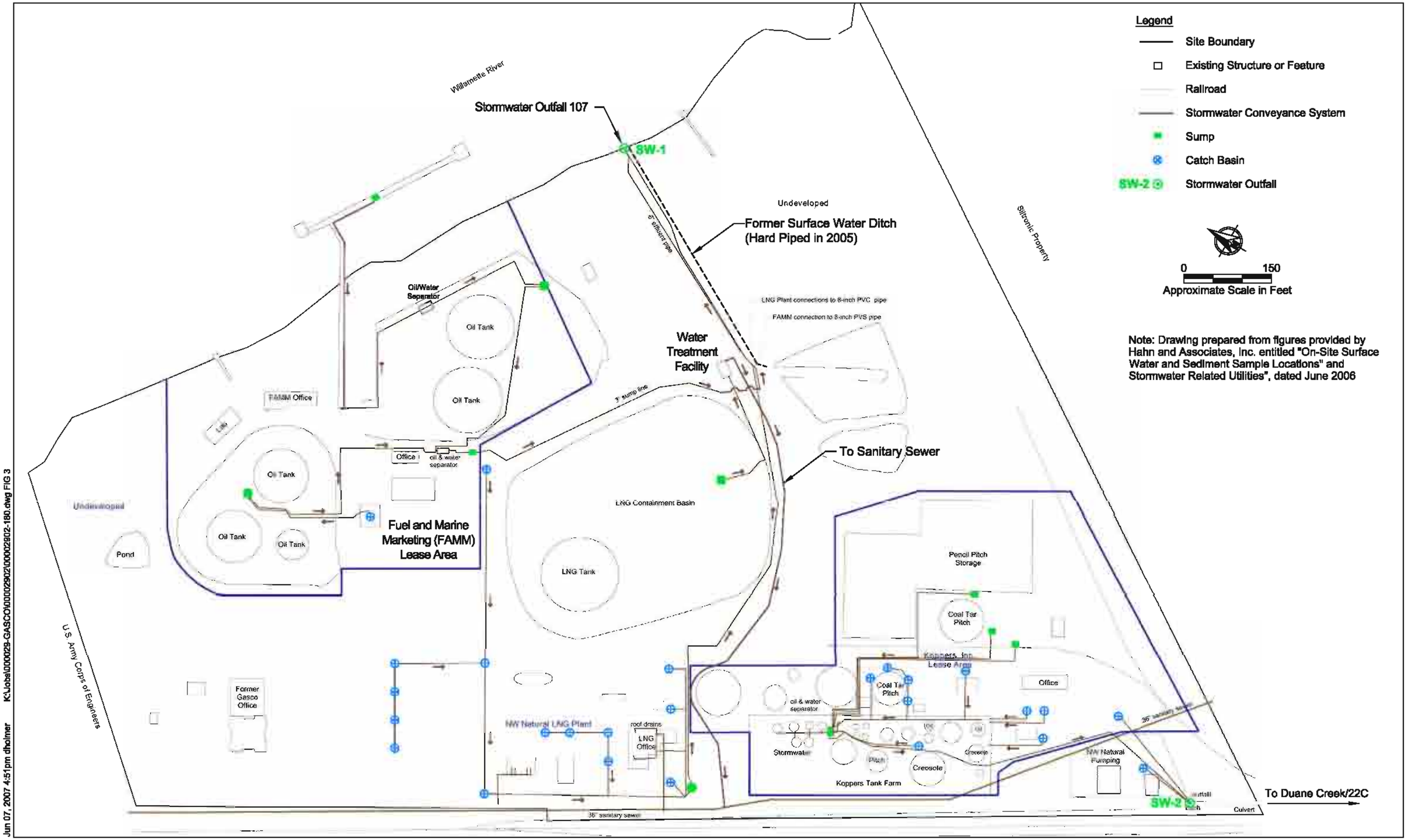
Figure 1
Outfall and Drainage Basins
NW Natural "Gasco" Site



Jun 07, 2007 4:51pm dholmer K:\Jobs\000029-GASCO\00002902\00002902-180.dwg FIG 2

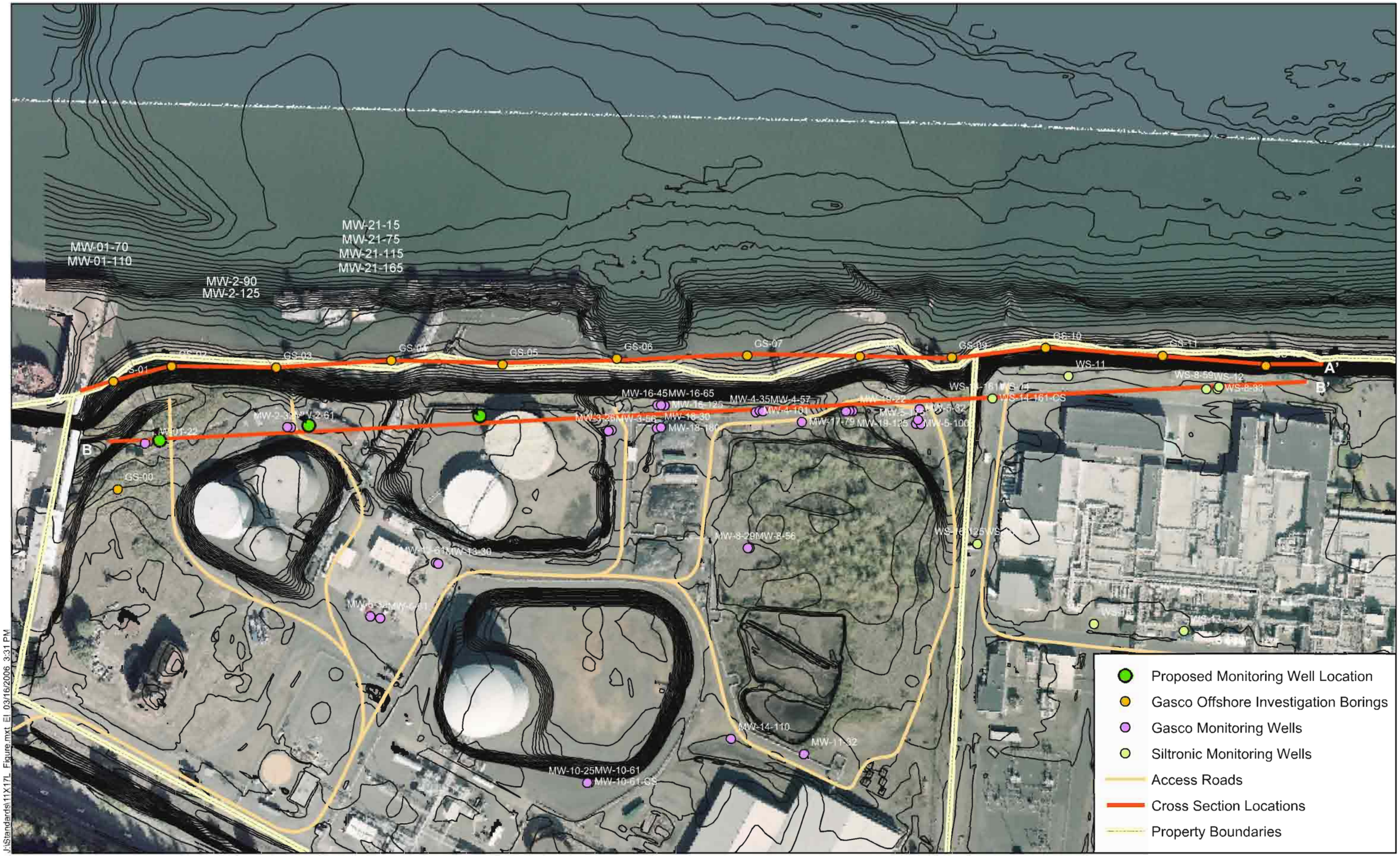
ANCHOR ENVIRONMENTAL, L.L.C.

Figure 2
Stormwater Conveyance Schematic and
Proposed Catch Basin Locations
NW Natural "Gasco" Site



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3
Stormwater Conveyance Schematic and
Proposed Stormwater Sampling Locations
NW Natural "Gasco" Site



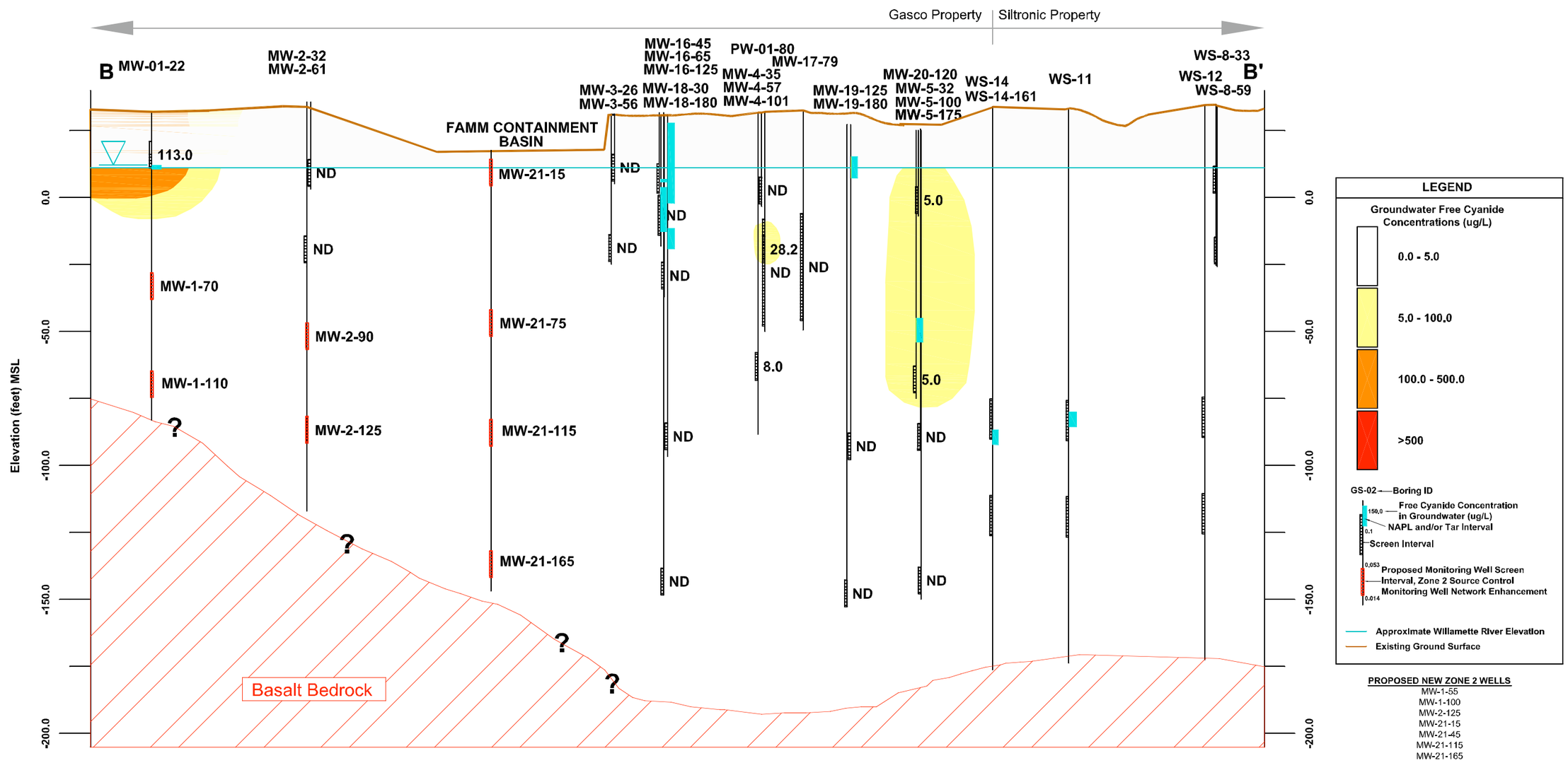
J:\Standards\11X17L_Figure.mxt El 03/16/2006 3:31 PM

ANCHOR ENVIRONMENTAL, L.L.C.

0 45 90 180
Scale in Feet

Horizontal Datum: Oregon State Plane North, Feet
Vertical Datum: City of Portland

Figure 4
Proposed Monitoring Wells - Source Control Segment 2
NW Natural-Gasco Site



Notes:

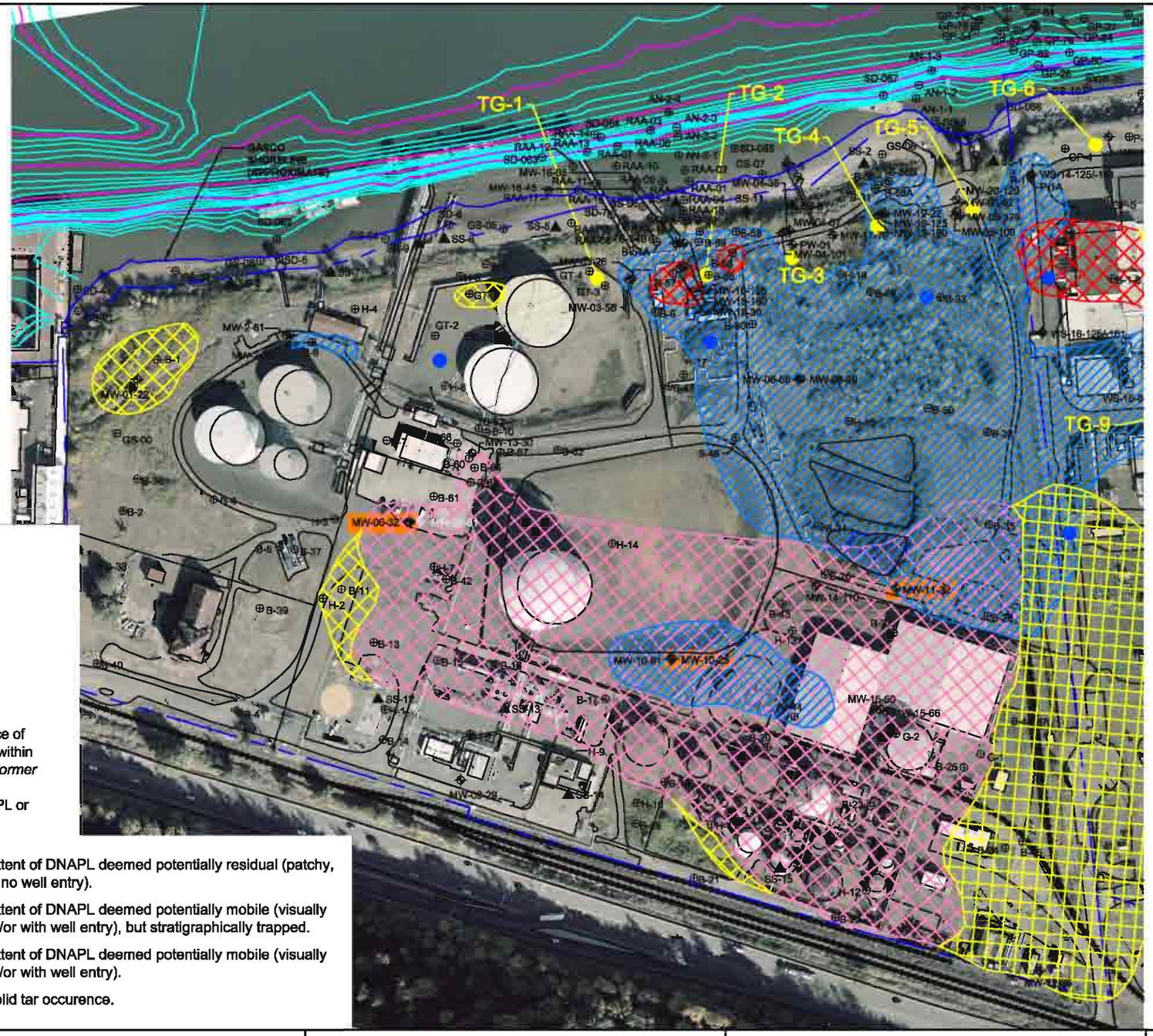
1. Vertical Datum: City of Portland
2. Horizontal Datum: Oregon State Plane NAD(83)
3. See Boring Logs for Sample Details
4. Gate/Fence needs removal for access to MW-1; alternative location is GS-00
5. Assumes installation of MW-21 in FAMM Containment is acceptable
6. Actual screen intervals to be re-evaluated after first boring to bedrock is complete. Potential modification based on local geology and deviation from assumed alluvial thickness possible.

C:_Documents and Settings_jpelc_My Documents_Gasco_CADstuff_ForReport_Zone2.dwg Free Cyanide

Jun 22, 2007 1:31pm jpelc

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 5
Cross Section B-B'
Proposed Monitoring Wells - Source Control Segment 2
NW Natural, Portland, Oregon



Notes:
Primary LIF-TarGOST Pairings

Proposed	Existing
TG-1	GT-3
TG-2	B-55
TG-3	PW-01
TG-4	MW-19
TG-5	MW-5/MW-20

NOTES:
Borings within outlined areas identified the presence of DNAPL and/or tar at some depth or depth interval within the fill unit. Tables 2 and 3 of *Summary Report - Former MGP Operations and DNAPL Occurrence* (HAI, November 2005) provide a description of the DNAPL or tar presence at each boring.

Interpreted Extent of DNAPL deemed potentially residual (patchy, limited and or no well entry).

Interpreted Extent of DNAPL deemed potentially mobile (visually saturated and/or with well entry), but stratigraphically trapped.

Interpreted Extent of DNAPL deemed potentially mobile (visually saturated and/or with well entry).

Solid/Semi-Solid tar occurence.

LEGEND

- Monitoring Well
- Soil Boring
- DNAPL In Well
- Property Line (Approximate)
- LIF-TarGost Pilot Locations (Primary)
- LIF-TarGost Contingent Locations (Secondary)

HAHN AND ASSOCIATES, INC.

ENVIRONMENTAL CONSULTANTS
434 NW 6th AVENUE, SUITE 203
PORTLAND, OREGON 97209
503-796-0717

Scale: 1 inch = 200 feet
200 0 200 400
feet

Project No. 2708-5237 REV. JUNE 2007

Figure 6
Proposed LIF-TarGOST Boring Locations with Estimated Tar and DNAPLwithin the Fill

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

X:\Hahn\Gasco Site 2007\Siltronic RI WorkPlan\DNAPL Fill.dwg 7/9/07

Notes:
Primary LIF-TarGOST Pairings

Proposed	Existing
TG-1	GT-3
TG-2	B-55
TG-3	PW-01
TG-4	MW-19
TG-5	MW-5/MW-20

NOTES:
Borings within outlined areas identified the presence of DNAPL at some depth or depth interval within the Alluvial water-bearing zone at depths shallower than 100' bgs. Tables 2 and 3 of *Summary Report - Former MGP Operations and DNAPL Occurrence* (HAI, November 2005) provide a description of the DNAPL presence at each boring.

Interpreted Extent of DNAPL deemed potentially mobile (visually saturated and/or with well entry).

LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- LIF-TarGost Pilot Locations (Primary)
- LIF-TarGost Contingent Locations (Secondary)

Note: Secondary locations to be installed if technology is deemed appropriate for the site.

HAHN AND ASSOCIATES, INC.

ENVIRONMENTAL CONSULTANTS
434 NW 6th AVENUE, SUITE 203
PORTLAND, OREGON 97209
503-796-0717

Scale: 1 inch = 200 feet
200 0 200 400
feet

Project No. 2708-5237 REV. JUNE 2007

Figure 7
Proposed LIF-TarGOST Boring Locations with Estimated DNAPLwithin Alluvial - Above 100' BGS

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

X:\Hahn\Gasco Site 2007\Siltronic RI WorkPlan\DNAPL Alluvial Shallow.dwg 7/6/07

Notes:
Primary LIF-TarGOST Pairings

Proposed	Existing
TG-1	GT-3
TG-2	B-55
TG-3	PW-01
TG-4	MW-19
TG-5	MW-5/MW-20

NOTES:
Borings within outlined areas identified the presence of DNAPL at some depth or depth interval within the Alluvial water-bearing zone at depths deeper than 100' bgs.
Tables 2 and 3 of *Summary Report - Former MGP Operations and DNAPL Occurrence* (HAI, November 2005) provide a description of the DNAPL presence at each boring.

Interpreted Extent of DNAPL deemed potentially mobile (visually saturated and/or with well entry).

LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- LIF-TarGost Pilot Locations (Primary)
- LIF-TarGost Contingent Locations (Secondary)

Note: Secondary locations to be installed if technology is deemed appropriate for the site.

HAHN AND ASSOCIATES, INC.

ENVIRONMENTAL CONSULTANTS
434 NW 6th AVENUE, SUITE 203
PORTLAND, OREGON 97209
503-796-0717

Scale: 1 inch = 200 feet
200 0 200 400
feet

Project No. 2708-5237 REV. JUNE 2007

Figure 8
Proposed LIF-TarGOST Boring Locations with Estimated DNAPL within Alluvial - Below 100' BGS

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

X:\Hahn\Gasco Site 2007\Siltronic RI WorkPlan\DNAPL Alluvial Deep.dwg 7/9/07

LEGEND

- Monitoring Well
- Soil Boring
- Property Line (Approximate)
- Proposed Geophysical Investigation Pilot Area

HAHN AND ASSOCIATES, INC.

ENVIRONMENTAL CONSULTANTS
434 NW 6th AVENUE, SUITE 203
PORTLAND, OREGON 97209
503-796-0717

Scale: 1 inch = 200 feet

200 0 200 400
feet

Project No. 2708-5237 REV.JUNE 2007

Figure 9
Proposed Geophysical Investigation Area

NW Natural Gasco Facility
7900 NW St. Helens Road
Portland, Oregon

X:\Hahn\Gasco Site 2007\Siltronic RI WorkPlan\Proposed Geophysical.dwg 7/6/07

APPENDIX A

SOURCE CONTROL DATA GAPS WORK PLAN
CATCH BASIN SEDIMENT AND STORMWATER
SAMPLE COLLECTION, PROCESSING, AND ANALYSIS PROCEDURES

NW NATURAL "GASCO" SITE

Prepared for

Northwest Natural, Inc.

7900 NW St. Helens Road

Portland, Oregon 97210

Prepared by

Anchor Environmental, L.L.C.

1423 Third Avenue, Suite 300

Seattle, Washington 98101

June 2007

1 SAMPLE COLLECTION AND PROCESSING PROCEDURES 1
1.1 Field Logbook and Forms 1
1.2 Equipment Decontamination Procedures 1
1.3 Catch Basin Sediment Sample Collection and Processing Pocedures 2
1.3.1 Field-Generated Waste 2
1.4 Stormwater Outfall Sample Collection and Processing Procedures 2
1.5 Sample Identification 3
1.6 Field Quality Assurance Samples 4
1.6.1 Field Blanks 4
1.6.2 Field Homogenization Duplicate 5

2 SAMPLE HANDLING AND STORAGE 6
2.1 Sample Custody Procedures 6
2.2 Sample Shipping and Receipt Requirements 6

3 ANALYTICAL METHODS 8

4 REFERENCES 10

List of Tables

Table 1 Container Size, Holding Time, and Preservation for Physical/Chemical Analysis
Table 2 Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits—Catch Basin Sediment
Table 3 Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits—Stormwater
Table 4 Data Quality Objectives
Table 5 Laboratory Quality Control Sample Analysis Summary

1 SAMPLE COLLECTION AND PROCESSING PROCEDURES

This section describes the sampling procedures, recordkeeping, sample handling, storage, and field quality control procedures that will be used during catch basin sediment and stormwater sampling.

1.1 Field Logbook and Forms

All field activities and observations will be noted in a field logbook. The field logbook will be a bound document containing individual field and sample log forms. Any changes that occur at the site (e.g., personnel, responsibilities, deviations from the Source Control Data Gaps Work Plan and the reasons for these changes will be documented in the field logbook. Logbook entries will be clearly written with enough detail so that participants can reconstruct events later, if necessary. The following data will be included in the field logbook:

- General field observations including, but not limited to, weather conditions, presence of other activities in the area, and any factors which may affect the quality of the data
- Date and time of sample collection
- Names of field coordinators and person(s) collection and logging in the samples
- Observations made during sample collection
- A general description of the sample including color, odor, and presence of an oil sheen

1.2 Equipment Decontamination Procedures

To prevent cross contamination, all sampling and processing equipment in contact with the catch basin sediments or stormwater will undergo the following decontamination procedures prior to and between collection activities:

- Rinse with tap water and wash with scrub brush until free of sediment
- Wash with phosphate-free detergent and tap water
- Rinse with tap water
- Rinse three times with distilled water
- Decontamination during stormwater sampling will include a final deionized water rinse

1.3 Catch Basin Sediment Sample Collection and Processing Procedures

This section describes the sample collection, processing, and handling procedures for the collection of stormwater catch basin sediments.

Sediments from selected catch basins will be sampled following methods described in *Guidance for Sampling of Catch Basin Solids* (City of Portland 2003). The catch basins sampled and approximate volume of solids collected from each catch basin will be documented on the field log sheet. A log sheet will be completed for each catch basin solids sample. The information summarized on this sheet will include, but not be limited to, the following:

- Date and time
- Sampling personnel
- Weather
- Sampling location
- Flow (if any)
- Characteristics or other observations of sample (e.g., color, odor, sheen, etc.)
- Other comments

The field logbook will include clear information concerning any modifications to the details and procedures identified in the Work Plan.

1.3.1 Field-Generated Waste

All sediment remaining after sampling and processing will be washed back into the catch basin prior to moving to the next station. All disposable sampling materials and personal protective equipment, such as disposable coveralls, gloves, and paper towels, will be placed in heavy-duty garbage bags or other appropriate containers. Disposable supplies will be placed in a normal refuse container for disposal as solid waste.

1.4 Stormwater Outfall Sample Collection and Processing Procedures

Stormwater samples will be collected from discharges from Outfall WR-107 and from the culvert into Doane Creek to City of Portland Outfall 22 following a precipitation event of sufficient intensity to cause an increase in discharge from these outfalls as described in Section 2.3.2 of the Source Control Data Gaps Work Plan (Anchor 2007) using methods described in *How to do Stormwater Sampling, A guide for industrial facilities* (Ecology 2002).

Stormwater will be collected by attaching a new, dedicated 1-liter wide-mouth sampling jar or similar container to a telescoping rod of sufficient length to reach the stormwater. Care will be taken to ensure that the sample jar is not scraped against the side of the outfall, to avoid introducing extra solids into the bottle. All samples from a single station will be collected using the same sampling jar. Each stormwater sample will be transferred into the appropriate pre-labeled sample containers (certified, pre-cleaned), and will immediately be stored on ice in a cooler.

Table 1 lists container size, holding times, and preservation for the categories of analytes. Field measurements will be performed near the end of the sampling period and will include temperature, pH, conductivity, and dissolved oxygen.

The outfall collection data will be recorded on a log sheet. A log sheet will be completed for each outfall stormwater sample. The information summarized on this sheet will include, but not be limited to, the following:

- Date and time
- Sampling personnel
- Weather
- Sampling location
- Flow in cubic feet per second (cfs; if any)
- Characteristics or other observations of sample (e.g., color, odor, sheen, etc.)
- Other comments

The field logbook will include clear information concerning any modifications to the details and procedures identified in this FSP.

1.5 Sample Identification

All samples will be assigned a unique identification number based on a sample designation scheme designed to meet the needs of the field personnel, laboratory and Gasco data management, validation chemists, and data users. The unique code will be assigned to each sample as part of the data record and will indicate the project phase, sample location, sample type, sampling event, and level of replication/duplication. Sample identifiers will consist of three components separated by dashes. The first component, GSW, identifies the

data as belonging to the Gasco stormwater sampling. The second component will begin with the sample number location designation followed by a SW or SS for stormwater or catch basin sump sediment samples, respectively. The final component will be the date in yy/mm/dd format.

Example sample identifiers are:

- GSW-01SW-070515: stormwater grab sample from Station 01 collected on May 15, 2007.
- GSW-02SS-070515: Catch basin sump sediment sample from Station 02 collected on May 15, 2007.

1.6 Field Quality Assurance Samples

Field quality assurance (QA) samples will be used to evaluate the efficiency of field decontamination and processing procedures. Although validation guidelines have not been established for field QA samples, their analysis is useful in identifying possible problems resulting during sample collection or sample processing in the field. All field QA samples will be documented in the field logbook and verified by the Quality Assurance/Quality Control (QA/QC) Manager.

1.6.1 Field Blanks

Field blank samples will be collected to evaluate the efficiency of field decontamination procedures. Based on the number of samples proposed for each media, one equipment filter wipe and one filter wipe blank will be collected during catch basin sediment sampling, and one equipment rinsate blank, one filter blank (if field filtering is required), and one deionized distilled water blank will be collected during stormwater outfall discharge sampling.

1.6.1.1 Field Blanks for Catch Basin Sediments

Filters used for the equipment wipes and blank will be provided by the laboratory. The equipment filter wipe consists of wiping down the sampling equipment after sample collection and decontamination with three sheets of clean, ashless filter paper and placing them into a sample jar. The filter blank will be prepared by placing

three clean pieces of ashless filter paper directly into a sampling container prior to arriving in the field. The filter wipes and blanks will be from the same lot and box.

One equipment filter wipe will be analyzed. The remaining equipment filter wipes and filter blanks will be archived and will be analyzed only in the event of questionable data. If analysis is required of the filter blanks and filter wipes, they will be weighed, extracted, or digested in the same manner as the sediment samples for this project. These extracts or digestates are subjected to the same cleanup procedures as the sediment samples. Results for these analyses are reported in micrograms (µg) or milligrams (mg) and are then compared to the total volume of sediment collected to evaluate whether or not any samples collected were impacted by cross-over contamination.

1.6.1.2 Field Blanks for Stormwater Grab Samples

The outfall discharge rinsate blanks will consist of filling an unused stormwater collection jar with laboratory water and collecting this water (i.e., splitting into individual bottles).

If field filtering is determined necessary for the stormwater discharge sample collection efforts, a filter blank will be prepared for each type of filter used in the field. This filter blank will consist of running deionized water through an unused filter and collecting the filtered water.

1.6.2 Field Homogenization Duplicate

At least one field homogenization sample will be collected and analyzed for catch basin sediment samples processed in the field. The field homogenization sample consists of collecting additional sediment from one location, processing that sample consistent with procedures outlined in this FSP, then submitting a blind split of that sample to the laboratory.

2 SAMPLE HANDLING AND STORAGE

This section addresses the sampling program requirements for maintaining custody of the samples throughout the sample collection and shipping process, and provides specific procedures for sample shipping.

2.1 Sample Custody Procedures

Samples are considered to be in one's custody if they are: (1) in the custodian's possession or view; (2) in a secured location (under lock) with restricted access; or (3) in a container that is secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s).

Chain-of-custody (COC) procedures described in Appendix A will be followed for all samples throughout the collection, handling, and analysis process.

2.2 Sample Shipping and Receipt Requirements

All samples will be shipped or hand-delivered to the analytical laboratory no later than the day after collection. If samples are collected on Friday, they may be held until the following Monday for shipment, provided that this does not adversely impact holding time requirements. Specific sample shipping procedures are as follows:

- Each cooler or container containing the samples for analysis will be shipped via overnight delivery to the appropriate analytical laboratory. In the event that Saturday delivery is required, the Field Coordinator will contact the analytical laboratory before 3 p.m. on Friday to ensure that the laboratory is aware of the number of coolers shipped and the airbill tracking numbers for those coolers. Following each shipment, the Field Coordinator will call the laboratory and verify the shipment from the day before has been received and is in good condition.
- Coolant ice will be sealed in separate double plastic bags and placed in the shipping containers.
- Individual sample containers will be placed in a sealable plastic bag, packed to prevent breakage, and transported in a sealed ice chest or other suitable container.
- Glass jars will be separated in the shipping container by shock absorbent material (e.g., bubble wrap) to prevent breakage.

- The shipping containers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container, and consultant's office name and address) to enable positive identification.
- The shipping waybill number will be documented on all COC forms accompanying the samples.
- A sealed envelope containing COC forms will be enclosed in a plastic bag and taped to the inside lid of the cooler.
- A minimum of two signed and dated COC seals will be placed on adjacent sides of each cooler prior to shipping.
- Each cooler will be wrapped securely with strapping tape, labeled "Glass – Fragile" and "This End Up," and will be clearly labeled with the laboratory's shipping address and the consultant's return address.

Upon transfer of sample possession to the analytical laboratory, the persons transferring custody of the sample container will sign the COC form. Upon receipt of samples at the laboratory, the shipping container seal will be broken and the receiver will record the condition of the samples on a sample receipt form. COC forms will be used internally in the lab to track sample handling and final disposition.

3 ANALYTICAL METHODS

This section summarizes the target physical and chemical analyses for the various media sampled. All sample analyses will be conducted in accordance with approved methods in the Work Plan. Prior to analysis, all samples will be maintained according to the appropriate holding times and temperatures for each analysis (Table 1). Tables 2 and 3 present the proposed analytes, the analytical methods to be used, and the targeted detection limits for the evaluation of catch basin sediment, stormwater outfall discharge, and field QA/QC samples. The analytical laboratory will prepare a detailed report to be included as an appendix in the Sediment and Stormwater Evaluation Data Report.

Prior to the analysis of the samples, the laboratory will calculate method detection limits for each analyte of interest, where applicable. Method detection limits will be below the Joint Source Control Strategy (JSCS) Screening Level Values for sediment and water quality criteria specified in Tables 2 and 3, respectively, if technically feasible. To achieve the required detection limits, some modifications to the methods may be necessary. These modifications from the specified analytical methods will be provided by the laboratory at the time of establishing the laboratory contract, and must be approved by DEQ prior to implementation.

Chemical and physical testing will be conducted at Columbia Analytical Services (CAS), located in Kelso, Washington. CAS is an Ecology-accredited laboratory and is also accredited under the National Environmental Laboratories Accreditation Program (NELAP). All chemical and physical testing will adhere to the most recent EPA methods.

In completing chemical analyses for this project, the contract laboratory is expected to meet the following minimum requirements:

- Adhere to the methods outlined in the Work Plan (Anchor 2007), including methods referenced for each analytical procedure (Tables 2 and 3)
- Deliver facsimile, hard copy, and electronic data as specified
- Meet reporting requirements for deliverables
- Meet turnaround times for deliverables
- Implement QA/QC procedures, including data quality objectives discussed in the QAPP (Table 4), laboratory QC requirements (Table 5), and performance evaluation testing requirements

- Notify the project QA/QC Manager of any QAPP QA/QC problems when they are identified to allow for quick resolution
- Allow laboratory and data audits to be performed, if deemed necessary

4 REFERENCES

Anchor. 2007. Source Control Data Gaps Work Plan, Catch Basin Sediment and Stormwater Sampling. Prepared for NW Natural. Anchor Environmental L.L.C., Seattle, WA. June 2007.

City of Portland. 2003. Standard Operating Procedures, Guidance for Sampling of Catch Basin Solids. Prepared for City of Portland. CH2MHill. July 2003.

DEQ and EPA. 2005. Portland Harbor Joint Source Control Strategy – Final. Prepared by State of Oregon Department of Environmental Quality and U.S. Environmental Protection Agency. December 2005.

Ecology. 2002. How to Do Stormwater Sampling, A Guide for Industrial Facilities. Washington State Department of Ecology, December 2002 (rev. 1/05) Publication #02-10-071.

TABLES

Table 1
Container Size, Holding Time, and Preservation for Physical/Chemical Analysis

Parameter	Sample Size	Container Size and Type	Holding Time	Preservative
Catch Basin Sediment Samples				
Polychlorinated biphenyls (PCB)	150 g	8-oz Glass	14 days until extraction	Cool/4° C
			1 year until extraction	Freeze -20°C
			40 days after extraction	Cool/4° C
Semivolatile organic compounds (SVOC)	150 g	8-oz Glass	14 days until extraction	Cool/4° C
			1 year until extraction	Freeze -20°C
			40 days after extraction	Cool/4° C
Total solids (TS)	25 g	8-oz Glass	14 days	Cool/4° C
			6 months	Freeze -20°C
BTEX Compounds		2-oz Glass	14 days	Cool/4° C
Polycyclic Aromatic Hydrocarbons (PAHs)		16-oz Glass	14 days until extraction	Cool/4° C
			1 year until extraction	Freeze -20°C
			40 days after extraction	
Metals	50 g	8-oz Glass	6 Months	Cool/4° C
			2 Years	Freeze -20°C
Total organic carbon	20 g	from TS container	14 days	Cool/4° C
			6 months	Freeze -20°C
Grain size	500 g	16-oz Plastic	6 months	Cool/4° C
Stormwater Samples				
Polychlorinated biphenyls (PCB)	2 1-liter	1-liter Amber glass	7 days until extraction	Cool/4° C
			40 days after extraction	Cool/4° C
Semivolatile organic compounds (SVOC)	1-liter	1-liter Amber glass	7 days until extraction	Cool/4° C
			40 days after extraction	Cool/4° C
BTEX Compounds	120-mls	3-40 ml VOAs	14 days for analysis	Cool/4° C/HCL
Total metals	200-mls	250-ml Poly	6 months, 28 days for Hg	HNO_3 to pH <2
Dissolved metals	200-mls	250-ml Poly	6 months, 28 days for Hg	HNO_3 to pH <2
Total suspended solids	1-liter	1-liter	7 days	Cool/4° C
Cyanide	100 ml	1-L Poly	14 days for analysis	NAOH to pH>14

Table 2
Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits—Catch Basin Sediment

Parameter	Unit	MacDonald PECs and other SQVs[c]	DEQ 2001 Bioaccumulative Sediment SLVs[c]	Analytical Method	Practical Quantitation Limit
Conventional Parameters					
Gravel	%	---	---	PSEP	0.1
Sand	%	---	---	PSEP	0.1
Silt	%	---	---	PSEP	0.1
Clay	%	---	---	PSEP	0.1
Fines	%	---	---	PSEP	0.1
Total solids	%	---	---	PSEP	0.1
Total organic carbon	%	---	---	PSEP	0.1
Metals					
Antimony	µg/kg dry	64,000	10,000	6020	50 µg/kg
Arsenic	µg/kg dry	33,000	---	6020	500 µg/kg
Cadmium	µg/kg dry	4,980	3	6020	50 µg/kg
Chromium	µg/kg dry	---	---	6020	200 µg/kg
Copper	µg/kg dry	149,000	10,000	6020	100 µg/kg
Cyanide	µg/kg dry	---	---	9014	500 µg/kg
Lead	µg/kg dry	128,000	128,000	6020	50 µg/kg
Mercury	µg/kg dry	1,060	---	1631	1 µg/kg
Nickel	µg/kg dry	48,600	316,000	6020	200 µg/kg
Silver	µg/kg dry	5,000	---	6020	20 µg/kg
Zinc	µg/kg dry	459,000	3,000	6020	500 µg/kg
Aromatic Hydrocarbons					
Naphthalene	µg/kg dry	561	---	8270C	20 µg/kg
2-Methylnaphthalene	µg/kg dry	200	---	8270C	20 µg/kg
Acenaphthylene	µg/kg dry	200	---	8270C	20 µg/kg
Acenaphthene	µg/kg dry	300	---	8270C	20 µg/kg
Fluorene	µg/kg dry	536	---	8270C	20 µg/kg
Phenanthrene	µg/kg dry	1170	---	8270C	20 µg/kg
Anthracene	µg/kg dry	845	---	8270C	20 µg/kg
Fluoranthene	µg/kg dry	2230	---	8270C	20 µg/kg
Pyrene	µg/kg dry	1,520	---	8270C	20 µg/kg
Benz[a]anthracene	µg/kg dry	1050	---	8270C	20 µg/kg
Chrysene	µg/kg dry	1290	---	8270C	20 µg/kg
Total benzofluoranthenes[b]	µg/kg dry	13000	---	8270C	40 µg/kg
Benzo[a]pyrene	µg/kg dry	1450	---	8270C	20 µg/kg
indeno[1,2,3-c,d]pyrene	µg/kg dry	100	---	8270C	20 µg/kg
Dibenz[a,h]anthracene	µg/kg dry	1300	---	8270C	20 µg/kg
Benzo[g,h,i]perylene	µg/kg dry	300	---	8270C	20 µg/kg
Phthalate Esters					
Dimethyl phthalate	µg/kg dry	---	---	8270C	100 µg/kg
Diethyl phthalate	µg/kg dry	600	---	8270C	200 µg/kg
Di-n-butyl phthalate	µg/kg dry	100	---	8270C	200 µg/kg
Butyl benzyl phthalate	µg/kg dry	---	---	8270C	200 µg/kg
Di-n-octyl phthalate	µg/kg dry	---	---	8270C	200 µg/kg
Bis[2-ethylhexyl]phthalate	µg/kg dry	800	330	8270C	200 µg/kg
Miscellaneous Semivolatile Organic Compounds (SVOCs)					
Dibenzofuran	µg/kg dry	---	---	8270C	50 µg/kg
Carbazole	µg/kg dry	1600	---	8270C	50 µg/kg

Table 2
Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits—Catch Basin Sediment

Parameter	Unit	MacDonald PECs and other SQVs[c]	DEQ 2001 Bioaccumulative Sediment SLVs[c]	Analytical Method	Practical Quantitation Limit
Volatile Organic Compounds					
Benzene	µg/kg dry	---	---	8260B	5.0 µg/kg
Toluene	µg/kg dry	---	---	8260B	5.0 µg/kg
Ethylbenzene	µg/kg dry	---	---	8260B	5.0 µg/kg
m,p-Xylene	µg/kg dry	---	---	8260B	5.0 µg/kg
o-Xylene	µg/kg dry	---	---	8260B	5.0 µg/kg
Total Xylenes	µg/kg dry	---	---	8260B	5.0 µg/kg
Polychlorinated Biphenyls (PCBs)					
Aroclor 1016	µg/kg dry	530	420	8082[a]	10 µg/kg
Aroclor 1221	µg/kg dry	---	---	8082[a]	10 µg/kg
Aroclor 1232	µg/kg dry	---	---	8082[a]	10 µg/kg
Aroclor 1242	µg/kg dry	---	2	8082[a]	10 µg/kg
Aroclor 1248	µg/kg dry	1500	4	8082[a]	10 µg/kg
Aroclor 1254	µg/kg dry	300	10	8082[a]	10 µg/kg
Aroclor 1260	µg/kg dry	200	---	8082[a]	10 µg/kg
Aroclor 1262	µg/kg dry	---	---	8082[a]	10 µg/kg
Aroclor 1268	µg/kg dry	---	---	8082[a]	10 µg/kg
Total PCB	µg/kg dry	676	---	8082[a]	10 µg/kg

Notes:

a All aroclors detected above the reporting limit must be confirmed by gas chromatograph mass spectrometer (GCMS).

b The total benzofluoranthenes criterion represents the sum of the concentrations of the b, j, and k isomers of benzofluoranthene.

c MacDonald PEC and DEQ 2001 Bioaccumulative Sediment SLVs taken from Table 3-1 Portland Harbor JSCS, December 2005

µg/kg dry wt = micrograms per kilogram, dry weight basis

PSEP = Puget Sound Estuary Program

Table 3
Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits—Stormwater

Parameter	Unit	Portland Harbor Specific Fish Consumption Rate	Analytical Method	Practical Quantitation Limit
Conventional Parameters				
Total suspended solids	mg/L	-	160.2	5 mg/L
Total organic carbon	mg/L	-	415.1,9060	1.5 mg/L
Metals				
Arsenic	µg/L	0.014	200.8,6020	2 µg/L
Cadmium	µg/L	-	200.8,6020	2 µg/L
Chromium	µg/L	-	200.8,6020	2 µg/L
Copper	µg/L	-	200.8,6020	2 µg/L
Cyanide		-		
Lead	µg/L	-	200.8,6020	2 µg/L
Mercury	µg/L	0.0146	1,631	0.001 µg/L
Nickel	µg/L	460	200.8,6020	2 µg/L
Selenium	µg/L	420	200.8,6020	2 µg/L
Silver	µg/L	-	200.8,6020	2 µg/L
Zinc	µg/L	2600	200.8,6020	5 µg/L
Aromatic Hydrocarbons				
Naphthalene	µg/L	-	8270C	2 µg/L
2-Methylnaphthalene	µg/L	-	8270C	1.0 µg/L
Acenaphthylene	µg/L	-	8270C	1.0 µg/L
Acenaphthene	µg/L	99	8270C	1.0 µg/L
Fluorene	µg/L	530	8270C	1.0 µg/L
Phenanthrene	µg/L	-	8270C	1.0 µg/L
Anthracene	µg/L	4,000	8270C	1.0 µg/L
Fluoranthene	µg/L	14	8270C	1.0 µg/L
Pyrene	µg/L	400	8270C	1.0 µg/L
Benz[a] anthracene	µg/L	0.0018	8270C-UL	0.003 µg/L
Chrysene	µg/L	0.0018	8270C-UL	0.003 µg/L
Total benzofluoranthenes	µg/L	0.0018	8270C-UL	0.003 µg/L
Benzo[a]pyrene	µg/L	0.0018	8270C-UL	0.003 µg/L
indeno[1,2,3-c,d]pyrene	µg/L	0.0018	8270C-UL	0.003 µg/L
Dibenzo[a,h]anthracene	µg/L	0.0018	8270C-UL	0.003 µg/L
Benzo[g,h,i]perylene	µg/L	-	8270C-UL	0.003 µg/L
Phthalate Esters				
Dimethyl phthalate	µg/L	110000	8270C	2.0 µg/L
Diethyl phthalate	µg/L	4400	8270C	2.0 µg/L
Di-n-butyl phthalate	µg/L	450	8270C	2.0 µg/L
Butyl benzyl phthalate	µg/L	190	8270C	3.0 µg/L
Di-n-octyl phthalate	µg/L	-	8270C	2.0 µg/L
Bis[2-ethylhexyl]phthalate	µg/L	0.22	8270C	15 µg/L
Miscellaneous Semivolatile Organic Compounds (SVOCs)				
Dibenzofuran	µg/L	-	8270C	2.0 µg/L
Carbazole	µg/L	-	8270C	2.0 µg/L
Volatile Organic Compounds				
Benzene	µg/L	5.1	8260B	0.5 µg/L
Toluene	µg/L	1500	8260B	0.5 µg/L
Ethylbenzene	µg/L	210	8260B	0.5 µg/L
m,p-Xylene	µg/L	-	8260B	0.5 µg/L
o-Xylene	µg/L	-	8260B	0.5 µg/L

Table 3
Parameters for Analysis, Evaluation Criteria, Methods, and Practical Quantitation Limits—Stormwater

Parameter	Unit	Portland Harbor Specific Fish Consumption Rate	Analytical Method	Practical Quantitation Limit
Total Xylenes	µg/L	-	8260B	0.5 µg/L
Polychlorinated biphenyls (PCBs)				
Aroclor 1016	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1221	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1232	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1242	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1248	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1254	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1260	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1262	µg/L	-	8082[a]	0.5 µg/L
Aroclor 1268	µg/L	-	8082[a]	0.5 µg/L
Total PCB	µg/L	-	8082[a]	0.5 µg/L

Notes:

a All aroclors detected above the reporting limit must be confirmed by gas chromatograph mass spectrometer (GCMS).

WQC = Water Quality Criteria

µg/L = micrograms per liter

mg/L = milligrams per liter

Table 4
Data Quality Objectives

Parameter	Precision	MS/MSD Accuracy	LCS Accuracy	Completeness
Grain size	+/- 20% RPD	NA	NA	95%
Total solids	+/- 20% RPD	NA	NA	95%
Total suspended solids	+/- 20% RPD	NA	NA	95%
Total metals	+/- 35% RPD	75-125% R	80-120% R	95%
Dissolved metals	+/- 20% RPD	75-125% R	80-120% R	95%
Total organic carbon	+/- 20% RPD	65-135% R	65-135% R	95%
Semivolatile Organic Compounds (SVOCs)				
1,2,4-Trichlorobenzene	+/- 28% RPD	51-141% R	51-141% R	95%
1,4-Dichlorobenzene	+/- 32% RPD	47-144% R	47-144% R	95%
2,4-Dinitrotoluene	+/- 31% RPD	35-141% R	35-141% R	95%
2-Chlorophenol	+/- 27% RPD	54-138% R	54-138% R	95%
2-Methylnaphthalene	+/- 27% RPD	51-138% R	51-138% R	95%
4-Chloro-3-methylphenol	+/- 27% RPD	51-141% R	51-141% R	95%
4-Nitrophenol	+/- 33% RPD	7-169% R	30-169% R	95%
Acenaphthene	+/- 27% RPD	50-144% R	50-144% R	95%
Acenaphthylene	+/- 28% RPD	52-130% R	52-130% R	95%
Anthracene	+/- 27% RPD	52-135% R	52-135% R	95%
Benzo(a)anthracene	+/- 27% RPD	55-135% R	55-135% R	95%
Benzo(a)pyrene	+/- 30% RPD	54-138% R	54-138% R	95%
Benzo(g,h,i)perylene	+/- 28% RPD	54-142% R	54-142% R	95%
Benzofluoranthenes	+/- 31% RPD	43-154% R	43-154% R	95%
Chrysene	+/- 26% RPD	59-133% R	59-133% R	95%
Dibenz(a,h)anthracene	+/- 30% RPD	50-150% R	50-150% R	95%
Fluoranthene	+/- 36% RPD	54-135% R	54-135% R	95%
Fluorene	+/- 31% RPD	50-134% R	50-134% R	95%
Indeno(1,2,3-cd)pyrene	+/- 29% RPD	45-153% R	45-153% R	95%
Naphthalene	+/- 26% RPD	54-131% R	54-131% R	95%
N-nitroso-di-n-propylamine	+/- 28% RPD	49-142% R	49-142% R	95%
Pentachlorophenol	+/- 68% RPD	5-143% R	30-143% R	95%
Phenanthrene	+/- 28% RPD	55-133% R	55-133% R	95%
Phenol	+/- 26% RPD	47-131% R	47-131% R	95%
Pyrene	+/- 31% RPD	47-152% R	47-152% R	95%
Volatile Organic Compounds (SVOCs)				
Benzene	+/- 30% RPD	60-130%	71-137 % R	95%
Ethylbenzene	+/- 30% RPD	60-130%	70-140 % R	95%
Toluene	+/- 30% RPD	60-130%	72-137 % R	95%
Total Xylenes	+/- 30% RPD	60-130%	67-140 % R	95%
Polychlorinated biphenyls (PCBs)				
Aroclor-1242	+/- 20% RPD	57-128% R	57-128% R	95%
Aroclor-1260	+/- 20% RPD	65-132% R	65-132% R	95%

Notes:

RPD = Relative percent difference

R = Recovery

MS/MSD = matrix spike/matrix spike duplicate

LCS = Laboratry Control Sample

Table 5
Laboratory Quality Control Sample Analysis Summary

Analysis Type	Initial Calibration	Ongoing Calibration	Standard Reference Material	Replicates	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes	Laboratory Control Samples
Grain size	Each batch[a]	NA	NA	1 per 20 samples	NA	NA	NA	NA	NA
Total solids	Daily[d]	NA	NA	1 per 20 samples	NA	NA	NA	NA	NA
Total suspended solids	Daily[d]	NA	NA	1 per 20 samples	NA	NA	NA	NA	NA
Total metals	Daily[b]	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA	1 per 20 samples
Total organic carbon	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA	1 per 20 samples
Polychorinated biphenyls (PCBs)	As needed[c]	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample	1 per 20 samples
Semivolatile organic compounds (SVOCs) (8270C)	As needed[c]	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample	1 per 20 samples
Volatile Organic Compounds	As needed[c]	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample	1 per 20 samples
Cyanide	As needed[c]	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Each batch	NA	1 per 20 samples

Notes:

a Calibration and certification of drying ovens and weighing scales are conducted bi-annually.

b Initial calibration verification and calibration blank must be analyzed at the beginning of each batch.

c Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.

d Scale should be calibrated with class 5 weights daily; weights must bracket the weight of sample and weighing vessel.

NA Not applicable