APPENDIX B

Quality Assurance Project Plan

QAPP
Remedial Investigation/Feasibility Study and Interim Action
Cap Sante Marine Lease Area
Anacortes, Washington

June 19, 2007

Prepared for

Port of Anacortes
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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) establishes the quality assurance (QA) objectives for soil, sediment, and groundwater sampling and sediment biological toxicity testing associated with the remedial investigation (RI) at the Cap Sante Marine site (site) located in Anacortes, Washington. Data from the RI will supplement the existing data collected as part of the Environmental Due Diligence Investigations (Floyd Snyder and McCarthy 2004 and Floyd|Snider 2005) to evaluate appropriate and protective remedial alternatives in the Feasibility Study (FS). This plan presents the quality control (QC) procedures developed to meet project QA objectives. Soil, groundwater, and sediment sampling QC procedures and QA criteria are described in Sections

1.1 DATA QUALITY OBJECTIVES

The overall data quality objectives (DQOs) for this project are to develop and implement procedures that will ensure collection of representative data of known, acceptable, and defensible quality. The data quality parameters used to assess the acceptability of the data are precision, accuracy, representativeness, comparability, and completeness. There parameters are discussed in the following sections.

1.1.1 PRECISION

Precision measures the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average values. Analytical precision is measured through matrix spike/matrix spike duplicate (MS/MSD) samples for organic analysis and through laboratory duplicate samples for inorganic analyses.

Analytical precision measurements will be carried out on project-specific samples at a minimum frequency of 1 per sampling event or 1 in 20 samples, whichever is more frequent per matrix analyzed, as practical. Laboratory precision will be evaluated against quantitative relative percent difference (RPD) performance criteria provided by the laboratory.

Field precision will be evaluated by the collection of blind field duplicates at a minimum frequency of 1 per laboratory analysis group or 1 in 20 samples. Control limits for the field duplicates will be 20 percent for groundwater and 35 percent for soil and sediment unless the duplicate sample values are within five times the reporting limit, in which case the control limit interval will be plus or minus the reporting limit for water, and plus or minus two times the reporting limit for soil.

Precision measurements can be affected by the nearness of a chemical concentration to the method detection limit, where the percent error (expressed as RPD) increases. The equation used to express precision is as follows:

$$RPD = \left| \frac{D_1 - D_2}{(D_1 + D_2)/2} \right| x\ 100$$

where: D_1 = first sample value

D_2 = second sample value (duplicate).

1.1.2 ACCURACY

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Field accuracy is controlled by adherence to sample collection procedures as outlined.

Analytical accuracy may be assessed by analyzing "spiked" samples with known standards (surrogates, laboratory control samples, and/or matrix spike) and measuring the percent recovery. Accuracy measurements on matrix spike samples will be carried out at a minimum frequency of 1 in 20 samples per matrix analyzed. Because MS/MSDs measure the effects of potential matrix interferences of a specific matrix, the laboratory will perform MS/MSDs only on samples from this investigation and not from other projects. Surrogate recoveries will be determined for every sample analyzed for organics.

Laboratory accuracy will be evaluated against quantitative matrix spike and surrogate spike recovery performance criteria provided by the laboratory. Accuracy can be expressed as a percentage of the true or reference value, or as a percent recovery in those analyses where reference materials are not available and spiked samples are analyzed. The equation used to express accuracy is as follows:

$$\text{Percent Recovery} = \frac{(\text{Spiked Sample Result} - \text{Unspiked Sample Result})}{\text{Amount of Spike Added}}\ x\ 100$$

Control limits for percent recovery for soil and groundwater samples will be laboratory acceptance limits generated according to U.S. Environmental Protection Agency (EPA) guidelines. Control limits for percent recovery for sediment samples will be as specified in Washington State Department of Ecology's (Ecology) *Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards* (Ecology 2003).

1.1.3 REPRESENTATIVENESS

Representativeness expresses the degree to which data accurately and precisely represent an actual condition or characteristic of a population. Representativeness can be evaluated using replicate samples, representative sampling locations, and blanks. Representativeness for the RI sampling will be accomplished using appropriate selection of sampling location and collection of field equipment blanks for nondedicated sampling equipment and analyzing method blanks to verify that the analytical results are representative of the sampled item and not influenced by cross-contamination.

1.1.4 COMPARABILITY

Comparability expresses the confidence with which one data set can be evaluated in relation to another data set. For this work, comparability of data will be established through the use of standard analytical methodologies and reporting formats and of common traceable calibration and reference materials.

1.1.5 COMPLETENESS

Completeness is a measure of the proportion of data obtained from a task sampling plan that is determined to be valid. It is calculated as the number of valid data points divided by the total number of data points requested. The QA objective for completeness during this project will be 95 percent. Completeness will be routinely determined and compared to this control criteria.

1.2 FIELD AND LABORATORY QUALITY CONTROL PROCEDURES

This section describes the procedures that will be implemented to: 1) ensure sample integrity from the time of sample collection to the time of analysis in the laboratory; 2) obtain the appropriate chemical and physical data; 3) collect field and laboratory quality control samples; 4) monitor performance of the laboratory and field measurement systems; 5) correct any deviations from the methods or QA requirements established in this QAPP; and 6) report and validate the data.

1.2.1 FIELD EQUIPMENT CALIBRATION

Field meters, including pH, conductivity, dissolved oxygen, temperature probes, and PID will be calibrated and maintained in accordance with the manufactures specifications. All routine maintenance will be recorded in the field sampling logs.

1.2.2 FIELD DOCUMENTATION

A complete record of all field activities will be maintained for the duration of the field phase of the work. Documentation will include the following:

- Daily recordkeeping by field personnel of all field activities
- Recordkeeping of all samples collected for analysis (field sampling forms)
- Use of sample labels and tracking forms for all samples collected for analysis.

The field logs will provide a description of all sampling activities, sampling personnel, weather conditions, and a record of all modifications to the procedures and plans identified in the work plan. The field logs are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the sampling period.

Sample possession and handling will also be documented so that it is traceable from the time of sample collection to the laboratory and data analysis. Sample Chain-of-Custody (COC) Records and procedures are described in Section 2.8 of the Sampling and Analysis Plan (SAP) provided in Appendix A of this work plan.

1.2.3 SAMPLE HANDLING PROCEDURES AND TRANSFER OF CUSTODY

Samples submitted to the analytical laboratories will be collected in the appropriate sample containers and preserved as specified in Table A-1 of the SAP (Appendix A of this work plan). The storage temperatures and maximum holding times for physical/chemical analyses are also presented in Table A-1.

The transportation and handling of groundwater samples will be accomplished in a manner that not only protects the integrity of the sample, but also prevents any detrimental effects due to release of samples. Samples will be logged on a COC form (Figure B-1) and will be kept in coolers on ice until delivery to the analytical laboratory. The COC will accompany each shipment of samples to the laboratory. Procedures for sample transportation and handling are described in Section 2.7 of the SAP (provided in Appendix A of this work plan).

1.2.4 FIELD AND LABORATORY QUALITY CONTROL SAMPLES

Field and analytical laboratory control samples will be collected to evaluate data precision, accuracy, representativeness, completeness, and comparability of the analytical results for this investigation. A summary of the quality control samples and the frequency at which they will be collected and/or analyzed is described in the following subsections.

1.2.4.1 Blind Field Duplicates

A blind field duplicate will be collected at a frequency of at least 1 per 20 samples per sample type per chemical analysis, not including QC samples, but not less than one field duplicate per sampling event (any continuous sampling period not interrupted by more than 2 days). The blind field duplicate will consist of a split sample collected at a single sample location. Except for soil and sediment samples collected for volatile organic compounds (VOCs) or gasoline analysis, soil and sediment samples will be homogenized by mixing in a stainless-steel bowl, split into duplicate sample containers, and submitted blind to the laboratory as discrete samples. No soil or sediment blind field duplicate samples will be collected for VOC or gasoline analysis. Groundwater blind field duplicates will be collected by alternately filling sample containers for both the original and the corresponding duplicate sample at the same location to decrease variability between the duplicates. Blind field duplicate sample results will be used to evaluate data precision.

1.2.4.2 Field Trip Blanks

Field trip blanks will consist of deionized water sealed in a sample container by the analytical laboratory. The trip blank will accompany VOCs; volatile petroleum hydrocarbon (VPH); and gasoline-range petroleum hydrocarbon (NWTPH-G) sample containers for soil, sediment, and groundwater samples during transportation to and from the field, and then will be returned to the laboratory with each shipment of VOC, VPH, and NWTPH-G samples. The trip blank will remain unopened until submitted to the laboratory for analysis of VOCs, VPH, and NWTPH-G. One trip blank per cooler containing samples for VOC, VPH, and NWTPH-G analysis will be evaluated to determine possible sample contamination during transport.

1.2.4.3 Laboratory Matrix Spike

A minimum of 1 laboratory matrix spike per 20 samples, not including QC samples, or 1 matrix spike sample per batch of samples if fewer than 20 samples are obtained, will be analyzed for all constituents except dioxins/furans. The matrix spikes will be performed using a project sample. These analyses will be performed to provide information on accuracy and to verify that extraction and concentration levels are acceptable. The laboratory spikes will follow EPA guidance for matrix and blank spikes.

1.2.4.4 Laboratory Matrix Spike Duplicate

A minimum of 1 laboratory matrix spike duplicate per 20 samples, not including QC samples, or one matrix spike duplicate sample per batch of samples if fewer than twenty samples are obtained, will be analyzed for all constituents except metals. These analyses will be performed to provide information on the precision of chemical analyses. The laboratory spikes will follow EPA guidance for matrix and blank spike duplicates.

1.2.4.5 Laboratory Duplicates

A minimum of 1 laboratory duplicate per 20 samples, not including QC samples, or 1 laboratory duplicate sample per batch of samples if fewer than 20 samples are obtained, will be analyzed for metals. These analyses will be performed to provide information on the precision of chemical analyses. The laboratory duplicate will follow EPA guidance in the method.

1.2.4.6 Laboratory Triplicates

A minimum of 1 laboratory triplicate per 20 sediment samples, not including QC samples, or 1 laboratory triplicate sample per batch of samples if fewer than 20 samples are obtained, will be analyzed for grain size; total organic carbon (TOC); and total solids. Laboratory triplicates will not be collected for soil and groundwater samples.

1.2.4.7 Laboratory Method Blanks

A minimum of 1 laboratory method blank per 20 samples, 1 every 12 hours, or 1 per batch of samples analyzed (if fewer than 20 samples are analyzed) will be analyzed for all parameters (except grain size and total solids) to assess possible laboratory contamination. Dilution water will be used whenever possible. Method blanks will contain all reagents used for analysis. The generation and analysis of additional method, reagent, and glassware blanks may be necessary to verify that laboratory procedures do not contaminate samples.

1.2.4.8 Laboratory Control Sample

A minimum of 1 laboratory control sample per 20 samples, not including QC samples, or 1 laboratory control sample per sample batch if fewer than 20 samples are obtained, will be analyzed for all parameters, except grain size and total solids.

1.2.4.9 Surrogate Spikes

All project samples analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined by the analytical methods.

1.2.5 SAMPLE ANALYSIS

Analytical procedures for the chemical analysis of soil, sediment, and groundwater samples collected during this investigation will include petroleum hydrocarbons; VOCs; carcinogenic polycyclic aromatic hydrocarbons (PAHs); metals (copper, lead, chromium, and zinc); chloride; polychlorinated biphenyls (PCBs); and conventional parameters (including total solids, grain size, and TOC). Laboratory chemical analyses will be conducted by an Ecology-certified laboratory.

Standard EPA sample preparation, cleanup, and analytical methods will be used for most chemical analyses, with the exception of petroleum hydrocarbons and some conventional parameters. An acid/silica gel cleanup will be applied to all soil samples analyzed for diesel-range and motor oil-range petroleum hydrocarbons by Ecology Method NWTPH-Dx. Cleanup procedures and analytical methods for TPH analyses described in Ecology's publication *Analytical Methods for Petroleum Hydrocarbons* (Ecology 1997), including the use of gas chromatogram calibration standards that have undergone acid/silica-gel cleanup, will be strictly adhered to by the laboratory. PSEP recommended guidelines for the measurement of conventional parameters in sediment will also be followed (PSEP 1986; 1997a,b). Sample preparation methods, cleanup methods, and analytical methods are summarized in Table A-1 of the SAP (Appendix A of this work plan). The laboratory QAPPs and standard operating procedures (SOP) will provide data quality procedures according to the protocols for the analytical method and cleanup steps, and at a level sufficient to meet the sampling program DQOs.

1.2.6 REPORTING LIMITS

The reporting limits for each chemical analysis are summarized in Table A-2 of the SAP (Appendix A of this work plan). These reporting limits are targeted to be lower than this preliminary cleanup levels presented in Section 3.1 of this work plan. The reporting limits listed are goals only, insofar as instances may arise where high sample concentrations, non-homogeneity of samples, or matrix interferences preclude achieving the desired reporting limit and associated QC criteria. In such instances, the laboratory will report the reasons for deviations from these reporting limits.

1.3 DATA REDUCTION, VALIDATION, AND REPORTING

Sufficient backup data and QC results to enable reviewers to determine the quality of the data will accompany project analytical reports from the laboratory. The Landau Associates quality assurance officer (QAO) for this project is responsible to the project manager for conducting checks for internal consistency, transmittal errors, laboratory protocols, and for complete adherence to the QC elements in this work plan. The QAO will also prepare a laboratory data quality evaluation report, based on appropriate sections of the EPA validation guidelines (EPA 1994a,b). This report will include evaluations of the following:

- Chain-of-custody methods
- Holding times
- Laboratory method blanks
- Surrogate recoveries
- Laboratory matrix spikes and matrix spike duplicates
- Blank spikes and blank spike duplicates
- Laboratory duplicates
- Completeness
- Overall assessment of data quality.

1.4 BIOLOGICAL ANALYSES QUALITY CONTROL PROCEDURES

The detailed bioassay procedures for this study can be provided on request. The following sections discuss and summarize the components of the bioassay QA/QC program.

1.4.1 PROJECT-SPECIFIC STANDARD OPERATING PROCEDURES

Three sediment toxicity tests (bioassay) will be conducted on the samples:

- Acute 10-day amphipod mortality (*Rhepoxynius abronis, Eohaustoris estuaries, Ampelisca abdita*)
- Acute larval mortality/abnormality (*Strongylocentrotus purpuratus, Strongylocentrotus droebachiensis*, or *Dendraster excentricus*)
- Chronic 20-day juvenile polychaete growth rate (*Neanthes arenoceodentata*)

Each of these tests is also described in Section 2.1.5 of the SAP (provided in Appendix A of this work plan).

1.4.2 TOXICITY TEST QUALITY CONTROL

All three sediment toxicity tests will incorporate standard QA/QC procedures to ensure that the test results are valid. Standard QA/QC procedures include the use of negative controls, positive controls, reference sediment samples, laboratory replicates, and measurements of water quality during testing.

The negative control to be used for the sediment toxicity test will be a clean control, which consists of a clean, inert material and the same diluent seawater used in testing sediment toxicity.

The positive control to be used for the sediment toxicity test will be a toxic control in which a reference toxicant is used to establish the relative sensitivity of the test organism. The positive control for sediment tests is typically conducted with diluent seawater and without sediment. Sodium dodecyl sulfate will be used as the reference toxicant in the larval tests. Cadmium chloride will be used as the reference toxicant for the amphipod and juvenile polychaete tests.

In addition to the positive control described above, an additional positive control may be conducted using ammonia. Ammonia may be present in marine sediments and can be a significant cause of toxicity observed in toxicity tests. The purpose of the ammonia-positive control is to determine the toxicity of ammonia to the test organisms. Of the three test organisms, the polychaete *Neanthes arenaceodentata* is relatively insensitive to environmental concentrations of ammonia, while both the amphipod and the larval stages of the bivalve can be sensitive to concentrations observed in the environment. For this reason, a positive control may be conducted for only the amphipod and bivalve larval tests. A sediment-spiked ammonia reference toxicant test will be used for the amphipod test series. In addition to these standard ammonia measurements, test chamber interstitial ammonia levels will be evaluated prior to initiating and at the termination of both the amphipod and juvenile polychaete tests. If interstitial ammonia levels are greater than or equal to 20 mg/L, then a purging procedure will be followed until interstitial ammonia levels that are below this limit. For the larval test, test chambers will be aerated if unionized ammonia concentrations exceed 0.014 mg/L in test waters (PSEP 1995).

A reference sediment sample will also be included with each toxicity test series. Reference sediments provide toxicity data that can be used to separate toxicant effects from unrelated effects, such as those of sediment grain size. They are also used in statistical comparisons to determine if test sediments are toxic. Sediment samples selected to be the test reference sediment should be collected from an area documented to be free from chemical contamination and should represent the range of important natural, physical, and chemical characteristics of the test sediments (specifically, sediment grain size and TOC). The Puget Sound Reference Areas survey was conducted by EPA and Ecology (PSDDA 1989) to document suitable reference conditions in Puget Sound and define reference area performance standards. Based on the results of this survey, Sammish Bay will be utilized as the biological reference site and will form the basis for assessing compliance with the biological criteria. This reference area was selected for

the following reasons: 1) availability of chemical and biological data to document suitability of the reference site, 2) geographic locations, and 3) broad range of grain size distributions available to match those anticipated within the site.

Five laboratory replicates of each test sediments, reference sediments, and negative controls will be run for each bioassay. Bioassays require that proper water quality conditions be maintained to ensure survival of the organisms, and to ensure that undue stress is not exerted on the organisms unrelated to test sediments. Salinity, dissolved oxygen, pH, ammonia, total sulfides, and temperature will be measured to monitor water quality during testing.

1.4.3 QA/QC PERFORMANCE STANDARDS

The amphipod bioassay test will be performed according to the procedures and QA/QC performance standards described in PSEP (1995) as revised by subsequent agency-approved updates and as described in sub-appendix D of the Sampling and Analysis Plan Appendix (SAPA; Ecology 2003), with survival as the endpoint. These standards are defined as a maximum of 10 percent mortality in control treatments and less than 25 percent mortality in treatments using reference sediment.

The juvenile polychaete bioassay test will be performed according to the procedures and QA/QC performance standards described in PSEP protocols (PSEP 1995) and as described in sub-appendix D of the SAPA (Ecology 2003), with survival and growth as the endpoint. The growth rate of organisms exposed to test sediments is compared to the growth rate of organisms in reference sediments. The control sediment has a performance standard of 10 percent mortality. The reference sediment has a performance standard of 80 percent of the control growth rate. The control growth rate guideline is 0.38 mg/individual/day. The test will be performed according to the procedures and QA/QC performance standards described in PSEP protocols (PSEP 1995) as revised by subsequent agency-approved updates and as described in sub-appendix D of the SAPA (Ecology 2003). These standards are defined as an initial worm weight within the range 0.5-1.0 mg (Ecology 1995), a maximum of 10 percent mortality in control treatments and mean individual growth of ≥ 0.38 mg/ind/day, on a dry weight basis (PSDDA 1996). The reference sediment will have a mean individual growth rate that is at least 80 percent of the mean individual growth rate found in control sediment.

The larval development bioassay test protocols and QA/QC performance standards will be in accordance with PSEP (1995) as revised by subsequent agency-approved updates and as described in sub-appendix D of the SAPA (Ecology 2003). The seawater control has a performance standard of less than 30 percent combined abnormality and mortality (i.e., a 70 percent normal survivorship). The reference sediment has a performance standard of less than 35 percent effective mortality normalized to seawater control (i.e., a 65 percent normal survivorship of seawater control result).

1.4.4 DATA DELIVERABLES

The laboratories will be responsible for internal checks on data reporting and will correct errors identified during the quality assurance review. The toxicity testing for this study will be required to report results that are supported by all information recommended by PSEP protocols for quality assurance review, including:

- A cover letter discussing analytical problems (if any) and procedures
- Sources of test organisms and control sediment
- Test methods used for biological testing and statistical analyses
- Protocol references and description of any nonstandard procedures
- Results for survival, growth, reburial, abnormalities, water quality parameters, reference toxicants, and statistical analyses, as appropriate
- Original data sheets for water quality, survival, growth, reburial, abnormalities, reference toxicant, and statistics
- Identification for each control, reference, and sample duplicate
- Original quality control checklists
- Chain-of-custody records.

Close contact with the laboratories will be maintained to resolve any quality control problems in a timely manner.

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Chain-of-Custody Record

Date _____

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Project Name _____ Project No. _____

Project Location/Event _____

Sampler's Name _____

Project Contact _____

Send Results To _____

Testing Parameters

Turnaround Time
☐ Standard
☐ Accelerated
☐ _____

Sample I.D.	Date	Time	Matrix	No. of Containers	Observations/Comments
					___ Allow water samples to settle, collect aliquot from clear portion
					NWTPH-Dx: ___ run acid wash/silica gel cleanup ___ run samples standardized to _____ product
					___ Analyze for EPH if no specific product identified
					VOC/BTEX/VPH (soil): ___ non-preserved ___ preserved w/methanol ___ preserved w/sodium bisulfate ___ Freese upon receipt
					___ Dissolved metal water samples field filtered
					Other _____

Special Shipment/Handling or Storage Requirements

Method of Shipment

Relinquished by	**Received by**	**Relinquished by**	**Received by**
Signature	Signature	Signature	Signature
Printed Name	Printed Name	Printed Name	Printed Name
Company	Company	Company	Company
Date _____ Time _____	Date _____ Time _____	Date _____ Time _____	Date _____ Time _____

WHITE COPY - Project File **YELLOW COPY - Laboratory** **PINK COPY - Client Representative**

Rev 4/01

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Cap Sante Marine
Anacortes, Washington

Chain-of-Custody Form

Figure
B-1