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Pacific Northwest National Laboratory
Operated by Battelle for the
U.S. Department of Energy

Metals Verification Study for Sinclair and Dyes Inlets, Washington

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Prepared for the
Puget Sound Naval Shipyard and
Intermediate Maintenance Facility
Project ENVVEST
Bremerton, Washington

under Contract DE-AC06-76RLO 1830
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SUMMARY

Sinclair and Dyes Inlets near Bremerton, Washington, are on the State of Washington's 1998 303(d) list of impaired waters because of fecal coliform contamination in marine water, metals in sediment and fish tissue, and organics in sediment and fish tissue. Because significant cleanup and source control activities have been conducted in the inlets since the data supporting the 1998 303(d) listings were collected, this Metals Verification Study was conducted to address the 303(d) segments that are listed for metal contaminants in marine sediment. The study was designed to obtain representative data on current sediment metals concentrations throughout Sinclair Inlet, Dyes Inlet, Port Orchard Passage, and Rich Passage, with stations spatially distributed to support 303(d) listing updates and also watershed-level water quality and contaminant transport modeling efforts. A total of 160 surface sediment samples from Sinclair Inlet, Dyes Inlet, Port Orchard Passage, and Rich Passage were screened for copper, lead, and zinc using X-ray fluorescence (XRF). Of these 160 samples, 40 samples (25%) were selected for confirmatory metals analysis by inductively coupled plasma mass spectroscopy (ICP-MS) for cadmium, silver, and arsenic in addition to copper, lead, and zinc. Regression relationships between the ICP-MS and XRF datasets were developed to estimate copper, lead, and zinc concentrations in all samples. The XRF results for copper, lead, and zinc correlated well with ICP-MS results, and predicted concentrations were calculated for all samples. The results of the Metals Verification Study show that sediment quality in Sinclair Inlet has improved markedly since implementation of cleanup and source control actions, and that the distribution of residual contaminants is limited to nearshore areas already within the actively managed Puget Sound Naval Shipyard Superfund Site where further source control actions and monitoring are underway. Outside of the immediate vicinity of the PSNS Superfund site in Sinclair Inlet, the target metals concentrations met state sediment quality standards.

CONTENTS

FIGURES

TABLES

1.0 INTRODUCTION

Sinclair and Dyes Inlets near Bremerton, Washington, are on the State of Washington's 1998 303(d) list of impaired waters because of fecal coliform contamination in marine water, metals in sediment and fish tissue, and organics in sediment and fish tissue (Ecology 2003) Sources of pollution include industry such as Puget Sound Naval Shipyard (PSNS) and Intermediate Maintenance Facility (IMF), publicly owned treatment works (POTW), combined sewer overflows, stormwater outfalls, marinas and private shipworks, and nonpoint source stormwater runoff. A partnership between the Navy, U.S. Environmental Protection Agency (EPA), state agencies, local governments, and the Suquamish Tribe was established to address water quality issues related to the PSNS and IMF facilities. This partnership, called Project ENVVEST (Environmental Investment), set a priority to address the development of total maximum daily loads (TMDLs) for the Sinclair and Dyes Inlets system. The first TMDL study initiated by Project ENVVEST was to support development of a fecal coliform TMDL for the inlets; the fecal coliform technical study is currently being completed. The second TMDL study being considered for execution is the development of a TMDL study plan for trace metals that exceed Washington State sediment quality standards (SQS) or minimum cleanup levels (MCUL). Future TMDL studies are planned that will address toxic organics in the sediment, mercury in sediment, nutrients and dissolved oxygen in the water column, and toxic chemicals in fish tissue.

The present Metals Verification Study for Sinclair and Dyes Inlets addresses the second ENVVEST priority: the 303(d) segments that are listed for metal contaminants in marine sediment. Most of the data supporting the 303(d) listings were collected in 1998 or earlier. Since those data were collected, significant cleanup and source control activities have been conducted in the inlets. The Metals Verification Study was conducted to provide recent metal concentration data for sediment throughout the study area and especially in the more contaminated areas where cleanup actions were implemented, to determine whether metals remain a source of sediment quality impairment.

1.1 Site History

The Sinclair and Dyes Inlets watershed (Figure 1) is home to the PSNS, located on Sinclair Inlet, an arm on the west side of Puget Sound. Sinclair Inlet is open to Puget Sound through the Port Orchard Passage, which extends northward along the west side of Bainbridge Island and through Rich Passage, which exits to the southeast (Figure 2). Immediately to the east of the PSNS, the Port Washington Narrows enters into Dyes Inlet (Figure 3). Sediment in both Sinclair and Dyes Inlets is the subject of this investigation.

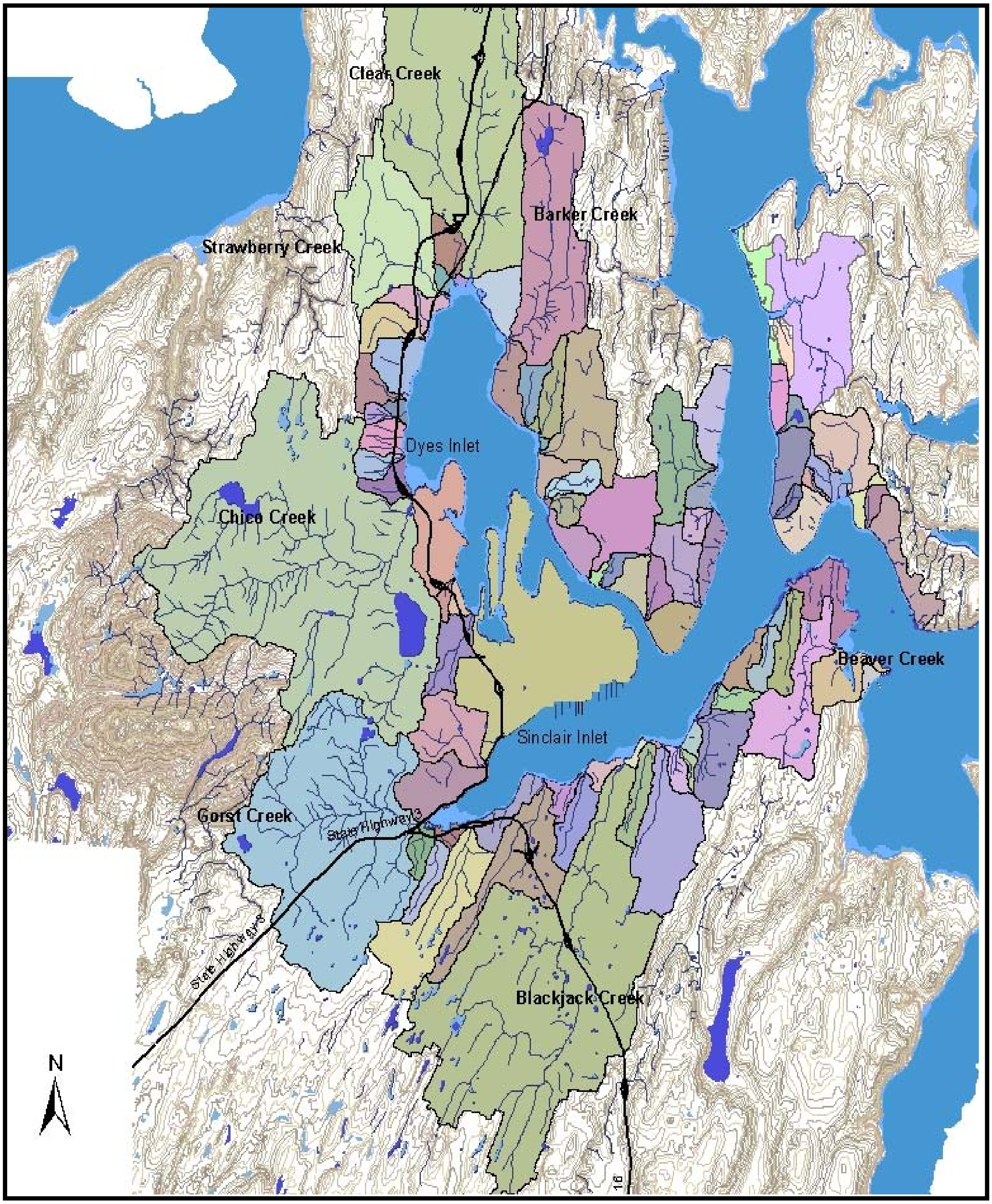

Figure 1. Sinclair and Dyes Inlet Study Area Showing Watershed Subbasins

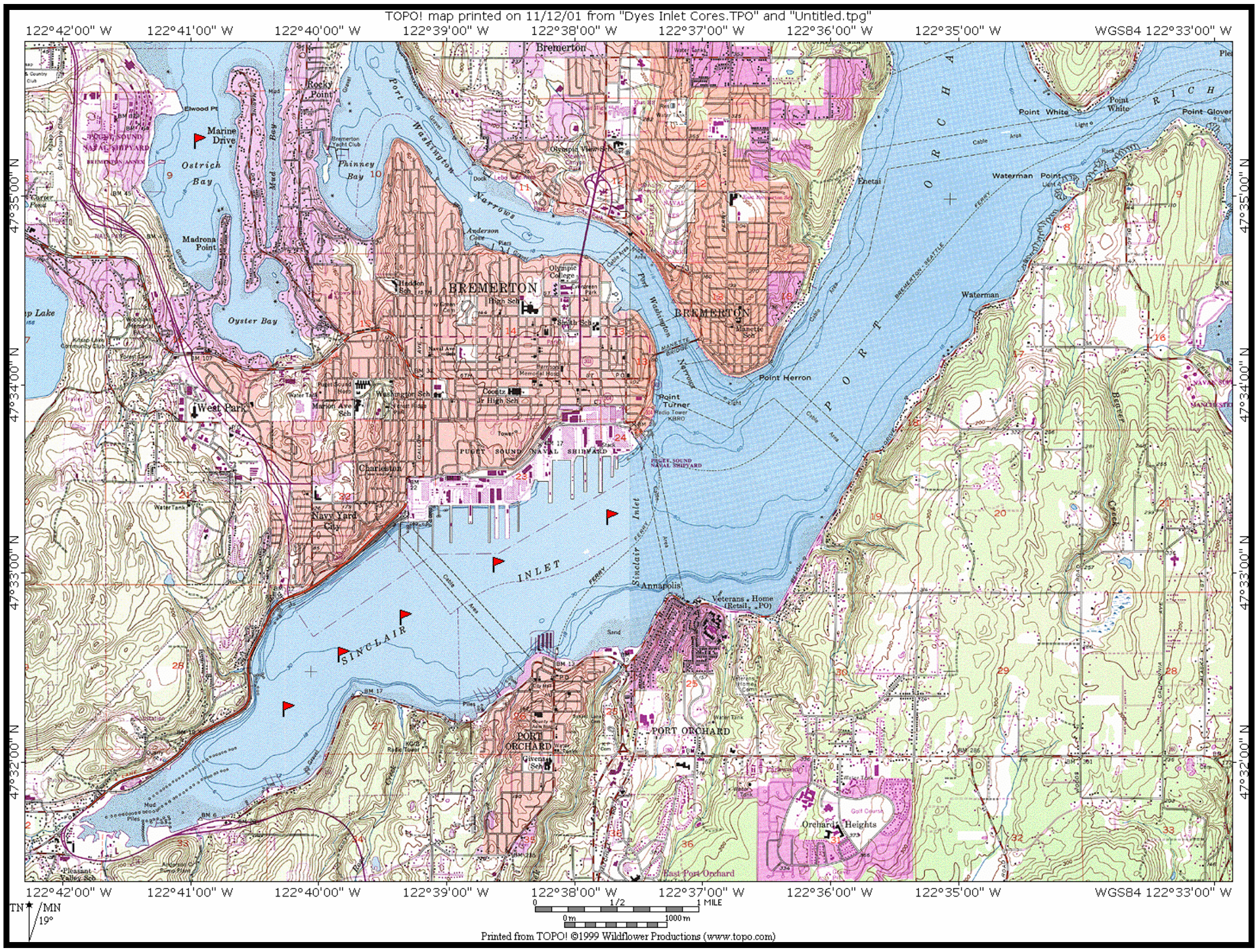

Figure 2. Sinclair Inlet and Surrounding Area

Previous studies indicated that marine sediment in Sinclair Inlet has been contaminated with heavy metals, polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons (PAHs). Contaminants released within the inlets as well as contaminants transported into the inlets from the greater Puget Sound will tend to accumulate in depositional areas (muddy sediment deposits) located within Sinclair and Dyes Inlets, Port Orchard Passage and Rich Passage. Historical geographic distributions have shown that PSNS was a significant source of the contamination (Katz et al., 1999; URS 2002a). Other sources include municipal wastewater, marinas, industrial and agricultural effluents, non-point source runoff, and atmospheric deposition. Storm water outfalls and combined sewer overflows (CSOs) discharge to Sinclair and Dyes Inlets and the Port Washington Narrows; those associated with the City of Bremerton and PSNS are shown in Figures 4 and 5.

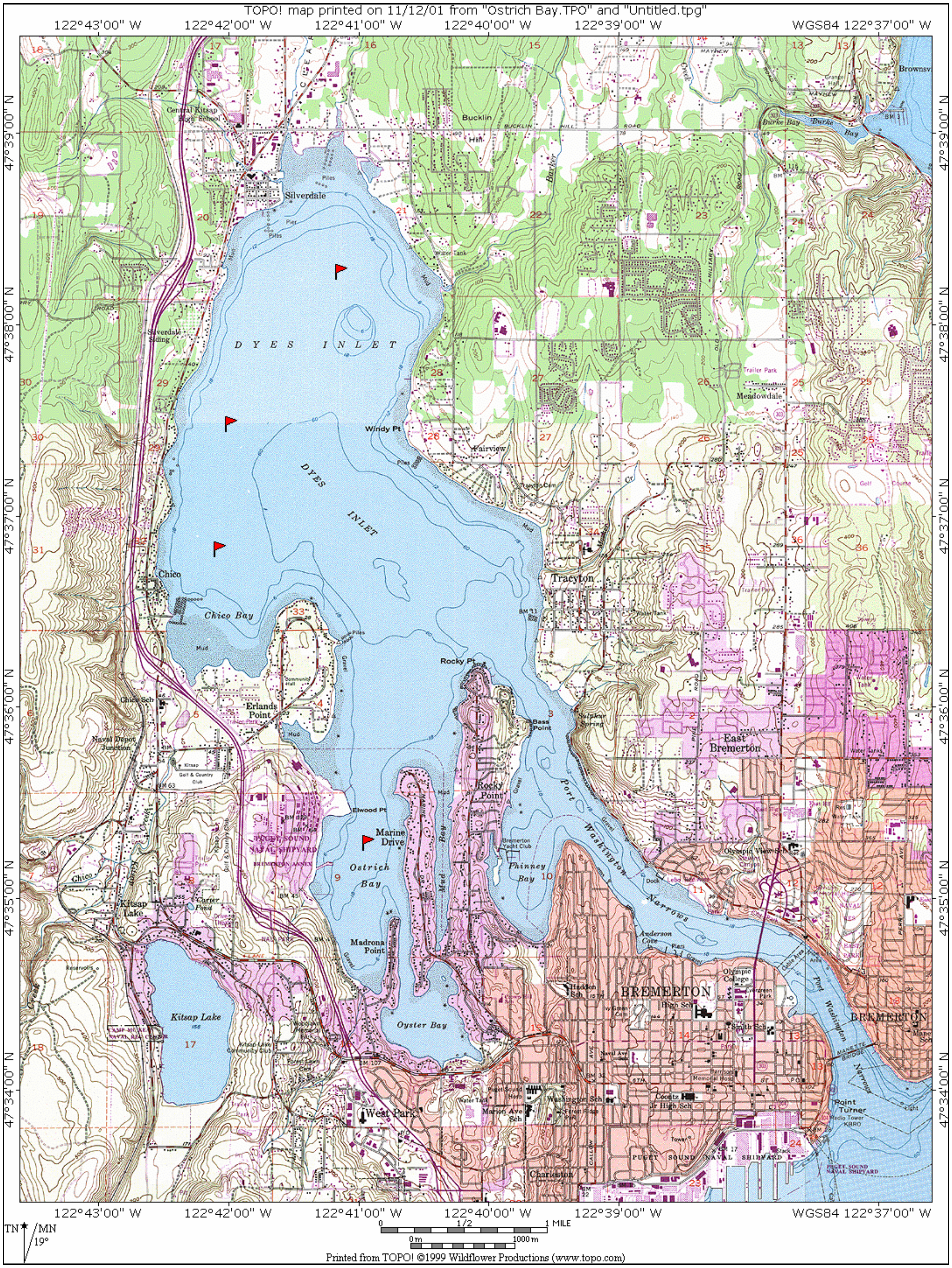

Figure 3. Dyes Inlet, Ostrich Bay, Port Washington Narrows, and Surrounding Area

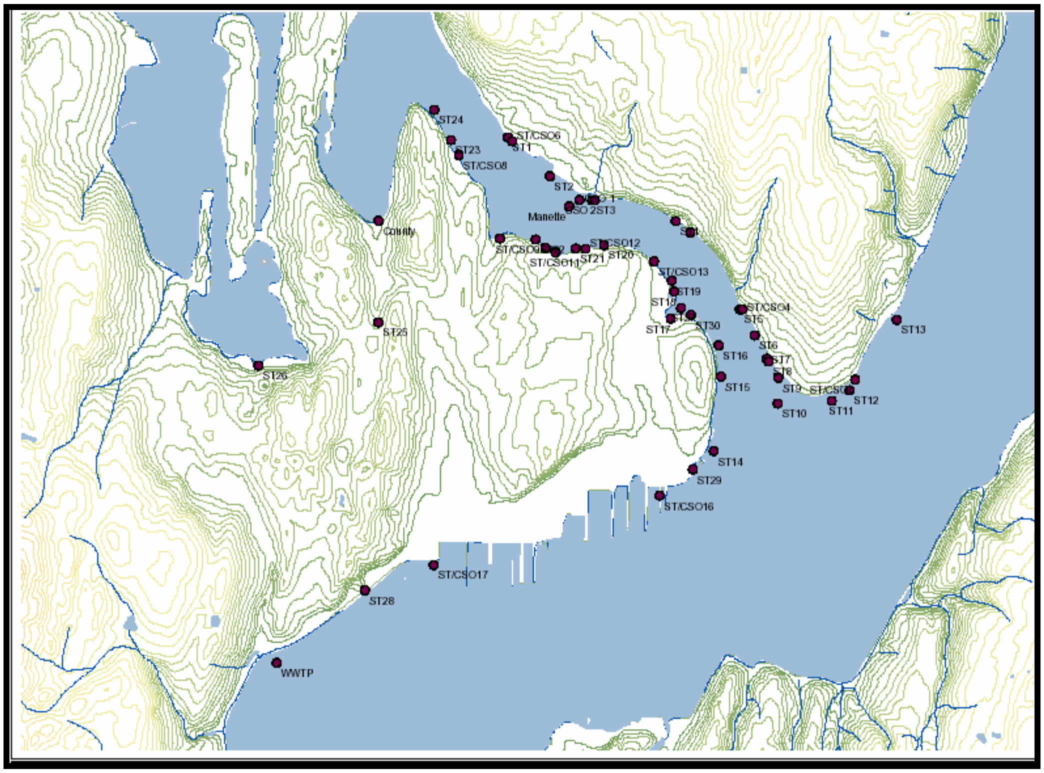

Figure 4. Storm Water Outfalls and Combined Sewer Overflows in the City of Bremerton

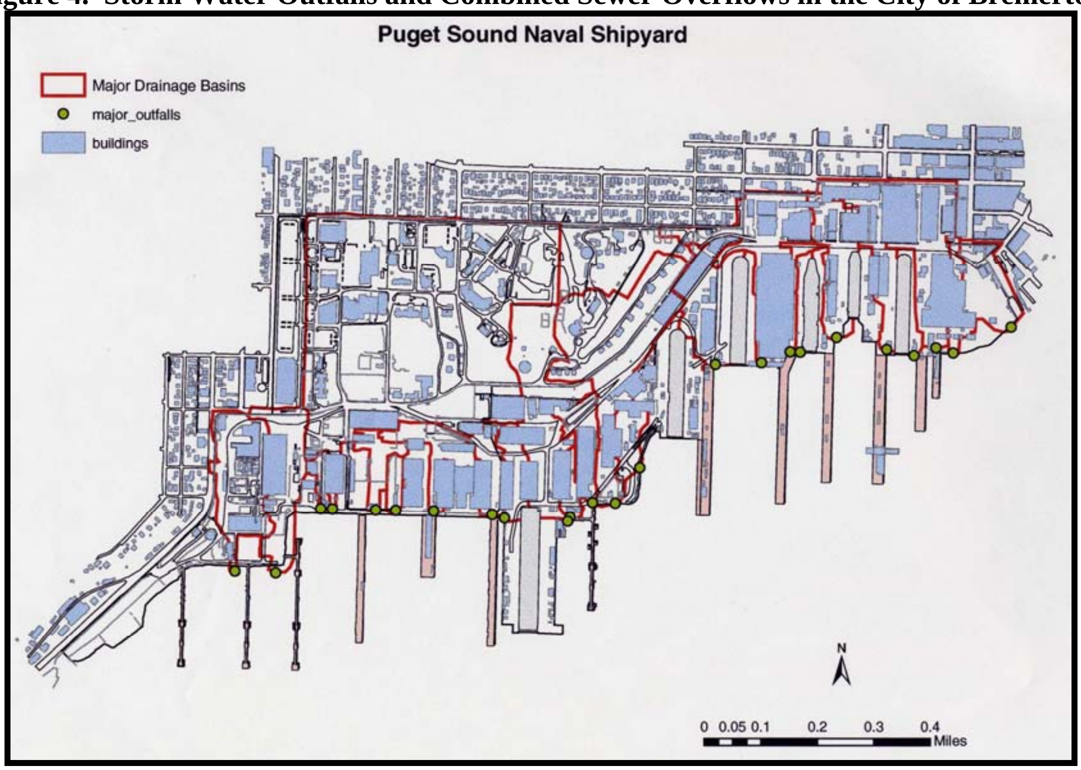

Figure 5. Buildings, Catch Basins, and Major Stormwater Outfalls Within the Bremerton Naval Complex

The 1998 303(d) list included arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), mercury (Hg), and zinc (Zn) in sediments of Sinclair Inlet and Cd, Hg, and silver (Ag) in the sediments of Dyes Inlet. Currently, two segments in Sinclair Inlet are listed for these metals of concern (47122F6F3 and 47122F6F4) and one in Dyes Inlet (47122F618). The 1998 303(d) listings were largely based on sediment data collected as part of remedial investigations and navigational dredging programs conducted for the Bremerton Naval Complex in Sinclair Inlet (U.S. Navy 2000a, 2003) and Jackson Park in Dyes Inlet (U.S. Navy 2000b). Most of the locations where existing sediment metals data exceed SQS are located immediately offshore of PSNS; the offshore sediment is part of a Superfund site and managed under the federal facilities Installation Restoration (IR) cleanup program by the Navy's Engineering Field Activity Northwest (EFANW). The marine sediment is designated as Operable Unit (OU) B Marine. Significant contaminated sediment removal and capping activities were performed in OU B Marine in 2000-2001. Post-remediation monitoring was planned, with the first round of monitoring sampling occurring in fall 2003.

1.2 Metals Verification Study Background and Objectives

During development of the metals TMDL study plan, the Project ENVVEST Technical Team conducted a review of the available sediment and water quality information for Sinclair and Dyes Inlets (Diefenderfer et al. 2003). The findings of this review were as follows:

- Hydrodynamic modeling has shown significant exchange of water and transport of sediment between Sinclair and Dyes Inlets; therefore, the two inlets should be treated as a single water body with respect to the TMDL study plan development. This is similar to the approach adopted for the fecal coliform TMDL study for the inlets.
- In the last decade, significant source control (pollution prevention, hazardous waste minimization, CSO reduction, remediation, etc), sediment cleanup, dredging, and capping activities have taken place in Sinclair Inlet, but much of the sediment chemistry data on which most of the 303(d) listings are based were collected prior to these activities.
- Two segments in Sinclair Inlet and one segment in Dyes Inlets are currently on the 1998 303(d) list because one or more metals (As, Cd, Cu, Pb, Ag, Zn, and/or Hg) exceeded the Washington State SQS or MCUL (Washington State 1995)

The technical team concluded that the sediment data on which the 303(d) listings were based may not be representative of the present-day sediment conditions in Sinclair and Dyes Inlets, and recommended that representative data be collected before continuing work on the metals TMDL study plan. Furthermore, data that are spatially representative of the Sinclair and Dyes Inlet watershed are needed to support watershed-level contaminant modeling, which would also support TMDL development. The schematic diagram in Figure 6 shows how such data would be used to verify the need for metals TMDL planning.

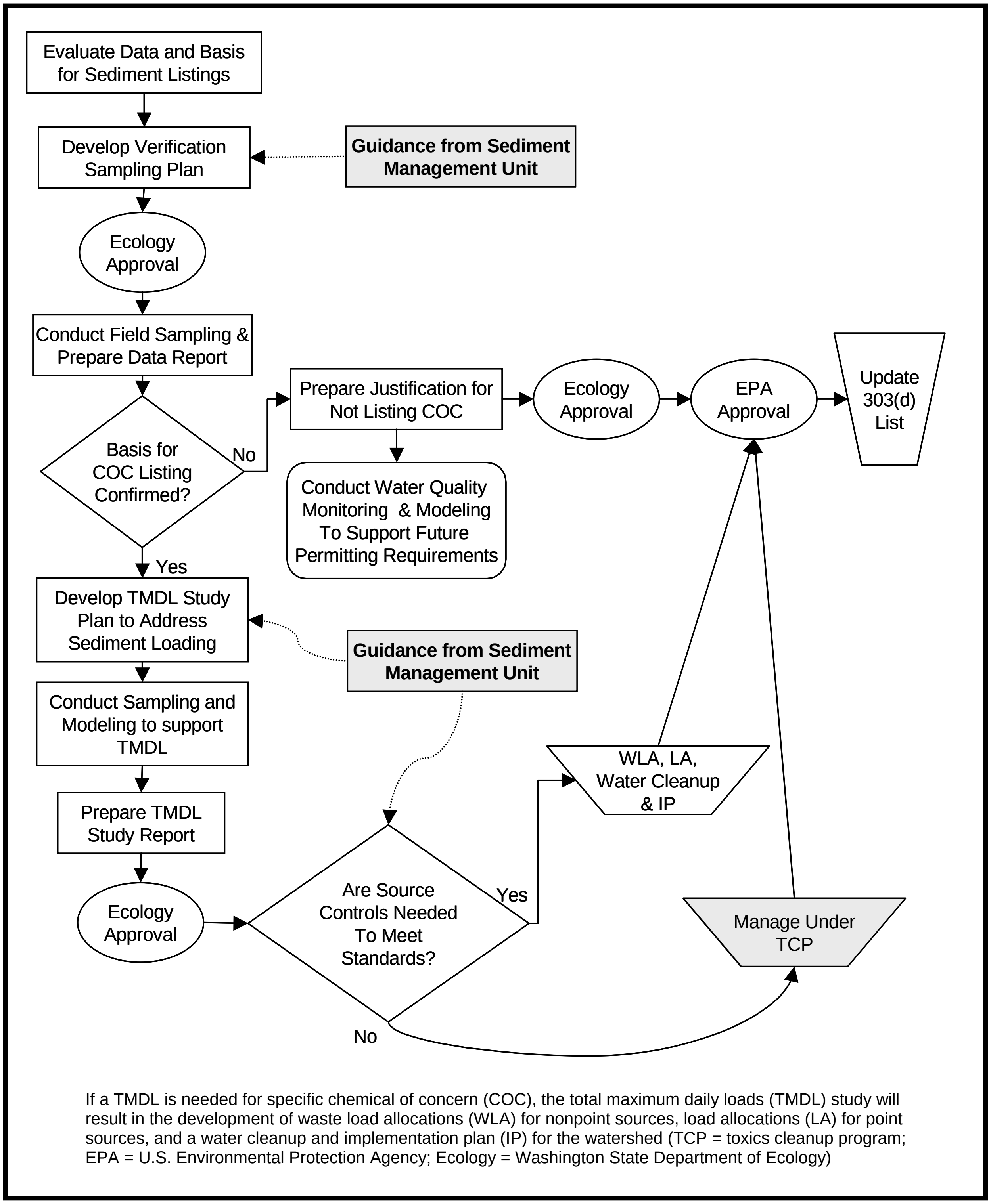

Figure 6. Schematic Drawing of the process to assess 303(d) metals listings in Sinclair and Dyes Inlets, Washington

ENVVEST proceeded to develop and implement a sampling analysis plan for the Metals Verification Study ("develop verification sampling plan" step in Figure 6), the results of which are presented in this report. The Metals Verification Study was designed to answer the following questions:

- Have sediment metals concentrations in Sinclair and Dyes Inlets decreased since cleanup and source reduction actions?
- Do present-day concentrations of metals in Sinclair and Dyes Inlet sediment still exceed Washington State Sediment Quality Standards?
- If so, where? Should sediment remain on the 303(d) list because of metals?

Because the 303(d) listings for metals in Sinclair and Dyes Inlets are primarily due to sediment concentrations, the Metals Verification Study was guided by state sediment management sampling and analysis requirements to assure collection of appropriate samples and data with which to meet the state Water Quality Program Policy. In addition, hydrodynamic modeling has shown significant water exchange and sediment transport between Sinclair and Dyes Inlets. Another objective was to provide metals and particle size data to support contaminant loading, transport modeling, and sediment trends analysis throughout Sinclair and Dyes Inlets. The Metals Verification Study Sampling and Analysis Plan was presented to the Washington State Department of Ecology (Ecology), the U. S. Environmental Protection Agency (EPA), and other ENVVEST parties in July 2003; the plan was approved by Ecology in August 2003 (Kohn et al. 2003).

2.0 METHODS

The Metals Verification Study approach was to collect and analyze surface sediment samples from throughout Sinclair and Dyes Inlets and the adjoining water bodies (Port Orchard Passage and Rich Passage). The study design and approaches for outside and inside Sinclair Inlet are described in Section 2.1. Sample collection and chemical analysis procedures are described in Sections 2.2 and 2.3.

2.1 Metals Verification Study Design

The overall study design for the Metals Verification Study considered a variety of research needs, primarily the needs of the state 303(d) and sediment management programs but also the existing monitoring program for OU B Marine and potential contaminant transport modeling. Specific design considerations for station placement were as follows:

- Higher sampling density in areas affected by dredging and cleanup activities (OU B Marine, Sinclair Inlet, Ostrich Bay)
- Proximity to known or potential sources
- Minimum of three samples in each 303(d) segment listed for metals in sediment
- Locations with recent existing data (i.e., from ENVVEST Mass Balance Study)
- Spatial coverage to support short- and long-term contaminant transport modeling
- Depositional vs. erosional areas.

Inside Sinclair Inlet, the Metals Verification Study obtained splits of over 100 surface sediment samples collected by the PSNS OU B Marine monitoring program, which allowed ENVVEST to avoid duplication of sampling effort and focus on optimizing the sampling design for Dyes Inlet and Port Orchard Passage outside of Sinclair Inlet. Sampling designs both inside and outside Sinclair Inlet are described below and summarized in Table 1.

The Metals Verification Study employed a tiered analytical approach to metals analysis in the large number of sediment samples generated for the study. The first step was to conduct rapid screening for a subset of target metals, followed by confirmatory analysis for all target metals in approximately 25% of samples. Analytical methods and selection criteria for confirmatory samples are provided in Section 2.3.

2.1.1 Sampling Design for Sinclair Inlet, OU B Marine

In Sinclair Inlet, two segments are listed for metals in sediment on the 1998 303(d) list. A significant portion of the listed segments are within the boundary of PSNS OU B Marine, which is managed as a contaminated sediment site with oversight by Ecology's Sediment Management Unit. A sediment

Table 1. Metals Verification Study Design Summary for Sinclair and Dyes Inlets

Location	Objective(s)	Approach[a]	Number of Stations[b]
Sinclair Inlet, Inside PSNS OU-B	1. Present-day sediment quality in listed segments 47122F6F3 and 47122F6F4 that are within OU B boundary 2. Spatially representative data to support contaminant transport modeling in Sinclair & Dyes Inlets	Obtain and analyze an aliquot of OU-B Marine monitoring samples[a,b]	71
Sinclair Inlet, Outside PSNS OU-B	1. Present-day sediment quality throughout Sinclair Inlet, outside OU-B boundary 2. Spatially representative data to support contaminant transport modeling in Sinclair & Dyes Inlets		32
		Sinclair Inlet Subtotal	103
Dyes Inlet	1. Present-day sediment quality in listed segment 47122F6I8 (Ostrich Bay) 2. Spatially representative data to support contaminant transport modeling in Sinclair & Dyes Inlets	Stratified design with stations on triangular grid with random start point.	37
Port Washington Narrows	1. Data from potential source and depositional areas to support contaminant transport modeling in Sinclair & Dyes Inlets	Use existing data from outfalls sampled during Mass Balance Study	1 (Phinney Bay)
Port Orchard Passage at confluence of Port Washington Narrows and Sinclair Inlet	1. Spatially representative data to support contaminant transport modeling in Sinclair & Dyes Inlets	Stations on triangular grid with random start point within defined area of interest	17
North Port Orchard Passage and Rich Passage	1. Sediment quality of locations not impacted by contaminants from Sinclair and Dyes Inlets, to initialize model parameters	Existing ENVVEST stations or new judgment stations	4
		Dyes Inlet, Port Washington Narrows, Port Orchard & Rich Passages Subtotal[b]	51

a Analytical approach for all samples is to analyze all samples for metals by XRF rapid screening technique, then use ICP-MS to confirm metals concentrations in ~25% of samples.

b 103 Sinclair Inlet samples to be collected by EFA NW under OUB Marine Monitoring; samples outside of Sinclair Inlet to be collected by Battelle/ENVVEST team.

management plan (OU B Marine Monitoring Program) is in place for OU B; the proposed monitoring area extent covers all of Sinclair Inlet. Post-remediation monitoring for OU B Marine focused on the goals of the Record of Decision (ROD) (U.S. Navy 2000a). The goals of the ROD were to (1) reduce the area-weighted concentration of PCBs to the minimum cleanup goal of 3 mg PCB per 1 kg of organic carbon (3 mg PCB/kg OC) within 10 years; (2) selectively remove high concentrations of Hg collocated with PCBs; and (3) control shoreline erosion of contaminated fill (U.S. Navy 2000a).

The ENVVEST Metals Verification Study coordinated with the OU B Marine Monitoring Program to maximize sample distribution (high density) and data utility, and to take advantage of the monitoring program's sample collection effort. The OU B Marine monitoring design consisted of intensive grab sampling at three stations in each of 71 500-ft grids within the OU B Marine boundary (OUBM), and at three stations in each of 32 1500-ft grids throughout Sinclair Inlet outside the OU B Marine boundary (OOUB) (Figures 7 and 8). The 0- to 10-cm surface sediment interval from each of the three stations was combined to form a composite sample representing the grid in which the grabs were collected. Although the OU B Marine Monitoring Program spatially covered all of Sinclair Inlet, its analyte list did not include any of the target metals (As, Cd, Cu, Pb, Ag, or Zn). The Metals Verification Study obtained an aliquot of each OUBM and OOUB composite sample for target metal analysis.

2.1.2 Dyes Inlet, Ostrich Bay, Port Orchard Passage, and Rich Passage

A different sampling strategy was required in the portion of the Sinclair-Dyes Inlet study area that is not included in the OU B Marine Monitoring Program. In this area, only two segments off Jackson Park Housing Complex are presently listed. Therefore, sample collection in Dyes Inlet, Port Washington Narrows, and Port Orchard Passage outside of OU B Marine is primarily to support contaminant transport modeling efforts as well as verify ambient sediment quality in the study area. To adequately describe the sediment ecosystem in the model, more sampling data points are needed where sediment is expected to accumulate, because that is where metals concentrations are expected to be most variable. Sediment depositional areas may not be near known sources, but sediment transport into Dyes Inlet could result in higher concentrations in sediment areas removed from direct sources. Fewer sampling data points are needed in erosional areas and areas for which recent sediment data are available. Data from Port Orchard and Rich Passages are needed to initialize model parameters for the entire model domain.

A stratified random sampling design was developed with three strata defined as follows:

- 303(d)-listed segment(s) ⇒ highest sampling density
- Depositional areas or close to PSNS ⇒ moderate sampling density
- Non-depositional areas, passages, sample for spatial extent ⇒ lower sampling density

Within each stratum, sampling locations on a triangular grid from a random starting point were selected using Visual Sampling Plan software (Ver. 2) developed by Pacific Northwest National Laboratory (Figure 9). Ostrich Bay in the vicinity of Jackson Park was the only area outside of Sinclair Inlet in the highest sampling density stratum. The depositional west side of Dyes Inlet was considered the moderate-density sampling area; the remaining areas of Dyes Inlet, Port Orchard Passage, and Rich Passage all fell into the lower sampling density stratum. Figure 9 also shows the locations of "core and grab" stations for which recent metals data are available from the ENVVEST Mass Balance Study.

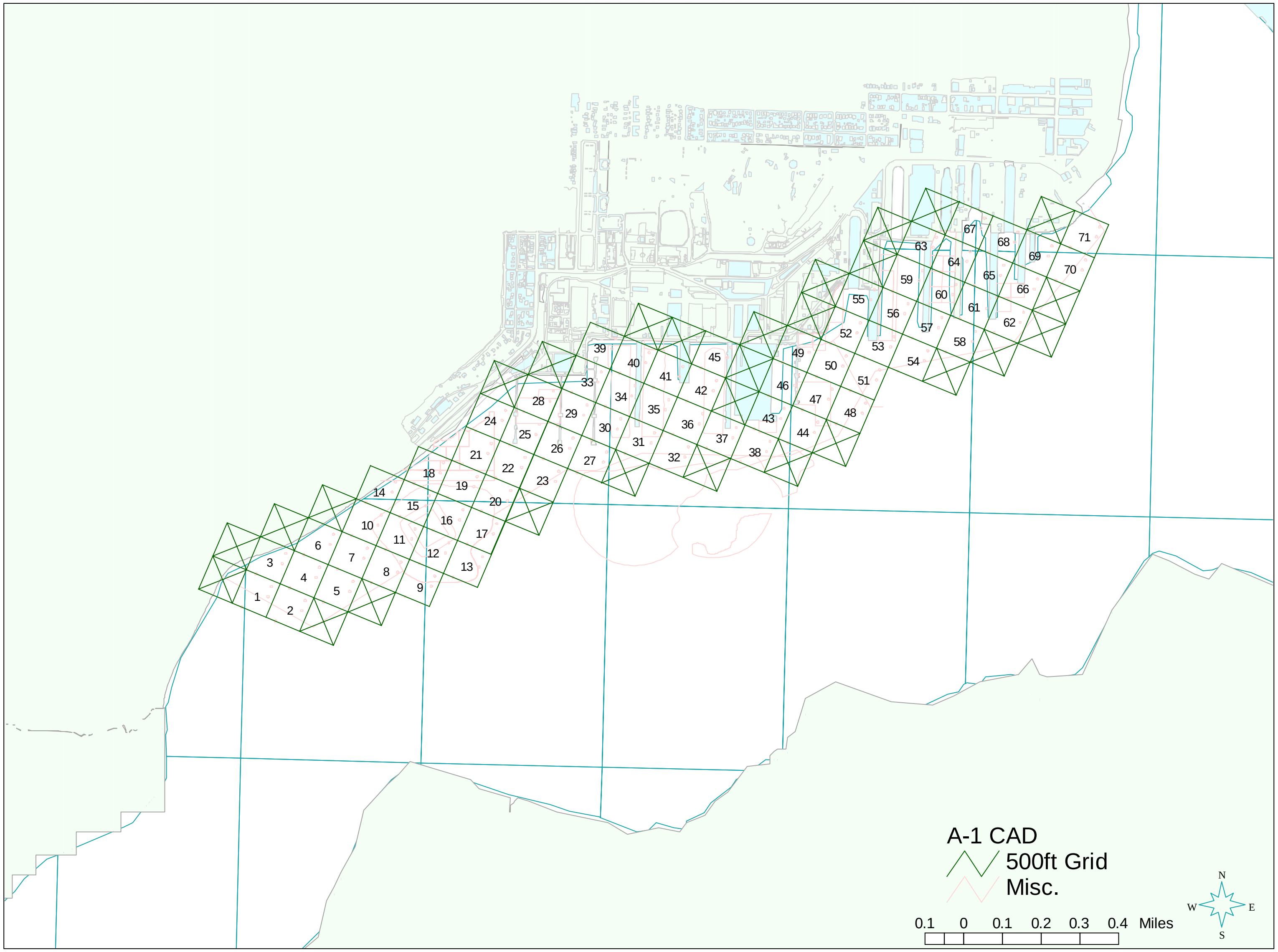

Figure 7. 500-ft monitoring grids within the OU B Marine boundary (OUBM), with 303(d) segment overlay (blue)

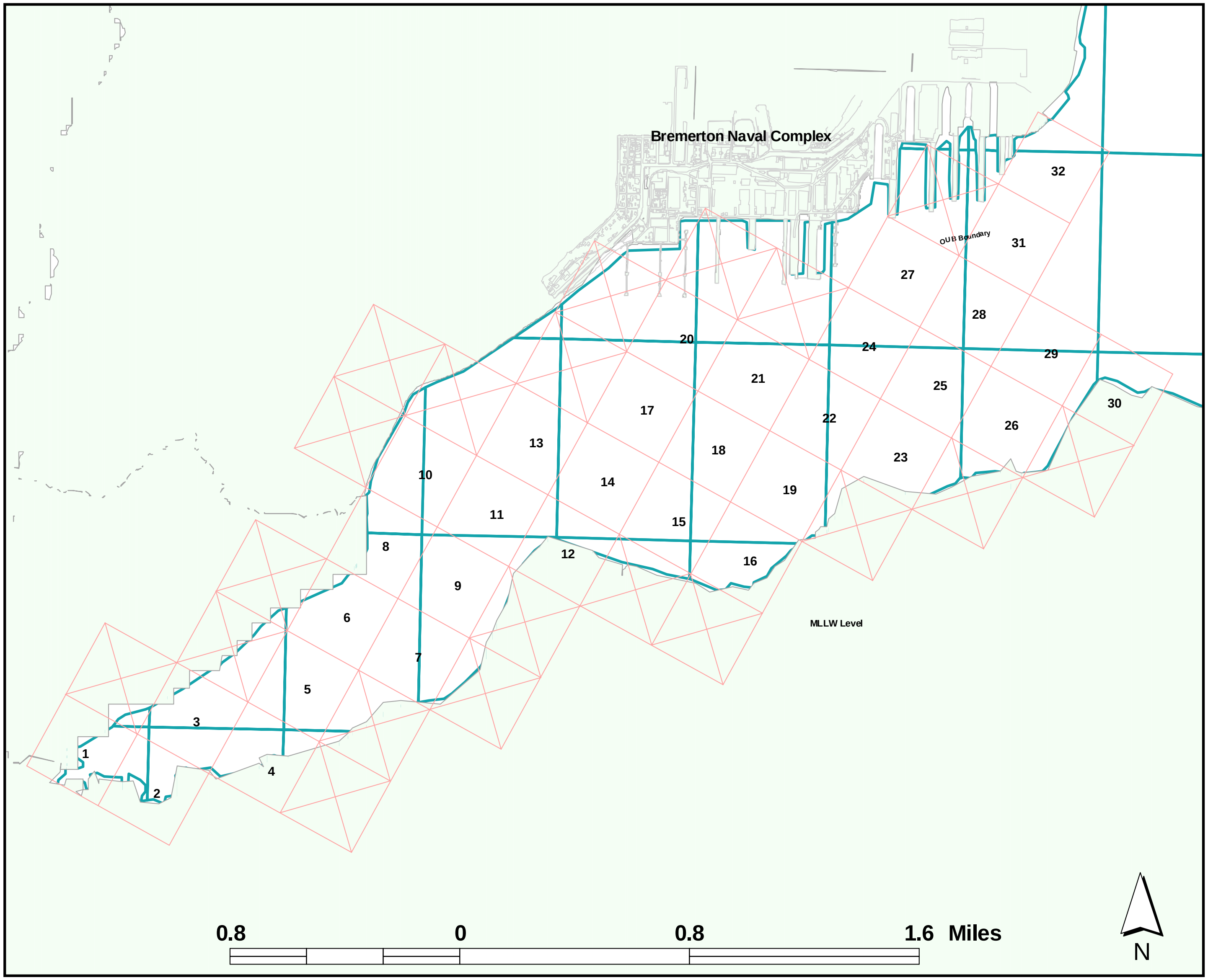

Figure 8. 1500-ft monitoring grids outside of the OU B Marine boundary (OOUB), with 303(d) segment overlay (blue)

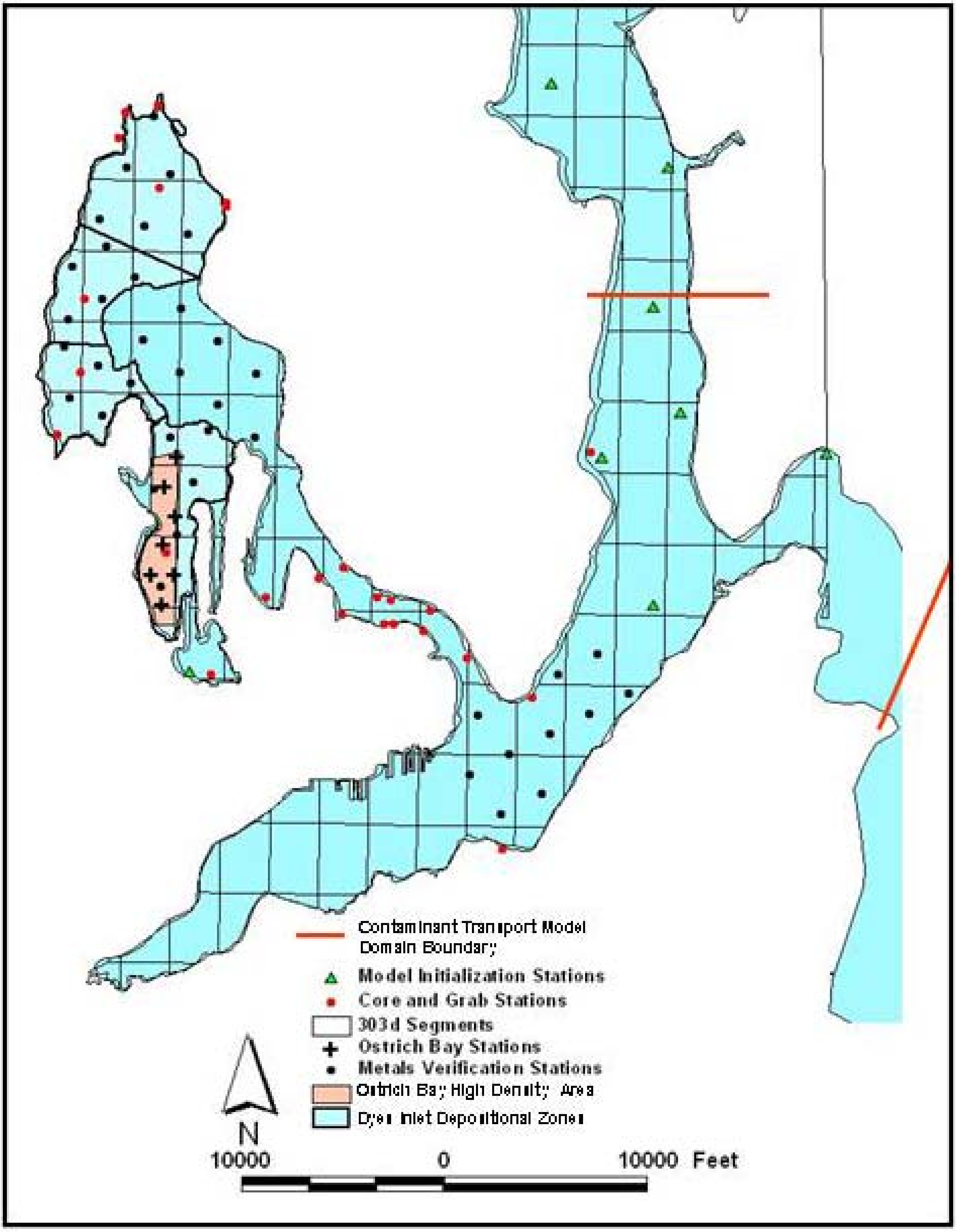

Figure 9. Planned Metals Verification Study (black dots and crosses) and model initialization (green triangles) stations in Dyes Inlet, Port Washington Narrows, and Port Orchard Passage

2.2 Sediment Sample Collection

Surface sediment samples outside of Sinclair Inlet were collected by Project ENVVEST, August 28-31, 2003. Samples were collected using a van Veen grab sampler deployed from the Battelle Marine Sciences Laboratory (MSL) research vessel *Strait Science*. Navigation to each planned location was by a differentially-corrected global positioning system (dGPS) aboard the sampling vessel. The van Veen grab sampler allows collection of undisturbed surficial sediment to a depth of up to 15 cm. The 0- to 10-cm interval was removed from the sampler using a clean stainless steel spoon and placed in a certified precleaned, labeled 1-gal wide-mouth high-density polyethylene (HDPE) container (Figure 10). HDPE sample containers were placed in a cooler with ice until transfer to the MSL's walk-in cold room.

Figure 10. Metals Verification Study grab sample collection

Generally one grab per station yielded a sufficient quantity of sediment for the proposed analyses and archive samples. Surface sediment sample cross-contamination was avoided by cleaning equipment thoroughly between sampling stations, and collecting only sample material that was not in direct contact with sample collection equipment. The grab sampler was scrubbed with a stiff brush and thoroughly rinsed with site water at the beginning of each day and between each sampling station. Sampling methods were consistent with the Puget Sound Estuary Program (PSEP) *Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound* (PSEP1997), and the more recent EPA document, *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical* Manual (EPA 2001).

Sediment samples from Sinclair Inlet were collected by a Navy contractor, URS Corporation, in October 2003. Field sampling methods for Sinclair Inlet are detailed in the Draft *Long Term Monitoring Plan, OU B Marine Bremerton Naval Complex* (URS 2002b). URS also collected samples using a van Veen grab sampler and removing the 0- to 10-cm surface interval. EFANW/URS provided an aliquot (approximately 400 mL) of homogenized composite sample for each OUBM and OOUB monitoring grid to Project ENVVEST.

2.3 Chemical Analysis

The target analytes for the Metals Verification Study, identified in Diefenderfer et al. (2003), are As, Cd, Cu, Pb, Ag and Zn. Listings for As are primarily based on observed tissue levels in marine biota, rather than in sediment. However, As was measured in all confirmatory Metals Verification Study sediment samples. Hg was not addressed in the Metals Verification Study for several reasons. In general, sediment Hg in Sinclair and Dyes Inlets is due to historical releases, rather than to ongoing or active discharges, and would likely be managed under a different program. Hg chemistry is more complex, and Hg risk is mainly associated with biota that uptake and accumulate methylmercury; Hg risk management would likely include sampling and analysis of biota as well as sediment. In Sinclair Inlet, Hg is being addressed by the OU B Marine Monitoring Program, and it is well documented that ambient Hg concentrations exceed sediment quality standards (Miller et al. 2003); therefore, verification sampling for Hg is not needed at this time.

The Metals Verification Study employed the following tiered analytical approach:

- Tier 1 - Rapid screening analysis of all samples by X-ray fluorescence (XRF), conducted by the Space and Naval Warfare Systems Center (SSC), San Diego, California
- Tier 2 - Confirmatory analysis of at least 25% of samples by inductively coupled plasma-mass spectrometer (ICP-MS), conducted by the MSL, Sequim, Washington
- Methods for each are described below.

Homogenized sediment from each Metals Verification Study sample was split into two labeled precleaned sample jars: a 4-oz glass jar with a Teflon-lined cap for metals screening analysis and a 16-oz glass jar with a Teflon-lined cap for archiving and other laboratory analyses. The 4-oz jar was shipped immediately to SSC; the 16-oz jar was held frozen at the MSL pending selection for ICP-MS or other ancillary analyses.

2.3.1 X-Ray Fluorescence Screening for Metals

All sediment samples collected in the Metals Verification Study were screened by XRF (modified EPA Method 6200 [EPA 1998]) at the SSC laboratory to determine the range of levels of the metals Ag, Cd, Cu, Pb and Zn. Samples are exposed to X-ray energy, which liberates electrons in the inner shell of metal atoms. As the outer electrons cascade toward the inner shells to fill the vacancies, energy is released (fluorescence). The fluorescing energy spectrum identifies the metals and the intensity is proportional to concentration. Inorganic analytes of interest are identified and quantitated using a QuanX EDXRF Spectrometer (Spectrace Instruments, Sunnyvale, California). This instrument contains an Rh-anode X-ray tube for primary generation of X-rays (4-50 kV) and a thermoelectrically cooled, solid-state Silicon (Si) (lithium [Li]) detector. The Si(Li) detector provides spectral resolution that exceeds that of other solid-state detectors or gas-filled proportional detectors. Quality control (QC) analyses to address accuracy and precision of XRF measurements included standard reference material samples and laboratory triplicate samples.

Historically, Pb, Cu, and Zn, concentrations measured by XRF show very good correlation with concentrations measured by ICP-MS (Figure 11, Miller et al. 2003), and reliable XRF detection limits for those metals are well below the state management standard concentrations (Table 2). However, XRF detection limits for Cd are close to the SQS concentration, and the XRF detection limit for Ag is greater than the SQS, to allow comparison (Table 2). For this reason, confirmatory ICP-MS analysis was done on at least three samples from segments listed for Cd or Ag.

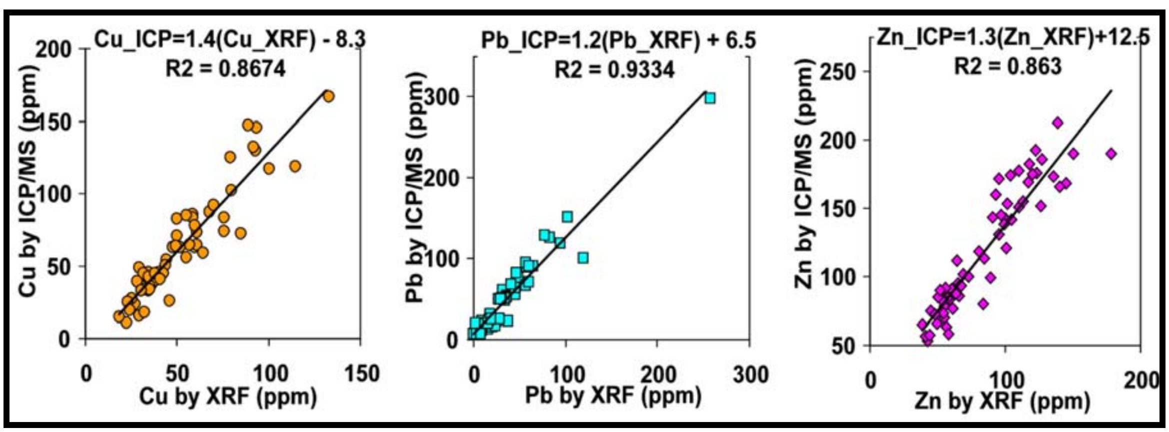

Figure 11. Linear correlation of XRF and ICP-MS Cu, Pb, and Zn measurements

Table 2. XRF Screening and ICP-MS Detection Limits Compared with State Sediment Management Standards for ENVVEST Metals of Concern

Analyte	Units	Reliable Detection Limit for XRF	Method Detection Limit for ICP/MS[a]	Washington State Sediment Management Standards	
				SQS	MCUL
Ag	mg/kg dry wt	10.0	0.013	6.1	6.1
As	mg/kg dry wt	20.0	0.7	57	93
Cd	mg/kg dry wt	5.0	0.01	5.1	6.7
Cr	mg/kg dry wt	100	0.2	260	270
Cu	mg/kg dry wt	18.0	0.09	390	390
Ni	mg/kg dry wt	50.0	0.02	None	none
Pb	mg/kg dry wt	8.0	0.03	450	530
Zn	mg/kg dry wt	16.0	0.2	410	960

a. Updated according to SOP MSL-I-022, Determination of Elements in Aqueous and Digestate Samples by ICP/MS, and MSL-Q-007, Procedure for Determining Method Detection Limits.

2.3.2 Confirmatory Analysis of Metals

Following XRF screening of all Metals Verification Study samples, 25% of the samples were selected for confirmatory ICP-MS analysis using the following criteria:

- samples in which XRF result exceeds 90% of the SQS for one or more target metals (Cu, Pb, and Zn)
- at least 3 samples in 303(d) segments listed for Cd or Ag (because XRF screening does not detect these metals at levels comparable to state SQS)
- samples in which XRF result was different (much higher or lower) than expected
- additional samples to represent range of concentrations observed for each target metal, particularly at high end of range where little XRF:ICP-MS correlation data exist.

ICP-MS is a high-resolution multi-element determination method with detection levels well below Washington State SQS (Table 2). Freeze-dried sediment samples are acid-digested; material in solution (digestate) is introduced by pneumatic nebulization into a radio-frequency plasma where energy transfer processes cause desolvation, atomization, and ionization. The ions are extracted from the plasma through a differentially pumped vacuum interface and separated on the basis of their mass-to-charge ratio by a quadrupole mass spectrometer having a minimum resolution capability of 1 amu peak width at 5% peak height. The ions transmitted through the quadrupole are detected by a continuous dynode electron multiplier assembly and the ion information processed by a data handling system. Interferences, instrumental drift, and suppressions or enhancements of instrument response caused by the sample matrix are corrected for by using internal standardization.

All target metals were analyzed by ICP-MS. Ag was also analyzed by graphite furnace atomic absorption (GFAA). GFAA results for Ag are reported here for comparability with data generated for other Project ENVVEST studies and stored in the ENVVEST database (i.e., mass balance, stormwater loading). QC samples to assess accuracy and precision of quantitative measurements included method blanks, laboratory duplicates, matrix spikes, standard reference materials, and laboratory control samples (blank spikes).

The Metals Verification Study XRF screening and quantitative metals concentrations were plotted to develop Sinclair-Dyes Inlet site-specific linear correlations. As in Figure 11, good linear relationships are expected between screening and quantitative measurements of at least three of the target metals (Cu, Pb, and Zn). The linear correlation equations were used to calculate definitive metal concentrations from screening concentrations in all Metals Verification Study samples.

2.3.3 Ancillary Sediment Analyses Outside of Metals Verification Study

Total Hg was not measured as part of the Metals Verification Study. Total Hg concentrations, grain size, and total organic carbon (TOC) in Sinclair Inlet (OUBM and OOUB) samples will be provided by the OU B Marine Monitoring Program. However, Project ENVVEST provided an aliquot of each Metals Verification Study sample from outside Sinclair Inlet for Hg analysis by Ecology's Manchester Environmental Laboratory. The Metals Verification Study also provided aliquots of sediment to GeoSea, Inc., for particle size analysis by laser diffraction; the purpose of these data was to support sediment trends analysis outside of the Metals Verification Study. Remaining Metals Verification Study samples continue to be archived frozen for possible later analysis of organics (PCB, PAH).

3.0 RESULTS AND DISCUSSION

3.1 Sample Collection

3.1.1 Dyes Inlet, Ostrich Bay, Port Orchard Passage, and Rich Passage

Fifty-seven sediment samples were collected from Dyes Inlet, Ostrich Bay, Port Orchard Passage, and Rich Passage by the Project ENVVEST technical team August 28-31, 2003. Sampling locations and sediment information are provided in Figures 12 and 13 and in Table 3. Most samples were successfully collected at or very close to the target sampling location. Several stations were moved slightly to reach navigable water or penetrable sediment. Two target stations at the confluence of Port Orchard and Rich Passages were attempted numerous times but were abandoned because the substrate of large rocks or shells could not be successfully sampled; such large-particle substrate indicates a high-energy environment where contaminants are unlikely to accumulate.

3.1.2 Sinclair Inlet

A total of 103 aliquots of Sinclair Inlet sediment composites was provided by the OU B Marine Monitoring team. OUBM 500-ft grid sampling locations are shown in Figure 14; OOUB 1500-ft grid sampling locations are shown in Figure 15. In these figures, the three light pink dots indicate the actual grab locations, and the single magenta dot is assigned to the geographical average location used to represent the composite sample received by the Metals Verification Study. Composite samples from grids marked with gold circles received confirmatory metals analysis by ICP-MS. A list of OU B Marine monitoring samples provided to Metals Verification Study and cross-referenced to 303(d) grids is provided in Table 4.

3.2 Sediment Metals Chemistry

All Metals Verification Study samples from outside Sinclair Inlet and all samples from Sinclair Inlet provided by the OU B Marine monitoring program were screened for Cu, Pb, Zn, Cd, and Ag by XRF. XRF screening results for all 160 samples are provided in Table 5. The laboratory data report for XRF analysis, including narrative summary and QC data, is provided in Appendix A. XRF results for standard reference materials were 1% to 25% different from the certified value for all metals except Cd. Two of four Cd percent differences were higher (33%, 49%) because the XRF quantitation limit is not as low as the certified value for Cd in the standard reference material. For all metals detected above the quantitation limit, relative standard deviations between triplicate samples were <20%, indicating acceptable laboratory precision.

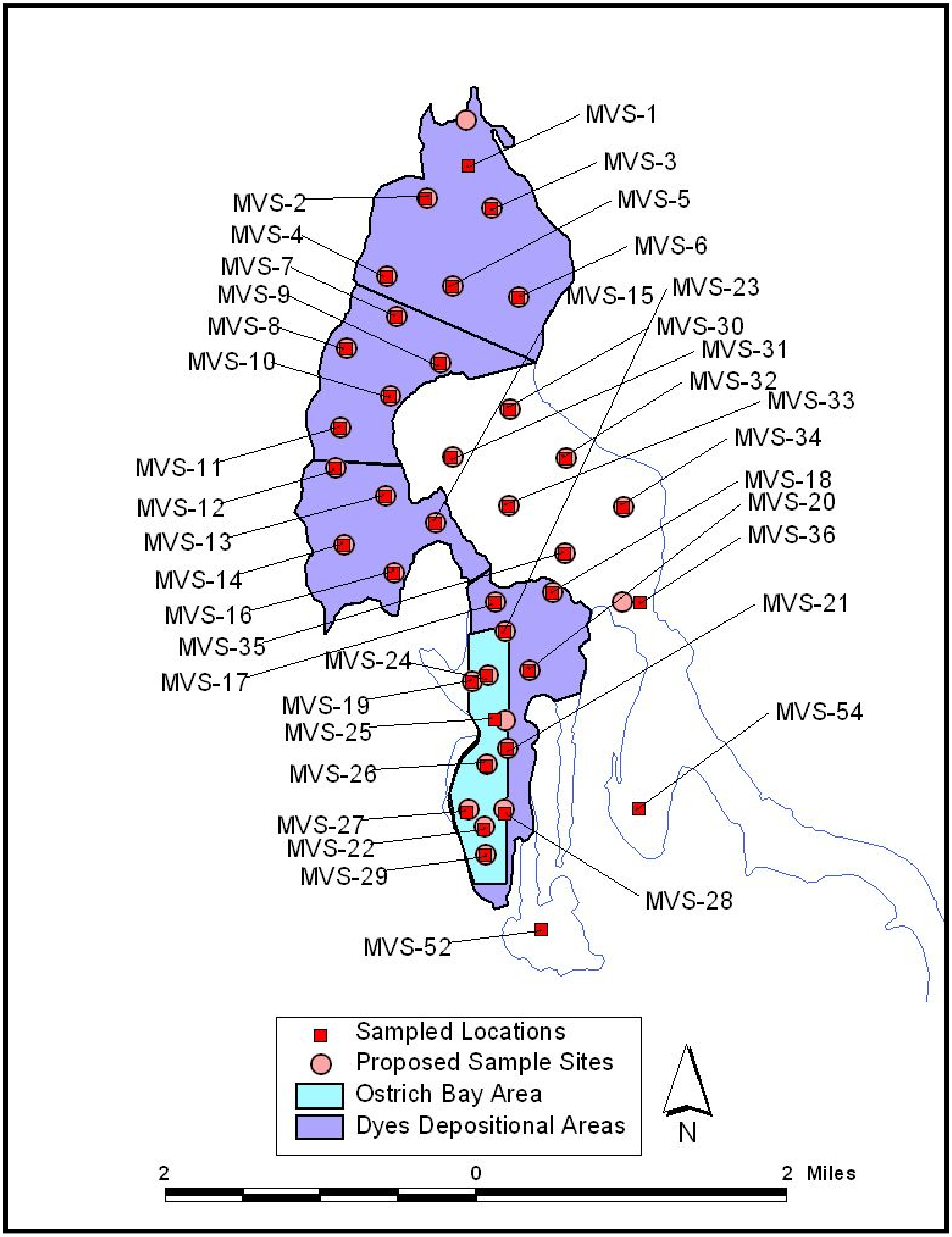

Figure 12. Metals Verification Study stations sampled in Dyes Inlet, including Ostrich Bay

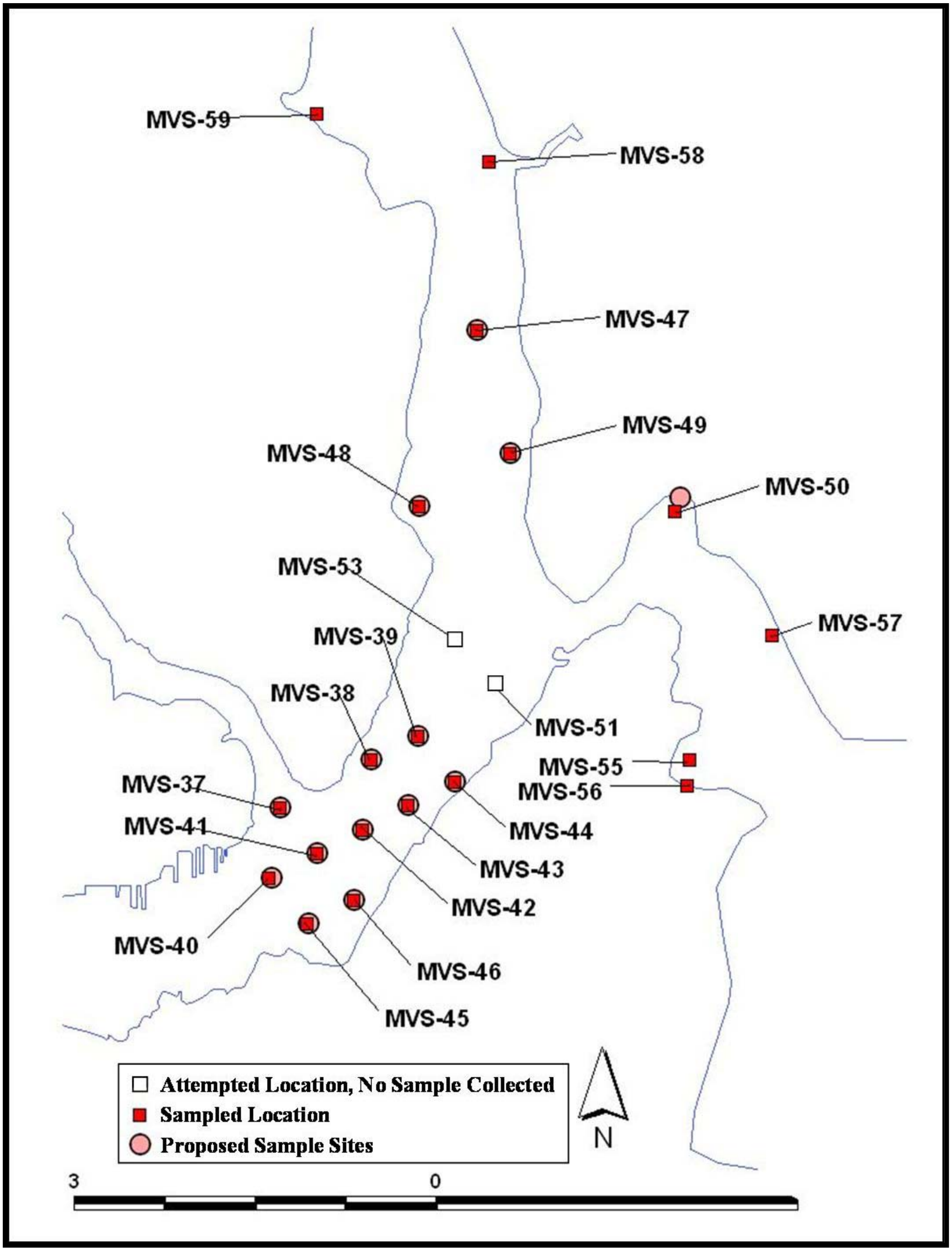

Figure 13. Metals Verification Study stations sampled in Port Orchard Passage and Rich Passage

Table 3. Metals Verification Study Sample Collection Information for Dyes Inlet, Port Orchard Passage, and Rich Passage

Area	MVS Sample ID	Collection		Water Depth (ft, Un-corrected)	Coordinates (dd mm.mmm, NAD 83)		Maximum Penetration Depth (cm)	Sampled Interval (cm)	Comments
		Date	Time		Latitude	Longitude			
Dyes Depositional Zone 1 (North)	MVS- 001	08/29/03	1518	7	47º 38.696	122º 41.186	15	0-10	Station located in as shallow water possible, between and north of MVS-002 and MVS-003. Dark gray medium-fine sand with wood chips, slight H2S odor.
Dyes Depositional Zone 1 (North)	MVS- 002	08/29/03	1358	13	47º 38.513	122º 41.525	12	0-10	Gray-brown medium sand with 0.5 cm fines on surface, worm tubes, worms, snails.
Dyes Depositional Zone 1 (North)	MVS- 003	08/29/03	1442	27	47º 38.457	122º 40.986	15	0-10	Dark gray-black clay, unconsolidated, few worms on top. Strong H2S odor.
Dyes Depositional Zone 1 (North)	MVS- 004	08/29/03	1339	29	47º 38.074	122º 41.842	12	0-10	Dark gray-brown silt clay, slight H2S odor.
Dyes Depositional Zone 1 (North)	MVS- 005	08/28/03	1305	32.6	47º 38.018	122º 41.304	15	0-10	Dark gray clay, moderate H2S odor.
Dyes Depositional Zone 1 (North)	MVS- 006	08/29/03	1502	28	47º 37.962	122º 40.766	13	0-10	Gray medium stiff clayey sand, few worm tubes, no odor.
Dyes Depositional Zone 2 (West)	MVS- 007	08/29/03	1327	32	47º 37.848	122º 41.760	15	0-10	Brown silt-clay, very soft and unconsolidated, slight H2S odor.
Dyes Depositional Zone 2 (West)	MVS- 008	08/29/03	1312	30	47º 37.664	122º 42.170	12	0-10	Dark gray slit clay, slight H2S odor.
Dyes Depositional Zone 2 (West)	MVS- 009	08/28/03	1322	45	47º 37.587	122º 41.400	15	0-10	Gray-brown silty sand on dark gray-brown mud.
Dyes Depositional Zone 2 (West)	MVS- 010	08/29/03	1255	52	47º 37.403	122º 41.808	9	0-8	Black fine sand, silt, clay, slight H2S odor, lots of biota, worm tubes.
Dyes Depositional Zone 2 (West)	MVS- 011	08/29/03	1236	38	47º 37.220	122º 42.212	13	0-10	Dark gray-brown fine sand and silt, slight H2S odor.
Dyes Depositional Zone 3 (SW)	MVS- 012	08/29/03	1224	35	47º 36.991	122º 42.256	15	0-10	Dark gray-brown silt clay, slight H2S odor.
Dyes Depositional Zone 3 (SW)	MVS- 013	08/29/03	1206	43	47º 36.842	122º 41.841	15	0-10	Dark gray-brown silt clay with some fine sand, slight H2S odor. Tunicate on surface.
Dyes Depositional Zone 3 (SW)	MVS- 014	08/29/03	1154	16	47º 36.560	122º 42.176	14.5	0-10	Dark gray fine clayey sand, shells, worm tubes, live snails, moderate H2S odor.
Dyes Depositional Zone 3 (SW)	MVS- 015	08/29/03	1122	16	47º 36.693	122º 41.429	6	0-5	Gray medium-fine sand with shells, no odor.
Dyes Depositional Zone 3 (SW)	MVS- 016	08/29/03	1138	14	47º 36.411	122º 41.767	15	0-10	Dark gray clay, very cohesive, slight H2S odor, worm tubes.
Dyes Depositional Zone 4 (South)	MVS- 017	08/28/03	1525	42	47º 36.244	122º 40.938	14	0-10	Dark gray-brown silt and clay.
Dyes Depositional Zone 4 (South)	MVS- 018	08/29/03	1100	47	47º 36.304	122º 40.464	10	0-9	Dark gray-brown silt and clay, moderate H2S odor, no biota.
Dyes Depositional Zone 4 (South)	MVS- 019	08/28/03	1601	8.4	47º 35.804	122º 41.122	12	0-10	Dark gray silt clay.
Dyes Depositional Zone 4 (South)	MVS- 020	08/29/03	1045	25	47º 35.864	122º 40.648	12	0-10	Dark gray-brown silt clay, no odor, 2 crabs, hydroid mats.
Dyes Depositional Zone 4 (South)	MVS- 021	08/28/03	1640	24.8	47º 35.424	122º 40.827	15	0-10	Dark gray silt clay, cohesive, no odor. Small jellyfish on sediment surface.
Dyes Depositional Zone 4 (South)	MVS- 022	08/29/03	0946	23.0	47º 34.976	122º 41.012	9	0-8	Moved position slightly for third attempt which was successful; dark gray-brown fine sand, silt, clay, slight H2S odor.

Table 3. (continued)

Area	MVS Sample ID	Collection		Water Depth (ft, Un-corrected)	Coordinates (dd mm.mmm, NAD 83)		Maximum Penetration Depth (cm)	Sampled Interval (cm)	Comments
		Date	Time		Latitude	Longitude			
Ostrich Bay	MVS- 023	08/28/03	1535	30	47º 36.084	122º 40.853	15	0-10	Gray sand, lots of algae and worms; 2 unsuccessful attempts on 08/28/03
Ostrich Bay	MVS- 024	08/28/03	1546	30	47º 35.833	122º 40.999	11	0-10	Dark gray silt clay.
Ostrich Bay	MVS- 025	08/28/03	1625	26	47º 35.589	122º 40.929	12	0-10	Station position moved NW from planned coordinates for third attempt; root-like mats (bryozoan or hydroid colonies) on and in sediment, which was dark gray-brown silt clay.
Ostrich Bay	MVS- 026	08/28/03	1651	37	47º 35.332	122º 41.001	15	0-10	Gray-brown silt clay, no odor.
Ostrich Bay	MVS- 027	08/29/03	1007	25.0	47º 35.070	122º 41.158	9	0-8	Position moved west (inshore) for third attempt. Dark gray-brown find sand in silt & clay, few shells, moderate H2S odor, few worm tubes.
Ostrich Bay	MVS- 028	08/29/03	1021	16.0	47º 35.066	122º 40.839	7	0-7	Position moved slightly for second attempt. Dark gray-brown medium fine sand with clay, slight H2S odor, lots of biota 9snails, crab, algae, worm tubes.
Ostrich Bay	MVS- 029	08/29/03	0926	22.4	47º 34.832	122º 40.998	15	0-10	Gray-brown silt clay, few shells, no odor.
Oyster Bay	MVS- 052	08/29/03	0855	17.5	47º 34.362	122º 40.562	15	0-10	Dark gray silt clay with some large shells, very cohesive. Slight H2S odor.
Dyes Inlet Nondepositional (East)	MVS- 030	08/29/03	1559	15	47º 37.330	122º 40.831	6	0-5	Gray med-coarse sand and gravel with shells and shell hash, no odor; 2 unsuccessful attempts on 08/28/03
Dyes Inlet Nondepositional (East)	MVS- 031	08/28/03	1350	108	47º 37.062	122º 41.301	12	0-10	Dark gray-brown fine silt, slight H2S odor.
Dyes Inlet Nondepositional (East)	MVS- 032	08/31/03	0950	24.6	47º 37.060	122º 40.363	4.5	0-4	Gray coarse sand and gravel with shells and pebbles, no odor.
Dyes Inlet Nondepositional (East)	MVS- 033	08/28/03	1408	62.4	47º 36.792	122º 40.834	15	0-10	Dark gray fine sand, silt, clay; very cohesive.
Dyes Inlet Nondepositional (East)	MVS- 034	08/31/03	1003	63	47º 36.790	122º 39.897	6	0-5	Gray medium sand, well-sorted with few shell pieces, no odor. Right on planned location.
Dyes Inlet Nondepositional (East)	MVS- 035	08/28/03	1434	59	47º 36.521	122º 40.367	6.5	0-6	Gray medium and coarse sand with shells, pebbles
Dyes Inlet Nondepositional (East)	MVS- 036	08/31/03	0938	34.8	47º 36.256	122º 39.751	5	0-5	2 unsuccessful attempts on 08/28/03, 2 more 08/31/03 before relocated to north side of channel and sampled at slack current. 5^{th} attempt kept, coarse gray sand, gravel, pebbles, and shell hash.
Phinney Bay	MVS- 054	08/29/03	1618	29	47º 35.094	122º 39.750	8	0-7	Dark gray-brown medium fine sand with clay, few worms, no odor.

Table 3. (continued)

Area	MVS Sample ID	Collection		Water Depth (ft, Un-corrected)	Coordinates (dd mm.mmm, NAD 83)		Maximum Penetration Depth (cm)	Sampled Interval (cm)	Comments
		Date	Time		Latitude	Longitude			
Port Orchard Passage	MVS- 037	08/31/03	0902	32.4	47º 33.943	122º 37.102	2	0-2	Kept all material since very difficult area to grab; Gray coarse sand, gravel, mostly pebbles, some shells, no odor.
Port Orchard Passage	MVS- 038	08/30/03	1342	42.0	47º 34.296	122º 36.139	3	0-2	Gray sand; 4 unsuccessful attempts before retaining a few cm sand.
Port Orchard Passage	MVS- 039	08/30/03	1236	163	47º 34.473	122º 35.655	4	0-3	Coarse gray sand and gravel with shell hash, unsorted, many shells & pieces of shells, no odor.
Port Orchard Passage	MVS- 040	08/30/03	1458	70.0	47º 33.437	122º 37.215	12	0-10	Gray brown medium-fine sand, silt, clay, worms, few hydroids.
Port Orchard Passage	MVS- 041	08/31/03	0847	110	47º 33.613	122º 36.707	3	0-2	Sample is composite of three grabs, each with 1-3 cm retained. Position varied <10 m between grabs. Coarse gray sand, gravel, cobbles, and shells.
Port Orchard Passage	MVS- 042	08/30/03	1355	84.6	47º 33.789	122º 36.224	8	0-7	Gray-brown fine sand and silt, diatoms on surface, worms & tubes, no odor.
Port Orchard Passage	MVS- 043	08/30/03	1307	73.6	47º 33.966	122º 35.743	7	0-6	Gray medium fine sand, no odor. Right on planned position!
Port Orchard Passage	MVS- 044	08/30/03	1251	27.0	47º 34.143	122º 35.261	8.5	0-8	Gray fine sand with silt & clay.
Port Orchard Passage	MVS- 045	08/30/03	1424	55.0	47º 33.107	122º 36.802	8	0-7	Gray brown silt and clay, many worms.
Port Orchard Passage	MVS- 046	08/30/03	1411	30.4	47º 33.284	122º 36.318	8	0-6	Gray-brown fine sand and silt, diatoms on surface, worms, no odor.
Port Orchard Passage	MVS- 047	08/30/03	1012	112	47º 37.416	122º 35.053	12	0-10	Dark gray silt clay, very cohesive, worms present, no odor.
Port Orchard Passage	MVS- 048	08/30/03	1046	49	47º 36.133	122º 35.645	12	0-10	Gray fine cohesive sand with silt & clay, many large worms, algae.
Port Orchard Passage	MVS- 049	08/30/03	1029	72	47º 36.526	122º 34.694	12.5	0-10	Dark gray silt clay, some fine sand, slight H2S odor, no organisms.
Port Orchard Passage	MVS- 051	08/30/03	1145	211	47º 34.900	122º 34.975	0	0	NO SAMPLE POSSIBLE--tried 2 locations, large rocks only.
Port Orchard Passage	MVS- 053	08/30/03	1120	152	47º 35.150	122º 35.199	0	0	NO SAMPLE POSSIBLE--tried 2 locations, large rocks and shells only.

Table 3. (continued)

Area	MVS Sample ID	Collection		Water Depth (ft, Un-corrected)	Coordinates (dd mm.mmm, NAD 83)		Maximum Penetration Depth (cm)	Sampled Interval (cm)	Comments
		Date	Time		Latitude	Longitude			
Port Orchard Passage, Fletcher Bay entrance	MVS- 058	08/31/03	1117	24.6	47º 38.640	122º 34.928	4.5	0-4	Gray coarse sand and gravel, shell hash, no odor. Sample collected to WNW of Fletcher Bay entrance after 5-6 attempts to collect closer to shore and bay mouth.
Port Orchard Passage, Brownsville	MVS- 059	08/31/03	1140	21.5	47º 38.977	122º 36.757	15	0-10	Dark gray silt and clay, very soft, moderate H2S odor.
Rich Passage, north	MVS- 050	08/30/03	0946	6.4	47º 36.109	122º 32.950	3	0-3	Positioned in shallow water as close to planned as possible; Gray medium sand, no odor, clean & dry.
Rich Passage, NW of Orchard Rocks	MVS- 057	08/30/03	0929	24	47º 35.217	122º 31.915	3	0-3	Moved N after 2 attempts in rocks; successful sample collected just SE of small boat ramp. Medium gray sand with shells, no odor.
Clam Bay north, near Manchester Pier	MVS- 055	08/30/03	0843	13	47º 34.308	122º 32.770	7	0-6	Kept sediment from 5th attempt only. Gray medium fine sand and silt, no odor, eelgrass growing in sand.
Clam Bay South, off mouth of Little Clam Bay	MVS- 056	08/30/03	0859	10.8	47º 34.125	122º 32.800	7	0-6	Gray medium fine sand and silt, no odor; green algae but no eelgrass.

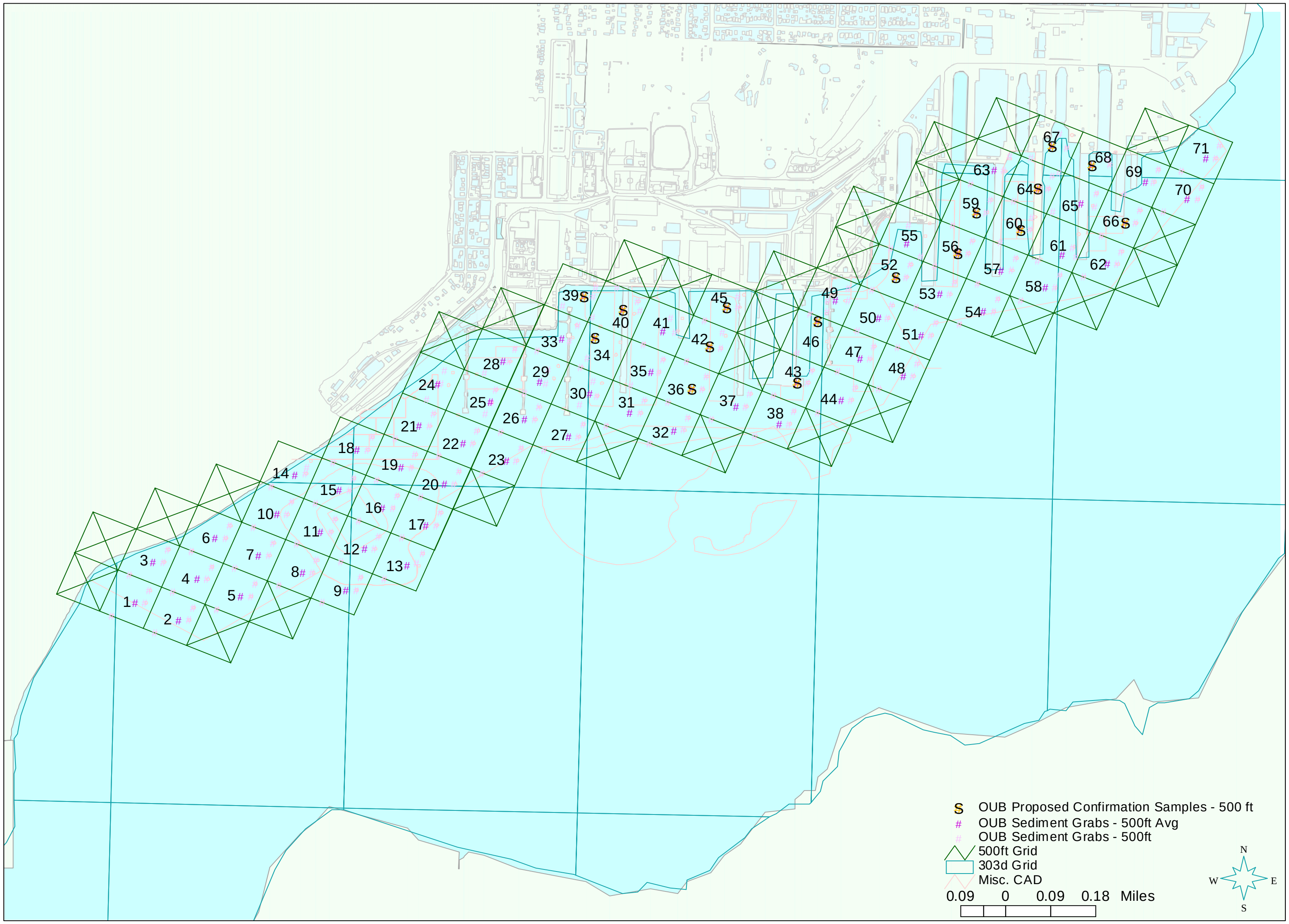

Figure 14. OU B Marine monitoring stations in 500-ft grid within OU B Marine boundary (OUBM)

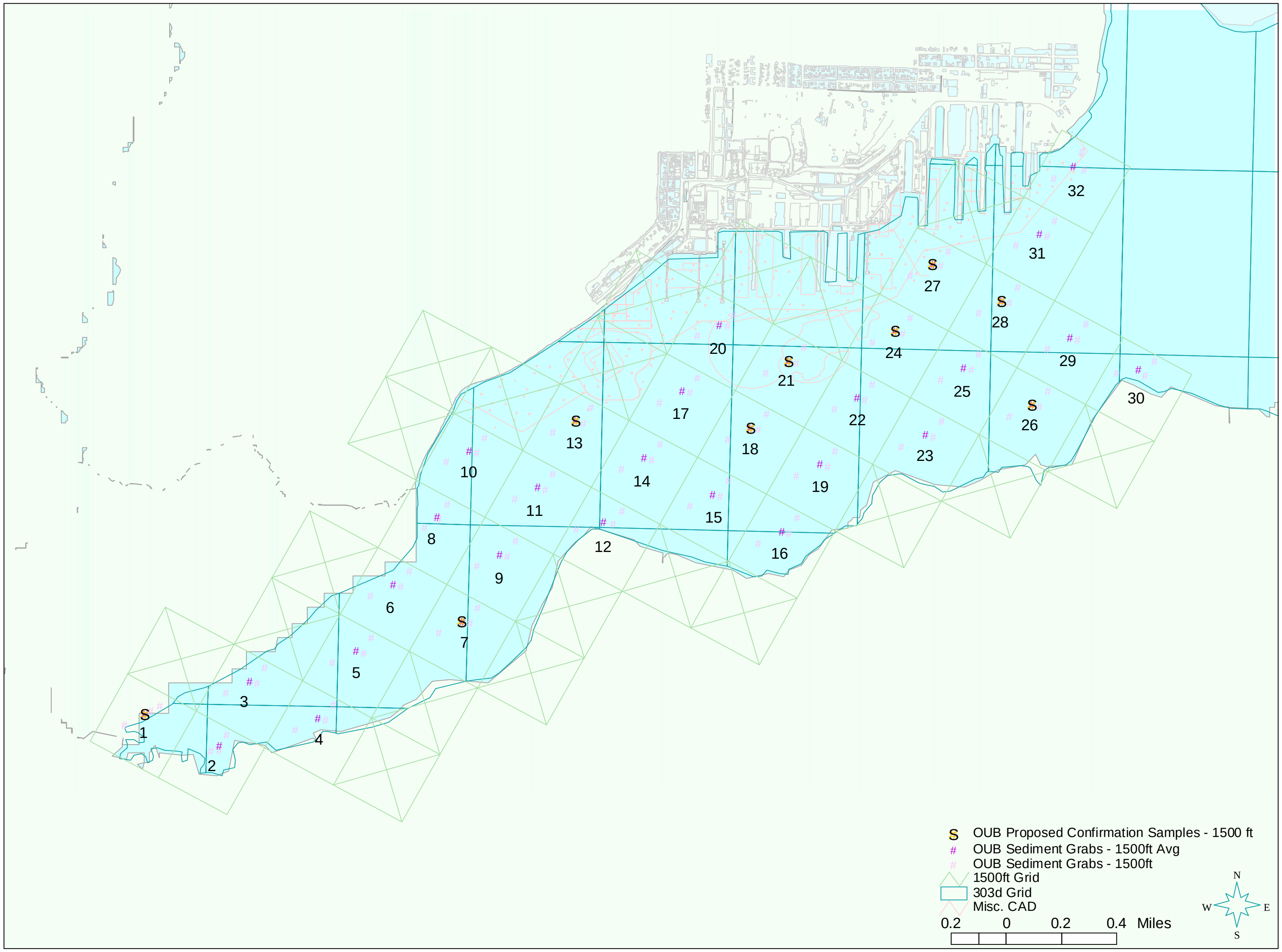

Figure 15. OU B Marine monitoring stations in 1500-ft grid outside OU B Marine boundary (OOUB)

Table 4. OU B Marine Monitoring Samples Received for Metals Verification Study

OU B Grid Cell	303d Segment(s)	OU B Marine Monitoring Sample Collection Information		
		Composite Sample ID	Collection Date	Collection Time
Inside OU B Marine (OUBM)				
OUBM-G 01	47122 F6E6	BNC 63181	10/13/2003	1020
OUBM-G 02	47122 F6E6	BNC 63182	10/13/2003	1045
OUBM-G 03	47122 F6E6	BNC 63183	10/13/2003	1120
OUBM-G 04	47122 F6E6	BNC 63184	10/13/2003	1150
OUBM-G 05	47122 F6E6	BNC 63185	10/13/2003	1215
OUBM-G 06	47122 F6E6	BNC 63186	10/13/2003	1330
OUBM-G 07	47122 F6E6	BNC 63188	10/13/2003	1410
OUBM-G 08	47122 F6E6	BNC 63189	10/13/2003	1440
OUBM-G 09	47122 F6E6, F6E5	BNC 63190	10/13/2003	1510
OUBM-G 10	47122 F6E6	BNC 63191	10/13/2003	1540
OUBM-G 11	47122 F6E6	BNC 63193	10/20/2003	1030
OUBM-G 12	47122 F6E5, F6E6	BNC 63194	10/20/2003	1100
OUBM-G 13	47122 F6E5	BNC 63195	10/20/2003	1135
OUBM-G 14	47122 F6F6, F6F5	BNC 63196	10/20/2003	1315
OUBM-G 15	47122 F6E6, F6F6	BNC 63197	10/20/2003	1355
OUBM-G 16	47122 F6E5	BNC 63198	10/20/2003	1430
OUBM-G 17	47122 F6E5	BNC 63200	10/20/2003	1515
OUBM-G 18	47122 F6F6, F6F5	BNC 63221	10/20/2003	1545
OUBM-G 19	47122 F6F5	BNC 63228	10/22/2003	1640
OUBM-G 20	47122 F6F5, F6F6	BNC 63253	10/27/2003	0920
OUBM-G 21	47122 F6F5	BNC 63254	10/27/2003	0945
OUBM-G 22	47122 F6F5	BNC 63255	10/27/2003	1010
OUBM-G 23	47122 F6F5	BNC 63256	10/27/2003	1035
OUBM-G 24	47122 F6F5	BNC 63267	10/28/2003	0950
OUBM-G 25	47122 F6F5	BNC 63257	10/27/2003	1125
OUBM-G 26	47122 F6F5	BNC 63259	10/27/2003	1155
OUBM-G 27	47122 F6F5	BNC 63240	10/23/2003	1615
OUBM-G 28	47122 F6F5	BNC 63262	10/27/2003	1420
OUBM-G 29	47122 F6F5	BNC 63261	10/27/2003	1310
OUBM-G 30	47122 F6F5, F6F4	BNC 63230	10/23/2003	0915
OUBM-G 31	47122 F6F4	BNC 63233	10/23/2003	1145
OUBM-G 32	47122 F6F4	BNC 63251	10/24/2003	1550
OUBM-G 33	47122 F6F5	BNC 63260	10/27/2003	1445
OUBM-G 34	47122 F6F5, F6F4	BNC 63232	10/23/2003	1120
OUBM-G 35	47122 F6F4	BNC 63227	10/22/2003	1600
OUBM-G 36	47122 F6F4	BNC 63235	10/23/2003	1245
OUBM-G 37	47122 F6F4	BNC 63239	10/23/2003	1545
OUBM-G 38	47122 F6F4	BNC 63248	10/24/2003	1430
OUBM-G 39	47122 F6F5	BNC 63231	10/23/2003	1015

Table 4. (continued)

OU B Grid Cell	303d Segment(s)	OU B Marine Monitoring Sample Collection Information		
		Composite Sample ID	Collection Date	Collection Time
Inside OU B Marine (OUBM) continued				
OUBM-G 40	47122 F6F4	BNC 63226	10/22/2003	1500
OUBM-G 41	47122 F6F4	BNC 63225	10/22/2003	1340
OUBM-G 42	47122 F6F4	BNC 63224	10/22/2003	1230
OUBM-G 43	47122 F6F4	BNC 63236	10/23/2003	1330
OUBM-G 44	47122 F6F3, F6F4	BNC 63242	10/24/2003	0910
OUBM-G 45	47122 F6F4	BNC 63223	10/22/2003	1130
OUBM-G 46	47122 F6F4, F6F3	BNC 63238	10/23/2003	1510
OUBM-G 47	47122 F6F3	BNC 63243	10/24/2003	0945
OUBM-G 48	47122 F6F3	BNC 63249	10/24/2003	1505
OUBM-G 49	47122 F6F4, F6F3	BNC 63237	10/23/2003	1410
OUBM-G 50	47122 F6F3	BNC 63244	10/24/2003	1025
OUBM-G 51	47122 F6F3	BNC 63250	10/24/2003	1525
OUBM-G 52	47122 F6F3	BNC 63245	10/24/2003	1050
OUBM-G 53	47122 F6F3	BNC 63165	10/3/2003	1330
OUBM-G 54	47122 F6F3	BNC 63167	10/3/2003	1545
OUBM-G 55	47122 F6F3	BNC 63247	10/24/2003	1245
OUBM-G 56	47122 F6F3	BNC 63163	10/3/2003	1210
OUBM-G 57	47122 F6F3	BNC 63162	10/3/2003	1130
OUBM-G 58	47122 F6F3	BNC 63153	10/2/2003	1015
OUBM-G 59	47122 F6F3	BNC 63161	10/3/2003	1050
OUBM-G 60	47122 F6F3	BNC 63166	10/3/2003	1450
OUBM-G 61	47122 F6F2, F6F3	BNC 63154	10/2/2003	1215
OUBM-G 62	47122 F6F2	BNC 63155	10/2/2003	1350
OUBM-G 63	47122 F6F3	BNC 63160	10/3/2003	1010
OUBM-G 64	47122 F6F3	BNC 63156	10/2/2003	1430
OUBM-G 65	47122 F6F2, F6F3	BNC 63263	10/27/2003	1530
OUBM-G 66	47122 F6F2	BNC 63157	10/2/2003	1610
OUBM-G 67	47122 F6G3?	BNC 63159	10/3/2003	0930
OUBM-G 68	47122 F6G2	BNC 63264	10/27/2003	1615
OUBM-G 69	47122 F6F2, F6G2	BNC 63265	10/27/2003	1710
OUBM-G 70	47122 F6F2	BNC 63179	10/10/2003	1415
OUBM-G 71	47122 F6G2	BNC 63178	10/10/2003	1325
Outside OU B Marine (OOUB)				
OOUB-G 01	47122 F6C9	BNC 63304	10/30/2003	1700
OOUB-G 02	47122 F6C8, F6C9	BNC 63280	10/29/2003	0940
OOUB-G 03	47122 F6C8, F6D8	BNC 63281	10/29/2003	1015
OOUB-G 04	47122 F6C8, F6D8	BNC 63282	10/29/2003	1040
OOUB-G 05	47122 F6D8, F6D7	BNC 63283	10/29/2003	1115
OOUB-G 06	47122 F6D7	BNC 63284	10/29/2003	1145

Table 4. (continued)

OU B Grid Cell	303d Segment(s)	OU B Marine Monitoring Sample Collection Information		
		Composite Sample ID	Collection Date	Collection Time
Outside OU B Marine (OOUB), continued				
OOUB-G 07	47122 F6D7	BNC 63302	10/30/2003	1455
OOUB-G 08	47122 F6E7	BNC 63301	10/30/2003	1415
OOUB-G 09	47122 F6D7, F6D6	BNC 63300	10/30/2003	1355
OOUB-G 10	47122 F6E7	BNC 63299	10/30/2003	1320
OOUB-G 11	47122 F6E6	BNC 63298	10/30/2003	1250
OOUB-G 13	47122 F6E6	BNC 63297	10/30/2003	1145
OOUB-G 14	47122 F6E5	BNC 63295	10/30/2003	1115
OOUB-G 15	47122 F6E5	BNC 63268	10/28/2003	1045
OOUB-G 17	47122 F6E5	BNC 63294	10/30/2003	1045
OOUB-G 18	47122 F6E4, F6E5	BNC 63293	10/30/2003	1015
OOUB-G 19	47122 F6E4	BNC 63270	10/28/2003	1145
OOUB-G 20	47122 F6F5	BNC 63292	10/30/2003	0945
OOUB-G 21	47122 F6E4	BNC 63291	10/30/2003	0915
OOUB-G 22	47122 F6E4	BNC 63277	10/28/2003	1625
OOUB-G 23	47122 F6E3	BNC 63271	10/28/2003	1215
OOUB-G 24	47122 F6F3	BNC 63276	10/28/2003	1540
OOUB-G 25	47122 F6E3	BNC 63272	10/28/2003	1345
OOUB-G 26	47122 F6E2	BNC 63287	10/29/2003	1420
OOUB-G 27	47122 F6F3	BNC 63275	10/28/2003	1510
OOUB-G 28	47122 F6F2, F6F3	BNC 63274	10/28/2003	1445
OOUB-G 29	47122 F6F2	BNC 63273	10/28/2003	1410
OOUB-G 31	47122 F6F2	BNC 63285	10/29/2003	1315
OOUB-G 32	47122 F6F2	BNC 63286	10/29/2003	1545

Table 5. XRF Screening Results

Location Description	Station or OUB Grid Cell	XRF Screening Concentration (mg/kg)				
		Cu	Pb	Zn	Cd	Ag
SQS		**390**	**450**	**410**	**5.1**	**6.1**
90% SQS		**351**	**405**	**369**	**4.6**	**5.5**
MCUL		**390**	**530**	**960**	**6.7**	**6.1**
Dyes Depositional Zone	MVS-001	34	17	58	1.2 J[a]	0.1 U[b]
Dyes Depositional Zone	MVS-002	18 J	9 J	38	2.3 J	0.3 U
Dyes Depositional Zone	MVS-003	46	30	84	0.5 U	0.3 U
Dyes Depositional Zone	MVS-004	63	41	98	ND[c]	0.9 U
Dyes Depositional Zone	MVS-005	56	38	91	0.6 U	1.4 J
Dyes Depositional Zone	MVS-006	25 J	16	52	0.8 U	0.4 U
Dyes Depositional Zone	MVS-007	57	39	97	0.6 U	0.7 U
Dyes Depositional Zone	MVS-008	41	24	85	ND	0.9 U
Dyes Depositional Zone	MVS-009	47	36	85	0.7 U	1.8 J
Dyes Depositional Zone	MVS-010	47	31	91	0.5 U	0.2 U
Dyes Depositional Zone	MVS-011	43	37	95	0.5 U	0.8 U
Dyes Depositional Zone	MVS-012	57	38	94	0.4 U	0.6 U
Dyes Depositional Zone	MVS-013	43	30	86	0.7 U	ND
Dyes Depositional Zone	MVS-014	37	15	62	ND	ND
Dyes Depositional Zone	MVS-015	28 J	9 J	59	0.0 U	0.4 U
Dyes Depositional Zone	MVS-016	34	14 J	65	0.7 U	0.1 U
Dyes Depositional Zone	MVS-017	45	27	79	0.3 U	0.3 U
Dyes Depositional Zone	MVS-018	44	36	84	1.5 J	0.9 U
Dyes Depositional Zone	MVS-019	34	13 J	45	0.6 U	0.1 U
Dyes Depositional Zone	MVS-020	45	32	77	ND	ND
Dyes Depositional Zone	MVS-021	46	26	72	1.0 J	1.3 J
Dyes Depositional Zone	MVS-022	53	32	89	1.3 J	ND
Dyes Nondepositional Zone	MVS-030	17 J	8 J	31	0.8 U	ND
Dyes Nondepositional Zone	MVS-031	29	14 J	49	1.3 J	ND
Dyes Nondepositional Zone	MVS-032	16 J	8 J	33	ND	ND
Dyes Nondepositional Zone	MVS-033	29	22	53	ND	1.3 J
Dyes Nondepositional Zone	MVS-034	16 J	7 J	29	ND	0.1 U
Dyes Nondepositional Zone	MVS-035	16 J	7 J	37	0.8 U	ND
Dyes Nondepositional Zone	MVS-036	18 J	10 J	33	ND	ND
Ostrich Bay	MVS-023	55	36	93	0.2 U	0.5 U
Ostrich Bay	MVS-024	49	26	77	ND	0.3 U
Ostrich Bay	MVS-025	44	28	71	0.7 U	0.5 U
Ostrich Bay	MVS-026	47	30	73	0.4 U	0.5 U
Ostrich Bay	MVS-027	50	30	77	0.8 U	0.3 U
Ostrich Bay	MVS-028	22 J	12 J	46	0.7 U	ND
Ostrich Bay	MVS-029	48	31	91	2.2 J	ND
Oyster Bay	MVS-052	37	28	78	2.3 J	0.4 U
Phinney Bay	MVS-054	22 J	12 J	46	1.3 J	1.8 J

Table 5. (continued)

Location Description	Station or OUB Grid Cell	XRF Screening Concentration (mg/kg)				
		Cu	Pb	Zn	Cd	Ag
SQS		**390**	**450**	**410**	**5.1**	**6.1**
90% SQS		**351**	**405**	**369**	**4.6**	**5.5**
MCUL		**390**	**530**	**960**	**6.7**	**6.1**
Port Orchard Passage	MVS-037	21 J	7 J	43	1.6 J	ND
Port Orchard Passage	MVS-038	22 J	6 J	38	0.6 U	ND
Port Orchard Passage	MVS-039	21 J	11 J	34	0.4 U	1.0 J
Port Orchard Passage	MVS-040	36	18	70	0.7 U	ND
Port Orchard Passage	MVS-041	45	21	68	ND	ND
Port Orchard Passage	MVS-042	25 J	18	52	0.7 U	0.3 U
Port Orchard Passage	MVS-043	13 J	11 J	33	1.6 J	2.3 J
Port Orchard Passage	MVS-044	18 J	9 J	29	ND	0.0 U
Port Orchard Passage	MVS-045	35	23	62	0.5 U	0.2 U
Port Orchard Passage	MVS-046	30	18	44	ND	ND
Port Orchard Passage (Ref)	MVS-047	55	22	72	1.5 J	0.4 U
Port Orchard Passage (Ref)	MVS-048	25 J	14 J	43	0.5 U	1.7 J
Port Orchard Passage (Ref)	MVS-049	39	19	72	1.1 J	1.2 J
Rich Passage, north	MVS-050	9 J	9 J	24 J	0.4 U	0.5 U
Rich Passage, NW of Orchard Rocks	MVS-057	21 J	10 J	38	0.3 U	0.7 U
Clam Bay north, near Manchester Pier	MVS-055	13 J	4 J	25 J	1.6 J	0.4 U
Clam Bay South, off mouth of Little Clam Bay	MVS-056	14 J	6 J	28	ND	0.9 U
Port Orchard Passage, Fletcher Bay entrance	MVS-058	27 J	14 J	47	2.1 J	ND
Port Orchard Passage, Brownsville	MVS-059	32	6 J	53	1.5 J	ND
OU B Marine (500-ft grid)	OUBM-G 01	99	52	137	2.7 J	1.4 J
OU B Marine (500-ft grid)	OUBM-G 02	94	48	96	1.7 J	1.0 J
OU B Marine (500-ft grid)	OUBM-G 03	71	33	106	1.5 J	1.3 J
OU B Marine (500-ft grid)	OUBM-G 04	87	45	99	1.6 J	0.7 U
OU B Marine (500-ft grid)	OUBM-G 05	78	49	102	1.5 J	0.9 U
OU B Marine (500-ft grid)	OUBM-G 06	106	59	129	1.0 J	2.4 J
OU B Marine (500-ft grid)	OUBM-G 07	78	43	108	1.1 J	1.1 J
OU B Marine (500-ft grid)	OUBM-G 08	105	50	115	0.2 U	2.2 J
OU B Marine (500-ft grid)	OUBM-G 09	108	66	138	0.0 U	1.3 J
OU B Marine (500-ft grid)	OUBM-G 10	63	31	89	0.8 U	0.5 U
OU B Marine (500-ft grid)	OUBM-G 11	65	31	87	1.1 J	1.9 J
OU B Marine (500-ft grid)	OUBM-G 12	46	25	76	1.6 J	0.1 U
OU B Marine (500-ft grid)	OUBM-G 13	80	51	110	1.6 J	1.2 J
OU B Marine (500-ft grid)	OUBM-G 14	69	43	104	0.9 U	0.2 U
OU B Marine (500-ft grid)	OUBM-G 15	58	28	88	2.4 J	0.0 U

Table 5. (continued)

Location Description	Station or OUB Grid Cell	XRF Screening Concentration (mg/kg)				
		Cu	Pb	Zn	Cd	Ag
SQS		**390**	**450**	**410**	**5.1**	**6.1**
90% SQS		**351**	**405**	**369**	**4.6**	**5.5**
MCUL		**390**	**530**	**960**	**6.7**	**6.1**
OU B Marine (500-ft grid)	OUBM-G 16	51	28	83	1.8 J	0.9 U
OU B Marine (500-ft grid)	OUBM-G 17	68	36	97	0.1 U	1.4 J
OU B Marine (500-ft grid)	OUBM-G 18	57	31	76	ND	0.1 U
OU B Marine (500-ft grid)	OUBM-G 19	62	30	91	1.4 J	1.0 J
OU B Marine (500-ft grid)	OUBM-G 20	66	39	92	0.7 U	0.8 U
OU B Marine (500-ft grid)	OUBM-G 21	78	31	85	ND	ND
OU B Marine (500-ft grid)	OUBM-G 22	79	48	103	1.9 J	0.5 U
OU B Marine (500-ft grid)	OUBM-G 23	92	45	102	1.6 J	1.2 J
OU B Marine (500-ft grid)	OUBM-G 24	114	44	131	1.5 J	ND
OU B Marine (500-ft grid)	OUBM-G 25	134	80	181	2.2 J	2.2 J
OU B Marine (500-ft grid)	OUBM-G 26	138	66	147	1.4 J	1.9 J
OU B Marine (500-ft grid)	OUBM-G 27	83	41	106	0.3 U	ND
OU B Marine (500-ft grid)	OUBM-G 28	122	42	134	0.6 U	0.6 U
OU B Marine (500-ft grid)	OUBM-G 29	146	102	166	2.3 J	1.1 J
OU B Marine (500-ft grid)	OUBM-G 30	108	49	120	2.1 J	1.6 J
OU B Marine (500-ft grid)	OUBM-G 31	83	45	101	1.0 J	0.7 U
OU B Marine (500-ft grid)	OUBM-G 32	87	41	105	0.6 U	0.1 U
OU B Marine (500-ft grid)	OUBM-G 33	135	64	168	1.8 J	0.6 U
OU B Marine (500-ft grid)	OUBM-G 34	152	98	247	2.0 J	1.0 J
OU B Marine (500-ft grid)	OUBM-G 35	80	43	93	0.3 U	0.1 U
OU B Marine (500-ft grid)	OUBM-G 36	105	56	133	0.4 U	0.6 U
OU B Marine (500-ft grid)	OUBM-G 37	98	55	132	ND	0.6 U
OU B Marine (500-ft grid)	OUBM-G 38	97	63	131	0.1 U	0.6 U
OU B Marine (500-ft grid)	OUBM-G 39	181	94	**425** [d]	0.7 U	1.3 J
OU B Marine (500-ft grid)	OUBM-G 40	99	55	142	ND	ND
OU B Marine (500-ft grid)	OUBM-G 41	89	47	125	0.8 U	0.6 U
OU B Marine (500-ft grid)	OUBM-G 42	100	52	129	0.0 U	0.1 U
OU B Marine (500-ft grid)	OUBM-G 43	106	49	148	2.6 J	ND
OU B Marine (500-ft grid)	OUBM-G 44	85	46	113	ND	0.9 U
OU B Marine (500-ft grid)	OUBM-G 45	114	60	151	2.2 J	1.5 J
OU B Marine (500-ft grid)	OUBM-G 46	133	92	286	1.7 J	1.8 J
OU B Marine (500-ft grid)	OUBM-G 47	84	45	125	0.3 U	0.4 U
OU B Marine (500-ft grid)	OUBM-G 48	70	34	90	ND	1.2 J
OU B Marine (500-ft grid)	OUBM-G 49	146	107	250	0.3 U	0.9 U
OU B Marine (500-ft grid)	OUBM-G 50	92	38	113	0.2 U	ND

Table 5. (continued)

Location Description	Station or OUB Grid Cell	XRF Screening Concentration (mg/kg)				
		Cu	**Pb**	**Zn**	**Cd**	**Ag**
SQS		**390**	**450**	**410**	**5.1**	**6.1**
90% SQS		**351**	**405**	**369**	**4.6**	**5.5**
MCUL		**390**	**530**	**960**	**6.7**	**6.1**
OU B Marine (500-ft grid)	OUBM-G 51	65	36	95	ND	0.4 U
OU B Marine (500-ft grid)	OUBM-G 52	247	171	**417**	1.1 J	0.8 U
OU B Marine (500-ft grid)	OUBM-G 53	74	45	112	0.8 U	ND
OU B Marine (500-ft grid)	OUBM-G 54	68	41	105	1.5 J	1.7 J
OU B Marine (500-ft grid)	OUBM-G 55	133	65	188	2.2 J	ND
OU B Marine (500-ft grid)	OUBM-G 56	122	61	166	1.5 J	0.5 U
OU B Marine (500-ft grid)	OUBM-G 57	100	87	177	1.2 J	ND
OU B Marine (500-ft grid)	OUBM-G 58	71	41	104	1.1 J	0.3 U
OU B Marine (500-ft grid)	OUBM-G 59	152	117	280	1.4 J	2.4 J
OU B Marine (500-ft grid)	OUBM-G 60	126	75	291	1.1 J	1.2 J
OU B Marine (500-ft grid)	OUBM-G 61	75	167	191	0.1 U	0.1 U
OU B Marine (500-ft grid)	OUBM-G 62	67	48	109	1.4 J	0.2 U
OU B Marine (500-ft grid)	OUBM-G 63	192	107	253	0.0 U	0.0 U
OU B Marine (500-ft grid)	OUBM-G 64	149	113	279	1.5 J	ND
OU B Marine (500-ft grid)	OUBM-G 65	118	70	197	ND	1.1 J
OU B Marine (500-ft grid)	OUBM-G 66	87	66	249	2.0 J	0.7 U
OU B Marine (500-ft grid)	OUBM-G 67	211	140	283	1.9 J	0.4 U
OU B Marine (500-ft grid)	OUBM-G 68	129	67	558	1.2 J	1.4 J
OU B Marine (500-ft grid)	OUBM-G 69	79	50	117	1.2 J	0.1 U
OU B Marine (500-ft grid)	OUBM-G 70	69	43	103	0.3 U	1.9 J
OU B Marine (500-ft grid)	OUBM-G 71	49	27	61	ND	ND
Outside OU B (1500-ft grid)	OOUB-G 01	63	102	260	0.5 U	0.9 U
Outside OU B (1500-ft grid)	OOUB-G 02	23 J	13 J	42	0.1 U	0.6 U
Outside OU B (1500-ft grid)	OOUB-G 03	36	13 J	53	0.1 U	1.0 J
Outside OU B (1500-ft grid)	OOUB-G 04	21 J	12 J	52	0.2 U	0.6 U
Outside OU B (1500-ft grid)	OOUB-G 05	74	31	91	1.6 J	1.2 J
Outside OU B (1500-ft grid)	OOUB-G 06	78	39	100	1.4 J	1.3 J
Outside OU B (1500-ft grid)	OOUB-G 07	92	45	110	1.9 J	1.7 J
Outside OU B (1500-ft grid)	OOUB-G 08	100	46	102	1.1 J	0.7 U
Outside OU B (1500-ft grid)	OOUB-G 09	86	41	109	0.9 U	0.3 U
Outside OU B (1500-ft grid)	OOUB-G 10	79	44	101	0.5 U	0.1 U
Outside OU B (1500-ft grid)	OOUB-G 11	85	44	94	0.5 U	0.2 U
Outside OU B (1500-ft grid)	OOUB-G 12	33	16	51	ND	0.3 U
Outside OU B (1500-ft grid)	OOUB-G 13	69	49	114	ND	0.2 U
Outside OU B (1500-ft grid)	OOUB-G 14	73	40	116	ND	0.7 U
Outside OU B (1500-ft grid)	OOUB-G 15	79	39	96	2.6 J	1.0 J

Table 5. (continued)

Location Description	Station or OUB Grid Cell	XRF Screening Concentration (mg/kg)				
		Cu	Pb	Zn	Cd	Ag
SQS		**390**	**450**	**410**	**5.1**	**6.1**
90% SQS		**351**	**405**	**369**	**4.6**	**5.5**
MCUL		**390**	**530**	**960**	**6.7**	**6.1**
Outside OU B (1500-ft grid)	OOUB-G 16	76	39	114	1.3 J	ND
Outside OU B (1500-ft grid)	OOUB-G 17	75	46	97	1.7 J	0.8 U
Outside OU B (1500-ft grid)	OOUB-G 18	88	44	100	ND	0.1 U
Outside OU B (1500-ft grid)	OOUB-G 19	69	43	101	1.2 J	1.7 J
Outside OU B (1500-ft grid)	OOUB-G 20	63	34	84	0.2 U	2.6 J
Outside OU B (1500-ft grid)	OOUB-G 21	75	47	102	1.4 J	0.9 U
Outside OU B (1500-ft grid)	OOUB-G 22	65	43	92	1.8 J	0.8 U
Outside OU B (1500-ft grid)	OOUB-G 23	62	31	79	0.3 U	ND
Outside OU B (1500-ft grid)	OOUB-G 24	84	49	102	0.3 U	1.2 J
Outside OU B (1500-ft grid)	OOUB-G 25	60	32	87	0.3 U	ND
Outside OU B (1500-ft grid)	OOUB-G 26	16 J	9 J	40	1.1 J	ND
Outside OU B (1500-ft grid)	OOUB-G 27	58	34	87	2.4 J	0.7 U
Outside OU B (1500-ft grid)	OOUB-G 28	66	38	99	0.3 U	1.5 J
Outside OU B (1500-ft grid)	OOUB-G 29	43	28	79	0.4 U	0.5 U
Outside OU B (1500-ft grid)	OOUB-G 30	15 J	11 J	42	ND	ND
Outside OU B (1500-ft grid)	OOUB-G 31	62	39	96	0.4 U	0.9 U
Outside OU B (1500-ft grid)	OOUB-G 32	45	31	76	ND	0.8 U

a. J Estimated value above method detection limit but below quantitation limit.
b. U Value is less than method detection limit.
c. ND The analyte was not detected.
d. Bold text in highlighted box indicates XRF result >90% SQS.

XRF data were examined to identify samples that met the selection criteria for confirmatory analysis. The criterion for concentrations ≥90% SQS was applied two ways: first, directly to the XRF results, and second, to predicted concentrations calculated using the existing linear correlation for Sinclair-Dyes Inlets that was generated during the Mass Balance study (Figure 11, Miller et al. 2003). The 40 samples (25%) selected for confirmatory analysis by ICP-MS and the rationale for their selection are provided in Table 6; the number of samples from each geographical area of the Sinclair-Dyes Inlet study area is summarized in Table 7.

Table 6. Samples Selected for Confirmatory Metals Analysis by ICP-MS

Selection Criteria	Selected Samples	Comments
XRF result ≥ 90% SQS	OUBM-G39, G52, G68	
Predicted concentration ≥ 90% SQS (calculated by applying Mass Balance XRF:ICP-MS correlation to present XRF result)	OUBM-G46, G59, G60, G64, G67	Most are located within listed segments
At least 3 samples per 303(d) segment listed for Cd or Ag	OUBM- G34, G36, G40, G42, G43, G45, G56 OOUB-G27 MVS-019, 024, 025, 026, 027, 022	Additional samples in listed segments, also covers high end of concentration range and possible spatial gradient from nearshore samples OOUB-G27 is only 1500-ft grid entirely within a listed segment Located in Ostrich Bay
XRF result much different from expected	None	No samples met this criterion
Representative of concentration range, and/or spatial distribution	OUBM-G66 OOUB-G21, G24, G28 OOUB-G01, G07, G13, G18, G26 MVS-002, 007, 013, 034, 039, 043, 047, 056	High end of concentration range Border listed segments; possible gradient from nearshore stations Spatial representation Spatial representation, distribution

Table 7. Metals Verification Study Sample Analysis Summary

Location	Number of XRF Screening Samples	Number of ICP-MS Confirmatory Samples
Sinclair Inlet, Inside PSNS OU-B	71	17
Sinclair Inlet, Outside PSNS OU-B	32	9
Sinclair Inlet Subtotal	103	26
Ostrich & Oyster Bays	12	6
Dyes Inlet (outside Ostrich Bay), Phinney Bay	26	4
Port Orchard Passage and Rich Passage	19	4
Dyes Inlet, Port Washington Narrows, Port Orchard & Rich Passages Subtotal	57	14
TOTAL	160	40

The results of confirmatory, quantitative metals analysis by ICP-MS on selected Metals Verification Study samples are provided in Table 8. The laboratory data report for ICP-MS analysis, including narrative summary and QC data, is provided in Appendix B. The ICP-MS quantitative data were validated by acceptable results for all QC measures. Target metals were undetected in the method blanks, and precision between laboratory duplicates was very good with relative percent differences (RPD) between duplicates of 1% to 8% (QC criterion is ±30%). Accuracy of measurements was assessed three different ways, with acceptable results for all three: matrix spike recoveries were 77% to 122% and laboratory control sample (blank spike) recoveries were 90% to 115%, both within the QC criterion range of 70% to 130%; standard reference material results were within 20% of the certified values.

3.3 Correlation of Screening and Quantitative Results

To predict actual metal concentrations from XRF screening data, quantitative analytical results for the 40 confirmatory samples were plotted against screening results for the same samples. Positive linear correlations were developed for Pb, Cu, and Zn, which were the only metals reliably detected by XRF in the majority of samples (Figure 16). There was one outlier sample for each metal, probably due to sample inhomogeneity as the outlier samples were all located in between PSNS piers where variable particulate metal concentrations are expected (OUBM-G59, -G60, and -G67, Figure 14). When these outlier values were removed from the correlation, the XRF results for Cu and Pb correlated very well with ICP-MS results (R^2 values were 0.876 for Cu, 0.932 for Pb). Zn measured by XRF correlated well with ICP-MS results (R^2 of 0.730), especially up to XRF concentrations of 200 ppm. However, when the XRF concentration was 250 ppm Zn or higher, there was much more variability between data points and the linear relationship between the two methods did not appear to be as strong. The resulting linear equations with outliers removed were used to predict a definitive metal concentration from the XRF result for those samples that did not receive confirmatory analysis (Table 9).

Table 8. Confirmatory Metals Analysis Results, Metals Verification Study

Location Description	MVS Station or OU B Grid Cell	Metal Concentration (mg/kg dry wt)							
		Ag[a]	Cr	Ni	Cu	Zn	As	Cd	Pb
Dyes Depositional Zone 1 (North)	MVS-002	0.120	60.0	22.8	16.4	46.6	4.17	0.783	12.2
Dyes Depositional Zone 2 (West)	MVS-007	0.790	96.8	49.0	78.8	159	14.8	1.26	63.8
Dyes Depositional Zone 3 (SW)	MVS-013	0.609	98.7	45.6	63.0	140	12.3	1.07	52.9
Dyes Depositional Zone 4 (South)	MVS-019	0.156	75.7	31.6	25.7	66.1	6.38	0.631	17.6
Dyes Depositional Zone 4 (South)	MVS-022	0.681	113	45.9	65.6	132	11.8	1.80	45.4
Ostrich Bay	MVS-024	0.484	95.9	41.2	54.6	113	10.4	0.986	41.7
Ostrich Bay	MVS-025	0.544	91.1	43.1	58.7	118	11.2	1.17	43.6
Ostrich Bay	MVS-026	0.489	100	41.6	52.7	112	10.6	1.15	39.4
Ostrich Bay	MVS-027	0.611	102	44.2	62.3	126	10.9	1.53	44.0
Ostrich Bay	MVS-028	0.127	67.4	30.5	17.6	50.9	5.60	0.525	12.2
Dyes Inlet Nondepositional (East)	MVS-034	0.063	71.7	24.3	10.4	41.1	3.64	0.206	9.50
Port Orchard Passage	MVS-039	0.056	43.4	27.3	11.8	47.9	4.04	0.136	11.1
Port Orchard Passage	MVS-043	0.056	52.1	19.1	9.56	37.9	3.83	0.184	11.1
Port Orchard Passage	MVS-047	0.534	81.3	43.7	58.8	126	13.4	0.846	41.6
Clam Bay South, off mouth of Little Clam Bay	MVS-056	0.080	46.7	15.7	11.8	43.4	4.29	0.656	8.69
OU-B Marine (500-ft grid)	OUBM-G 34	2.38	91.8	45.4	171	391	20.2	1.51	132
OU-B Marine (500-ft grid)	OUBM-G 36	0.838	99.6	59.5	150	185	14.9	1.09	86.3
OU-B Marine (500-ft grid)	OUBM-G 39	1.11	84.1	40.6	173	288	11.9	1.39	128
OU-B Marine (500-ft grid)	OUBM-G 40	0.709	108	49.9	135	208	12.1	1.33	84.9
OU-B Marine (500-ft grid)	OUBM-G 42	0.688	103	77.2	180	188	13.1	1.06	77.8
OU-B Marine (500-ft grid)	OUBM-G 43	0.588	84.0	51.4	155	241	15.8	1.12	74.3
OU-B Marine (500-ft grid)	OUBM-G 45	0.740	88.7	48.4	154	238	13.1	1.44	90.0
OU-B Marine (500-ft grid)	OUBM-G 46	0.495	105	40.1	142	428 D[b]	15.8	0.621	155
OU-B Marine (500-ft grid)	OUBM-G 52	1.07	119	79.1	398 D	785 D	36.1	1.30	279
OU-B Marine (500-ft grid)	OUBM-G 56	0.691	99.9	47.5	194	324 D	19.6	1.54	105
OU-B Marine (500-ft grid)	OUBM-G 59	0.712	102	52.9	272	736	23.1	3.17	439 D
OU-B Marine (500-ft grid)	OUBM-G 60	0.642	85.7	45.5	200	1480 D	19.7	2.01	180
OU-B Marine (500-ft grid)	OUBM-G 64	0.777	98.1	51.7	230	425 D	19.9	1.85	209

Table 8. (continued)

Location Description	MVS Station or OU B Grid Cell	Metal Concentration (mg/kg dry wt)							
		Ag[a]	Cr	Ni	Cu	Zn	As	Cd	Pb
OU-B Marine (500-ft grid)	OUBM-G 66	0.547	101	46.1	227	428 D	15.2	1.71	159
OU-B Marine (500-ft grid)	OUBM-G 67	1.03	104	479	710 D	547 D	43.0	1.53	204
OU-B Marine (500-ft grid)	OUBM-G 68	0.762	103	54.7	217	526 D	20.6	1.72	144
Outside OU B Marine (1500-ft grid)	OOUB-G 01	0.175	114	97.0	102	547 D	15.3	0.479	198
Outside OU B Marine (1500-ft grid)	OOUB-G 07	1.35	109	53.4	130	177	17.2	2.47	72.3
Outside OU B Marine (1500-ft grid)	OOUB-G 13	0.971	98.0	48.0	116	164	14.6	1.30	83.8
Outside OU B Marine (1500-ft grid)	OOUB-G 18	0.943	96.4	47.7	117	159	15.9	1.04	75.1
Outside OU B Marine (1500-ft grid)	OOUB-G 21	0.715	99.7	48.6	102	159	15.9	1.32	71.8
Outside OU B Marine (1500-ft grid)	OOUB-G 24	0.705	87.4	45.4	107	162	13.8	0.797	72.0
Outside OU B Marine (1500-ft grid)	OOUB-G 26	0.042	83.6	27.0	11.7	45.4	2.67	0.193	8.53
Outside OU B Marine (1500-ft grid)	OOUB-G 27	0.417	84.8	42.5	72.5	128	11.7	1.04	55.4
Outside OU B Marine (1500-ft grid)	OOUB-G 28	0.500	84.5	42.6	76.1	141	12.3	0.778	58.4

a. Ag was analyzed by graphite-furnace atomic absorption for comparability with other ENVVEST data; all other metals analyzed by ICP-MS.
b. D Diluted analysis (100x)

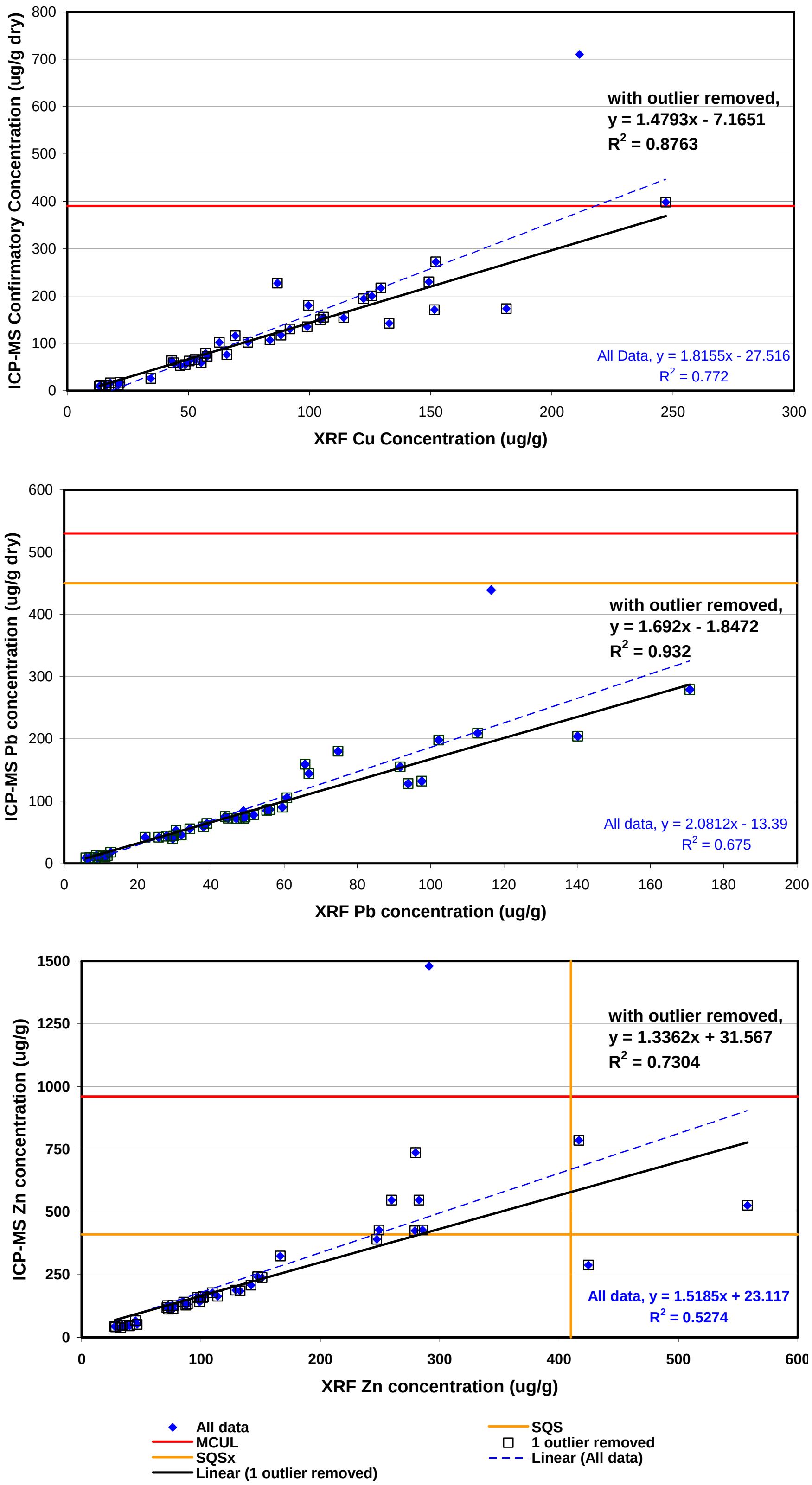

Figure 16. Linear correlations of XRF and ICP-MS measurements for Cu (top), Pb (middle), Zn (bottom), ENVVEST Metals Verification Study

Table 9. Definitive Sediment Metals Concentrations, Metals Verification Study

Location Description	Station or OUB Grid Cell	Confirm-atory Sample?	Definitive[a] Concentration (mg/kg dry weight)							
			Cu	Pb	Zn	Cd[b]		Ag[b]	
SQS			**390**	**450**	**410**	**5.1**		**6.1**	
MCUL			**390**	**530**	**960**	**6.7**		**6.1**	
Dyes Depositional Zone	MVS-001	No	44	27.5	109	1.2	J[c]	0.1	U[d]
Dyes Depositional Zone	MVS-002	Yes	16	12.2	47	0.783		0.12	
Dyes Depositional Zone	MVS-003	No	61	48.5	144	0.5	U	0.3	U
Dyes Depositional Zone	MVS-004	No	86	68.0	163	ND		0.9	U
Dyes Depositional Zone	MVS-005	No	76	62.6	153	0.6	U	1.4	J
Dyes Depositional Zone	MVS-006	No	29	25.6	101	0.8	U	0.4	U
Dyes Depositional Zone	MVS-007	Yes	79	63.8	159	1.26		0.79	
Dyes Depositional Zone	MVS-008	No	54	38.7	145	ND		0.9	U
Dyes Depositional Zone	MVS-009	No	63	59.3	146	0.7	U	1.8	J
Dyes Depositional Zone	MVS-010	No	63	50.3	153	0.5	U	0.2	U
Dyes Depositional Zone	MVS-011	No	56	60.9	158	0.5	U	0.8	U
Dyes Depositional Zone	MVS-012	No	77	63.2	157	0.4	U	0.6	U
Dyes Depositional Zone	MVS-013	Yes	63	52.9	140	1.07		0.609	
Dyes Depositional Zone	MVS-014	No	48	23.4	114	ND		ND	
Dyes Depositional Zone	MVS-015	No	34	13.5	110	0.0	U	0.4	U
Dyes Depositional Zone	MVS-016	No	43	21.5	118	0.7	U	0.1	U
Dyes Depositional Zone	MVS-017	No	60	44.4	137	0.3	U	0.3	U
Dyes Depositional Zone	MVS-018	No	57	59.4	144	1.5	J	0.9	U
Dyes Depositional Zone	MVS-019	Yes	26	17.6	66	0.631		0.156	
Dyes Depositional Zone	MVS-020	No	59	52.5	134	ND		ND	
Dyes Depositional Zone	MVS-021	No	60	42.7	128	1.0	J	1.3	J
Dyes Depositional Zone	MVS-022	Yes	66	45.4	132	1.80		0.681	
Dyes Inlet Nondepositional	MVS-030	No	18	11.0	73	0.8	U	ND	
Dyes Inlet Nondepositional	MVS-031	No	36	21.7	97	1.3	J	ND	
Dyes Inlet Nondepositional	MVS-032	No	17	11.2	76	ND		ND	
Dyes Inlet Nondepositional	MVS-033	No	35	35.1	103	ND		1.3	J
Dyes Inlet Nondepositional	MVS-034	Yes	10	9.5	41	0.21		0.06	
Dyes Inlet Nondepositional	MVS-035	No	17	9.7	81	0.8	U	ND	
Dyes Inlet Nondepositional	MVS-036	No	19	14.7	76	ND		ND	
Ostrich Bay	MVS-023	No	75	58.5	156	0.2	U	0.5	U
Ostrich Bay	MVS-024	Yes	55	41.7	113	0.986		0.484	
Ostrich Bay	MVS-025	Yes	59	43.6	118	1.17		0.544	
Ostrich Bay	MVS-026	Yes	53	39.4	112	1.15		0.489	
Ostrich Bay	MVS-027	Yes	62	44.0	126	1.53		0.611	
Ostrich Bay	MVS-028	Yes	18	12.2	51	0.525		0.127	
Ostrich Bay	MVS-029	No	63	50.7	153	2.2	J	ND	
Oyster Bay	MVS-052	No	47	45.5	136	2.3	J	0.4	U
Phinney Bay	MVS-054	No	25	18.2	93	1.3	J	1.8	J

Table 9. (continued)

Location Description	Station or OUB Grid Cell	Confirm -atory Sample?	Definitive[a] Concentration (mg/kg dry weight)						
			Cu	Pb	Zn	Cd[b]		Ag[b]	
SQS			**390**	**450**	**410**	**5.1**		**6.1**	
MCUL			**390**	**530**	**960**	**6.7**		**6.1**	
Port Orchard Passage	MVS-037	No	24	10.4	90	1.6	J	ND	
Port Orchard Passage	MVS-038	No	25	7.7	82	0.6	U	ND	
Port Orchard Passage	MVS-039	Yes	12	11.1	48	0.136		0.056	
Port Orchard Passage	MVS-040	No	46	28.9	125	0.7	U	ND	
Port Orchard Passage	MVS-041	No	59	33.1	123	ND		ND	
Port Orchard Passage	MVS-042	No	31	28.7	101	0.7	U	0.3	U
Port Orchard Passage	MVS-043	Yes	10	11.1	38	0.184		0.056	
Port Orchard Passage	MVS-044	No	20	13.1	71	ND		0.0	U
Port Orchard Passage	MVS-045	No	44	36.3	114	0.5	U	0.2	U
Port Orchard Passage	MVS-046	No	37	28.7	91	ND		ND	
Port Orchard Passage	MVS-047	Yes	59	41.6	126	0.846		0.534	
Port Orchard Passage	MVS-048	No	29	21.7	89	0.5	U	1.7	J
Port Orchard Passage	MVS-049	No	50	31.0	127	1.1	J	1.2	J
Port Orchard Passage, Fletcher Bay entrance	MVS-058	No	33	22.2	94	2.1	J	ND	
Port Orchard Passage, Brownsville	MVS-059	No	40	9.1	102	1.5	J	ND	
Rich Passage, north	MVS-050	No	6	12.8	63	0.4	U	0.5	U
Clam Bay north, near Manchester Pier	MVS-055	No	12	5.5	65	1.6	J	0.4	U
Clam Bay South, off mouth of Little Clam Bay	MVS-056	Yes	12	8.7	43	0.656		0.08	
Rich Passage, NW of Orchard Rocks	MVS-057	No	24	14.3	82	0.3	U	0.7	U
OU-B Marine (500-ft grid)	OUBM-G 01	No	140	85.8	215	2.7	J	1.4	J
OU-B Marine (500-ft grid)	OUBM-G 02	No	131	80.0	160	1.7	J	1.0	J
OU-B Marine (500-ft grid)	OUBM-G 03	No	98	53.8	173	1.5	J	1.3	J
OU-B Marine (500-ft grid)	OUBM-G 04	No	122	74.5	164	1.6	J	0.7	U
OU-B Marine (500-ft grid)	OUBM-G 05	No	109	80.6	168	1.5	J	0.9	U
OU-B Marine (500-ft grid)	OUBM-G 06	No	150	98.3	203	1.0	J	2.4	J
OU-B Marine (500-ft grid)	OUBM-G 07	No	109	71.6	175	1.1	J	1.1	J
OU-B Marine (500-ft grid)	OUBM-G 08	No	149	82.3	186	0.2	U	2.2	J
OU-B Marine (500-ft grid)	OUBM-G 09	No	152	109.3	217	0.0	U	1.3	J
OU-B Marine (500-ft grid)	OUBM-G 10	No	86	51.4	151	0.8	U	0.5	U
OU-B Marine (500-ft grid)	OUBM-G 11	No	89	50.0	147	1.1	J	1.9	J
OU-B Marine (500-ft grid)	OUBM-G 12	No	61	41.0	133	1.6	J	0.1	U
OU-B Marine (500-ft grid)	OUBM-G 13	No	110	83.8	178	1.6	J	1.2	J
OU-B Marine (500-ft grid)	OUBM-G 14	No	95	70.4	171	0.9	U	0.2	U
OU-B Marine (500-ft grid)	OUBM-G 15	No	78	44.8	148	2.4	J	0.0	U
OU-B Marine (500-ft grid)	OUBM-G 16	No	68	46.2	142	1.8	J	0.9	U
OU-B Marine (500-ft grid)	OUBM-G 17	No	94	59.3	161	0.1	U	1.4	J
OU-B Marine (500-ft grid)	OUBM-G 18	No	77	50.2	133	ND		0.1	U
OU-B Marine (500-ft grid)	OUBM-G 19	No	84	48.8	153	1.4	J	1.0	J
OU-B Marine (500-ft grid)	OUBM-G 20	No	90	64.8	154	0.7	U	0.8	U

Table 9. (continued)

Location Description	Station or OUB Grid Cell	Confirm - atory Sample?	Definitive[a] Concentration (mg/kg dry weight)				
			Cu	Pb	Zn	Cd[b]	Ag[b]
SQS			**390**	**450**	**410**	**5.1**	**6.1**
MCUL			**390**	**530**	**960**	**6.7**	**6.1**
OU-B Marine (500-ft grid)	OUBM-G 21	No	108	51.0	145	ND	ND
OU-B Marine (500-ft grid)	OUBM-G 22	No	109	78.6	169	1.9 J	0.5 U
OU-B Marine (500-ft grid)	OUBM-G 23	No	128	74.1	168	1.6 J	1.2 J
OU-B Marine (500-ft grid)	OUBM-G 24	No	161	72.6	206	1.5 J	ND
OU-B Marine (500-ft grid)	OUBM-G 25	No	191	134	273	2.2 J	2.2 J
OU-B Marine (500-ft grid)	OUBM-G 26	No	197	111	228	1.4 J	1.9 J
OU-B Marine (500-ft grid)	OUBM-G 27	No	116	68.0	173	0.3 U	ND
OU-B Marine (500-ft grid)	OUBM-G 28	No	174	69.7	210	0.6 U	0.6 U
OU-B Marine (500-ft grid)	OUBM-G 29	No	209	170	253	2.3 J	1.1 J
OU-B Marine (500-ft grid)	OUBM-G 30	No	152	81.8	192	2.1 J	1.6 J
OU-B Marine (500-ft grid)	OUBM-G 31	No	116	73.8	166	1.0 J	0.7 U
OU-B Marine (500-ft grid)	OUBM-G 32	No	121	67.1	172	0.6 U	0.1 U
OU-B Marine (500-ft grid)	OUBM-G 33	No	193	106	256	1.8 J	0.6 U
OU-B Marine (500-ft grid)	OUBM-G 34	Yes	171	132	391	1.51	2.38
OU-B Marine (500-ft grid)	OUBM-G 35	No	111	70.5	155	0.3 U	0.1 U
OU-B Marine (500-ft grid)	OUBM-G 36	Yes	150	86.3	185	1.09	0.838
OU-B Marine (500-ft grid)	OUBM-G 37	No	139	91.6	207	ND	0.6 U
OU-B Marine (500-ft grid)	OUBM-G 38	No	137	105	207	0.1 U	0.6 U
OU-B Marine (500-ft grid)	OUBM-G 39	Yes	173	128	288	1.39	1.11
OU-B Marine (500-ft grid)	OUBM-G 40	Yes	135	84.9	208	1.33	0.709
OU-B Marine (500-ft grid)	OUBM-G 41	No	125	77.4	199	0.8 U	0.6 U
OU-B Marine (500-ft grid)	OUBM-G 42	Yes	180	77.8	188	1.06	0.688
OU-B Marine (500-ft grid)	OUBM-G 43	Yes	155	74.3	241	1.12	0.588
OU-B Marine (500-ft grid)	OUBM-G 44	No	118	76.6	182	0.0 U	0.9 U
OU-B Marine (500-ft grid)	OUBM-G 45	Yes	154	90.0	238	1.44	0.74
OU-B Marine (500-ft grid)	OUBM-G 46	Yes	142	155	**428**[e]	0.621	0.495
OU-B Marine (500-ft grid)	OUBM-G 47	No	117	73.8	199	0.3 U	0.4 U
OU-B Marine (500-ft grid)	OUBM-G 48	No	97	56.5	152	ND	1.2 J
OU-B Marine (500-ft grid)	OUBM-G 49	No	209	180	366	0.3 U	0.9 U
OU-B Marine (500-ft grid)	OUBM-G 50	No	129	62.8	182	0.2 U	ND
OU-B Marine (500-ft grid)	OUBM-G 51	No	89	58.5	158	ND	0.4 U
OU-B Marine (500-ft grid)	OUBM-G 52	Yes	**398**	279	**785**	1.30	1.07
OU-B Marine (500-ft grid)	OUBM-G 53	No	103	73.9	181	0.8 U	ND
OU-B Marine (500-ft grid)	OUBM-G 54	No	94	66.7	171	1.5 J	1.7 J
OU-B Marine (500-ft grid)	OUBM-G 55	No	190	109	282	2.2 J	ND
OU-B Marine (500-ft grid)	OUBM-G 56	Yes	194	105	324	1.54	0.691
OU-B Marine (500-ft grid)	OUBM-G 57	No	140	145	268	1.2 J	ND
OU-B Marine (500-ft grid)	OUBM-G 58	No	99	67.9	171	1.1 J	0.3 U
OU-B Marine (500-ft grid)	OUBM-G 59	Yes	272	439	**736**	3.17	0.712
OU-B Marine (500-ft grid)	OUBM-G 60	Yes	200	180	**1480**	2.01	0.642
OU-B Marine (500-ft grid)	OUBM-G 61	No	103	280	286	0.1 U	0.1 U
OU-B Marine (500-ft grid)	OUBM-G 62	No	92	79.6	178	1.4 J	0.2 U
OU-B Marine (500-ft grid)	OUBM-G 63	No	276	180	369	0.0 U	0.0 U
OU-B Marine (500-ft grid)	OUBM-G 64	Yes	230	209	**425**	1.85	0.777

Table 9. (continued)

Location Description	Station or OUB Grid Cell	Confirm-atory Sample?	Definitive[a] Concentration (mg/kg dry weight)				
			Cu	Pb	Zn	Cd[b]	Ag[b]
SQS			**390**	**450**	**410**	**5.1**	**6.1**
MCUL			**390**	**530**	**960**	**6.7**	**6.1**
OU-B Marine (500-ft grid)	OUBM-G 65	No	167	116	295	ND	1.1 J
OU-B Marine (500-ft grid)	OUBM-G 66	Yes	227	159	**428**	1.71	0.547
OU-B Marine (500-ft grid)	OUBM-G 67	Yes	710	204	**547**	1.53	1.03
OU-B Marine (500-ft grid)	OUBM-G 68	Yes	217	144	**526**	1.72	0.762
OU-B Marine (500-ft grid)	OUBM-G 69	No	109	82.9	188	1.2 J	0.1 U
OU-B Marine (500-ft grid)	OUBM-G 70	No	96	70.8	170	0.3 U	1.9 J
OU-B Marine (500-ft grid)	OUBM-G 71	No	65	43.4	113	ND	ND
Outside OU B (1500-ft grid)	OOUB-G 01	Yes	102	198	**547**	0.479	0.175
Outside OU B (1500-ft grid)	OOUB-G 02	No	27	19.9	88	0.1 U	0.6 U
Outside OU B (1500-ft grid)	OOUB-G 03	No	46	20.7	102	0.1 U	1.0 J
Outside OU B (1500-ft grid)	OOUB-G 04	No	24	18.2	101	0.2 U	0.6 U
Outside OU B (1500-ft grid)	OOUB-G 05	No	102	50.0	153	1.6 J	1.2 J
Outside OU B (1500-ft grid)	OOUB-G 06	No	108	63.3	165	1.4 J	1.3 J
Outside OU B (1500-ft grid)	OOUB-G 07	Yes	130	72.3	177	2.47	1.35
Outside OU B (1500-ft grid)	OOUB-G 08	No	141	75.6	167	1.1 J	0.7 U
Outside OU B (1500-ft grid)	OOUB-G 09	No	120	66.8	177	0.9 U	0.3 U
Outside OU B (1500-ft grid)	OOUB-G 10	No	109	72.4	166	0.5 U	0.1 U
Outside OU B (1500-ft grid)	OOUB-G 11	No	118	72.1	157	0.5 U	0.2 U
Outside OU B (1500-ft grid)	OOUB-G 12	No	42	25.2	100	ND	0.3 U
Outside OU B (1500-ft grid)	OOUB-G 13	Yes	116	83.8	164	1.30	0.971
Outside OU B (1500-ft grid)	OOUB-G 14	No	100	66.5	187	ND	0.7 U
Outside OU B (1500-ft grid)	OOUB-G 15	No	109	64.4	160	2.6 J	1.0 J
Outside OU B (1500-ft grid)	OOUB-G 16	No	105	63.6	184	1.3 J	ND
Outside OU B (1500-ft grid)	OOUB-G 17	No	103	75.8	161	1.7 J	0.8 U
Outside OU B (1500-ft grid)	OOUB-G 18	Yes	117	75.1	159	1.04	0.943
Outside OU B (1500-ft grid)	OOUB-G 19	No	95	71.5	166	1.2 J	1.7 J
Outside OU B (1500-ft grid)	OOUB-G 20	No	85	54.9	143	0.2 U	2.6 J
Outside OU B (1500-ft grid)	OOUB-G 21	Yes	102	71.8	159	1.32	0.715
Outside OU B (1500-ft grid)	OOUB-G 22	No	88	71.3	154	1.8 J	0.8 U
Outside OU B (1500-ft grid)	OOUB-G 23	No	84	50.6	138	0.3 U	ND
Outside OU B (1500-ft grid)	OOUB-G 24	Yes	107	72.0	162	0.80	0.705
Outside OU B (1500-ft grid)	OOUB-G 25	No	81	52.6	147	0.3 U	ND
Outside OU B (1500-ft grid)	OOUB-G 26	Yes	12	8.5	45	0.193	0.042
Outside OU B (1500-ft grid)	OOUB-G 27	Yes	73	55.4	128	1.04	0.417
Outside OU B (1500-ft grid)	OOUB-G 28	Yes	76	58.4	141	0.778	0.50
Outside OU B (1500-ft grid)	OOUB-G 29	No	56	46.0	137	0.4 U	0.5 U
Outside OU B (1500-ft grid)	OOUB-G 30	No	14	17.5	87	ND	ND
Outside OU B (1500-ft grid)	OOUB-G 31	No	84	64.7	160	0.4 U	0.9 U
Outside OU B (1500-ft grid)	OOUB-G 32	No	59	50.3	134	ND	0.8 U

a. Definitive concentrations are ICP-MS result for confirmatory samples; estimated by linear regression for non-confirmatory samples.
b. Ag and Cd values are GFAA or ICP-MS result for confirmatory samples; XRF result for non-confirmatory samples.
c. J XRF result estimated above method detection limit but below quantitation limit.
d. U XRF result less than method detection limit.
e. Bold type in highlighted box indicates definitive result greater than SQS.

4.0 DISCUSSION AND CONCLUSIONS

The Metals Verification Study was conducted to verify the present sediment metals concentrations in Sinclair and Dyes Inlets, where significant cleanup and source control actions have been implemented since the data were collected that led to placing several segments of those water bodies on the 303(d) list of impaired water bodies. The definitive metal concentrations are shown relative to Washington SQS and MCUL for Cu, Pb, and Zn in Figure 17. The vertical dashed lines indicate the major geographic divisions of outside Sinclair Inlet (Stations MVS-01 through MVS-59), inside Sinclair Inlet OU B Marine (OUBM-G01 through G71), and inside Sinclair Inlet but outside OU B Marine (OOUB-G01 through OOUB-G32).

Outside Sinclair Inlet, all Ag, Cd, Cu, Pb, and Zn concentrations were below Washington state SQS and MCUL (Figure 18); these sediment metals concentrations do not appear to be significant contributors to water quality impairment outside Sinclair Inlet, including Ostrich Bay in southern Dyes Inlet. Inside Sinclair Inlet, concentrations of Ag and Cd were below SQS in all sediment samples; therefore, the present-day data do not support 303(d) listing based on these metals in sediment. Present-day Cu, Pb, and Zn data also show that sediment metals concentrations are substantially lower than prior to cleanup and capping, with only the following samples exceeding state SQS or MCUL (Figure 19):

- Measured or predicted ICP-MS concentrations of Cu exceeded the SQS and MCUL in only 2 of the 103 samples, the composites representing OUBM Grids 52 and 67 (map Figure 14; chemistry results Figure 17).
- Measured or predicted ICP-MS concentrations of Zn exceeded the SQS in 6 of the 103 samples and the MCUL in just 1. Except for OOUB Grid 1 at Gorst, all of the samples were located in OU B Marine near PSNS piers or stormwater outfalls. OU-B continues to be managed and monitored under Superfund, and part of the source control efforts there includes stormwater monitoring and improvements to PSNS stormwater catchment systems. Zn at Gorst is likely due to nonpoint runoff sources as well as transport and deposition.

The primary outcome of the study was a nonstatistical comparison of target metal concentrations with Washington state SQS and MCUL, but the sampling and analysis design was intended to reduce uncertainty associated with the target measurements. The chance of false negatives (samples in which true metal concentration exceeds MCUL but measured concentration is less than MCUL) was limited by 1) increased sampling density where concentrations are likely to exceed SQS; 2) selecting methods and setting quality control limits to minimize analytical error; and 3) comparing screening level concentrations to 90% MCUL. The chance of false positives (samples in which true metal concentration is below MCUL but measured concentration exceeds MCUL) was also limited by appropriate sampling density, analytical method selection, and analytical quality control.

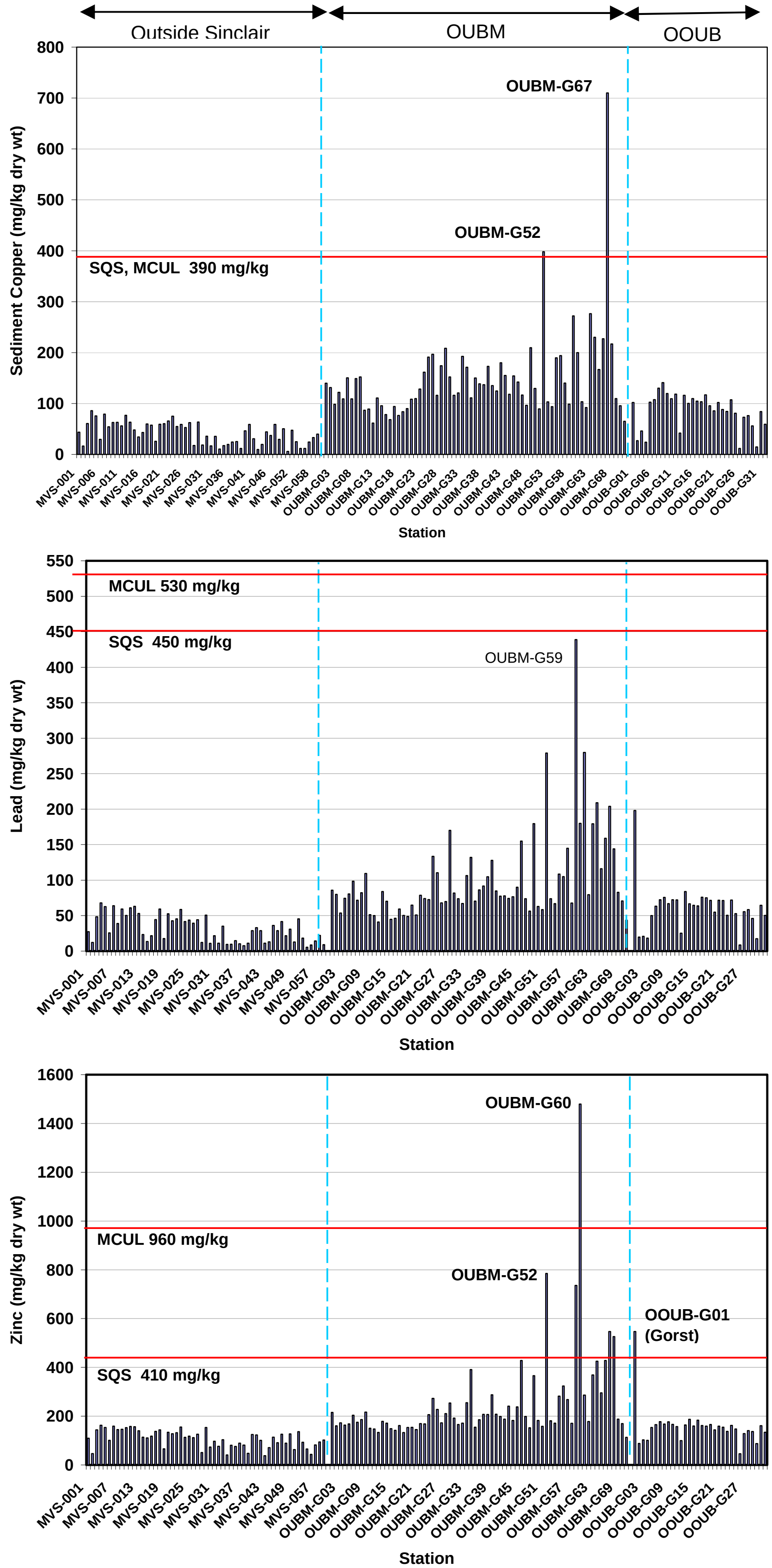

Figure 17. Definitive sediment Cu (top), Pb (middle), and Zn (bottom) ENVVEST Metals Verification Study

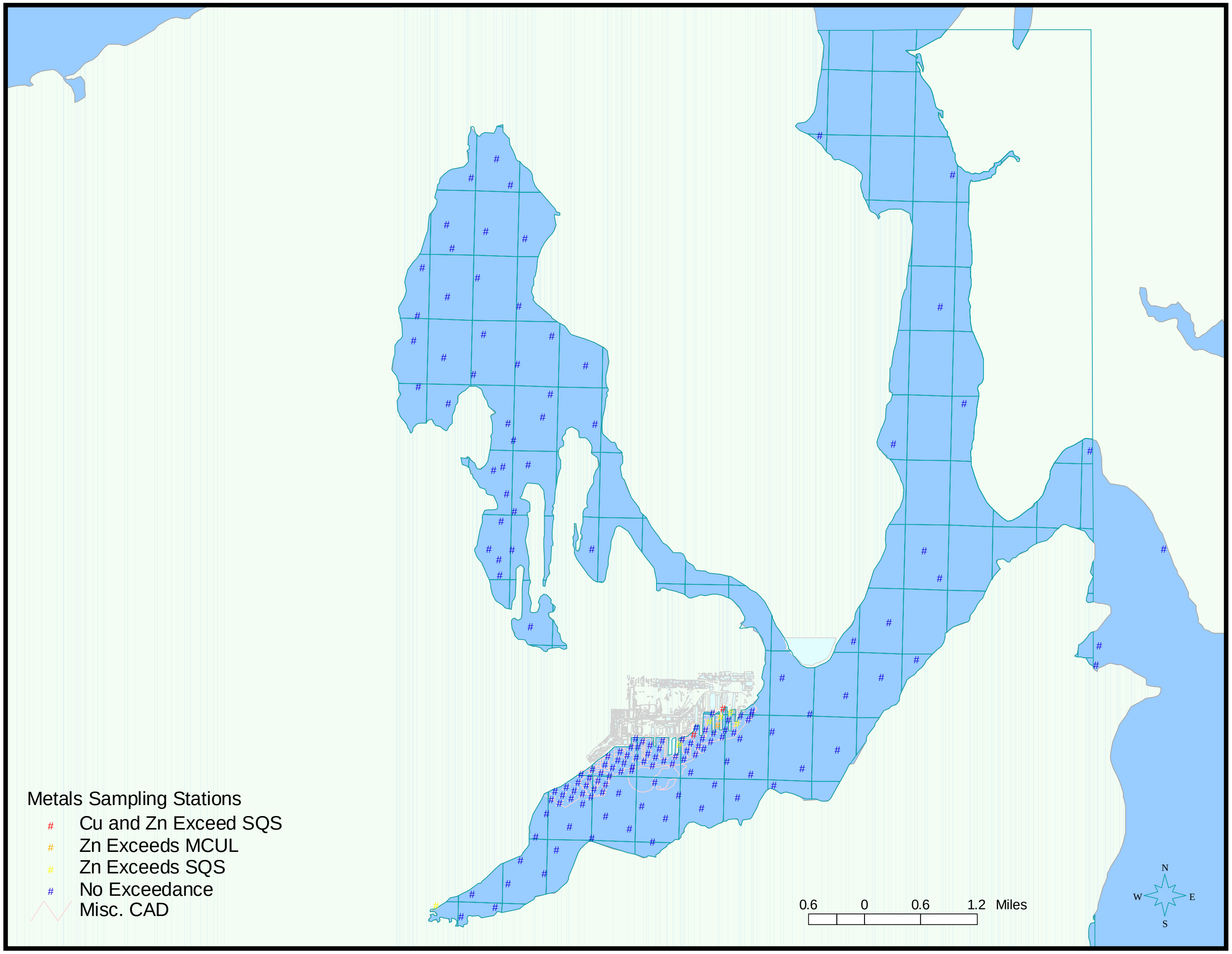

Figure 18. Locations where definitive concentrations exceed SQS or MCUL in entire Metals Verification Study area

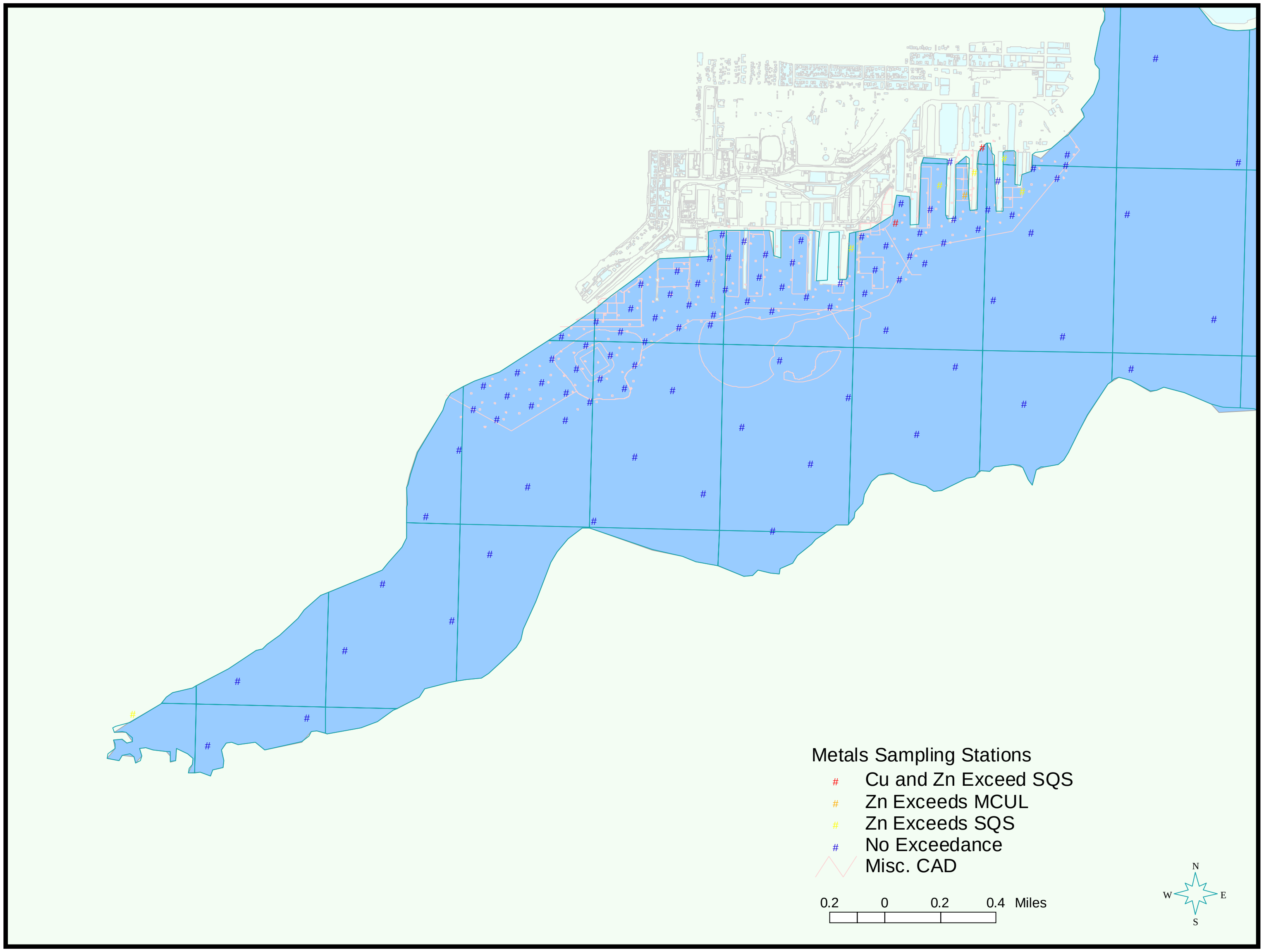

Figure 19. Locations where definitive concentrations exceed SQS or MCUL in Sinclair Inlet

The XRF method with ~20% confirmatory analyses by ICP-MS provides cost-effective alternative of screening a large number of samples for Cu, Pb, and Zn. However, samples with highest XRF concentrations are always recommended for confirmatory analysis because there are fewer data to support the linear relationship between methods.

In conclusion, the Metals Verification Study was successful in showing that Ag, Cd, and Pb concentrations met Washington SQS in all sediment throughout Sinclair and Dyes Inlets. SQS for Cu and Zn were met in all but a few samples concentrated near known sources where pollution source controls, stormwater monitoring, and sediment monitoring are in place. Where As in sediment was measured (at least 3 samples per 303(d)-listed segment), concentrations also met SQS throughout Sinclair and Dyes Inlets.

The Metals Verification Study data indicate that sediment quality in Sinclair Inlet has improved markedly since implementation of cleanup and source control actions; these 2003 data do not support 303(d) listing for most if not all the target metals in this study. The Metals Verification Study also supports Sinclair-Dyes Inlet watershed and water quality models by providing spatially distributed sediment metals data collected throughout the Sinclair-Dyes Inlet water quality modeling domain, including model initialization stations in eastern Rich Passage and northern Port Orchard Passage.

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APPENDIX A

X-RAY FLUORESCENCE LABORATORY REPORT

Sample Location: Puget Sound Naval Shipyard (Dyes Inlet, Port Orchard Passage, Rich Passage)
Sample Type: Marine sediment samples
Analysis: Metals by Energy Dispersive X-ray Fluorescence (EDXRF) Spectrometry
EDXRF Application: Soils Method (06/99) (Rapid Screening Method 1: wet samples)
Sample Date: 8/28/03 - 8/31/03,
Analysis Date: 9/8/03 - 9/16/03,
Analyst: Brian Ayers, SPAWARSYSCEN, San Diego: 619.553.1613
Analysis Location: SPAWARSYSCEN, San Diego (SSC SD), BS Bldg 111 Rm 236)

POC: Victoria Kirtay, SPAWARSYSCEN, San Diego: 619.553.1395; Brian Ayers, SPAWARSYSCEN, San Diego: 619.553.1613

Analytical Technique:

X-Ray Fluorescence spectrometry is an analytical technique that can provide rapid, multi-element analysis of metals in sediment. Samples are exposed to x-ray energy, which liberates electrons in the inner shell of metal atoms. As the outer electrons cascade towards the inner shells to fill the vacancies, energy is released (fluorescence). The fluorescing energy spectrum identifies the metals and the intensity is proportional to concentration.

Analytical Instrument:

Sediment samples will be analyzed using a QuanX EDXRF Spectrometer (Spectrace Instruments, Sunnyvale, CA). This instrument contains a Rh-anode x-ray tube for primary generation of x-rays (4-50 kV) and a thermoelectrically cooled, solid-state Silicon(Lithium) detector. The Si(Li) detector provides spectral resolution which exceeds other solid-state detectors or gas-filled proportional detectors.

Instrument Calibration:
The QuanX EDXRF is calibrated using semi-standardless calibration (Fundamental Parameters).

Five standard reference materials (NIST 2704, 2709, 2710, 2711 and CNRC PACS-1) are used for standardization.

Statistically-based Method Detection Limits (note: not field-based detection limits)

The QuanX EDXRF was calibrated using semi-standardless calibration (Fundamental Parameters). Five standard reference materials (NIST 2704, 2709, 2710, 2711 and CRC PACS-1) were used for standardization. Detection limits were calculated from these standards as follows:

LLD = 3(sqrt N_b)*conc./N_p

where;
N_b = the background counts
N_p = the peak counts
conc. = concentration of the analyte in the standard

IDL = Instrument Detection Limit (quartz)
MDL = Method Detection Limit (same as LLD, 3 sigma)
LOQ Limit of Quantitation (10 sigma)

Analyte	(quartz) IDL	(3 sigma) MDL	(10 sigma) LOQ
Cl (%)	NC	0.083	0.277
K (%)	0.009	0.021	0.070
Ca (%)	0.006	0.014	0.047
Ti (ppm)	11	39	130
Cr (ppm)	4	11	36
Mn (ppm)	7	14	48
Fe (%)	0.003	0.005	0.017
Ni (ppm)	14	17	55
Cu (ppm)	7	9	29
Zn (ppm)	5	8	27
Se (ppm)	1	2	5
As (ppm)	2	9	29
Ag (ppm)	1	1	3
Cd (ppm)	1	1	4
Sn (ppm)	1	1	4
Ba (ppm)	10	10	34
Pb (ppm)	3	4	15

Sample Handling and Analysis:

Sediment screening samples will be shipped to the destination laboratory by overnight courier at the end of each sampling day in coolers with blue ice.

Sediment screening samples will be shipped to the Space and Naval Warfare Systems Center San Diego (SSC San Diego).
For rapid screening analysis of sediment samples, five to ten grams of the wet sediment are placed in an XRF sample cup and covered with Mylar film.
Analysis time for each sample is 30 minutes.

The sample will be analyzed for a suite of metals (e.g., Cl, K, Ca, Ti, Fe, Mn, Ba, Cr, Cu, Zn, Pb, Se, As, Ag, Cd, Sn and Ni).

Results are calculated based on Fundamental Parameters (FP) calibration and are computed using FP algorithms.
Because XRF is a non-destructive technique, the samples can either be archived or used for other analyses.

Data Quality (see EDXRFQAPP_0803.doc for details)

<u>Accuracy</u>
1. % Recovery (used for accuracy measurement with SRMs)
2. Instrument Blank (analysis of ground quartz; results should not exceed MDL)

<u>Precision</u>
1. RPD = Relative Percent Difference (used for comparison of field duplicate measurements)
2. RSD= Relative Standard Deviation (comparis (10 sigma)

Project: **ENVVEST Metals Verification Study (Project No. 43043)**
Samples Received: **9/4/2003**
Metals Reported: **Fe, Cu, Pb, Zn, Cd, Ag**

Rapid Screening Method: EDXRF (wet) (concentrations in mg/kg, except where noted; not blank corrected)

Sample ID	Fe (%)	Stdev	Q	Cu	Stdev	Q	Pb	Stdev	Q	Zn	Stdev	Q	Cd	Stdev	Q	Ag	Stdev	Q
MVS-001-XRF	2.092			34			17			58			1.2		J	0.1		U
MVS-002-XRF	1.601			18		J	9		J	38			2.3		J	0.3		U
MVS-003-XRF	2.071	0.024		46	3		30	4		84	4		0.5	0.1	U	0.3	0.3	U
MVS-004-XRF	2.192			63			41			98			ND		U	0.9		U
MVS-005-XRF	2.073			56			38			91			0.6		U	1.4		J
MVS-006-XRF	1.884			25		J	16			52			0.8		U	0.4		U
MVS-007-XRF	2.208	0.035		57	5		39	3		97	1		0.6	0.6	U	0.7	0.6	U
MVS-008-XRF	2.078			41			24			85			ND		U	0.9		U
MVS-009-XRF	2.217			47			36			85			0.7		U	1.8		J
MVS-010-XRF	2.073	0.014		47	1		31	4		91	3		0.5	0.3	U	0.2	0.3	U
MVS-011-XRF	2.164			43			37			95			0.5		U	0.8		U
MVS-012-XRF	2.246			57			38			94			0.4		U	0.6		U
MVS-013-XRF	2.239			43			30			86			0.7		U	ND		U
MVS-014-XRF	2.337			37			15			62			ND		U	ND		U
MVS-015-XRF	3.032	0.063		28	3	J	9	1	J	59	4		0.0	0.0	U	0.4	0.4	U
MVS-016-XRF	2.456	0.020		34	4		14	1	J	65	0		0.7	0.4	U	0.1	0.1	U
MVS-017-XRF	2.072			45			27			79			0.3		U	0.3		U
MVS-018-XRF	2.191			44			36			84			1.5		J	0.9		U
MVS-019-XRF	1.523			34			13		J	45			0.6		U	0.1		U
MVS-020-XRF	2.053			45			32			77			ND		U	ND		U
MVS-021-XRF	2.002	0.038		46	4		26	3		72	7		1.0	1.2	J	1.3	0.2	J
MVS-022-XRF	2.207			53			32			89			1.3		J	ND		U
MVS-023-XRF	2.160			55			36			93			0.2		U	0.5		U
MVS-024-XRF	2.140			49			26			77			ND		U	0.3		U
MVS-025-XRF	1.986	0.021		44	8		28	3		71	5		0.7	0.6	U	0.5	0.4	U
MVS-026-XRF	2.046			47			30			73			0.4		U	0.5		U
MVS-027-XRF	2.083	0.009		50	5		30	5		77	7		0.8	0.5	U	0.3	0.5	U
MVS-028-XRF	1.757			22		J	12		J	46			0.7		U	ND		U
MVS-029-XRF	2.123			48			31			91			2.2		J	ND		U
MVS-030-XRF	1.506			17		J	8		J	31			0.8		U	ND		U
MVS-031-XRF	1.715			29			14		J	49			1.3		J	ND		U
MVS-032-XRF	1.739			16		J	8		J	33			ND		U	ND		U
MVS-033-XRF	1.844			29			22			53			ND		U	1.3		J
MVS-034-XRF	1.442			16		J	7		J	29			ND		U	0.1		U
MVS-035-XRF	1.542			16		J	7		J	37			0.8		U	ND		U
MVS-036-XRF	1.810			18		J	10		J	33			ND		U	ND		U
MVS-037-XRF	1.689			21		J	7		J	43			1.6		J	ND		U
MVS-038-XRF	1.716			22		J	6		J	38			0.6		U	ND		U
MVS-039-XRF	1.786			21		J	11		J	34			0.4		U	1.0		J
MVS-040-XRF	2.090			36			18			70			0.7		U	ND		U
MVS-041-XRF	2.153			45			21			68			ND		U	ND		U
MVS-042-XRF	1.966	0.039		25	2	J	18	5		52	2		0.7	1.1	U	0.3	0.3	U
MVS-043-XRF	1.550			13		J	11		J	33			1.6		J	2.3		J
MVS-044-XRF	1.396			18		J	9		J	29			ND		U	0.0		U
MVS-045-XRF	2.027	0.037		35	6		23	1		62	2		0.5	0.5	U	0.2	0.4	U
MVS-046-XRF	1.754			30			18			44			ND		U	ND		U
MVS-047-XRF	2.284			55			22			72			1.5		J	0.4		U
MVS-048-XRF	2.021			25		J	14		J	43			0.5		U	1.7		J
MVS-049-XRF	2.178			39			19			72			1.1		J	1.2		J
MVS-050-XRF	1.288			9		J	9		J	24		J	0.4		U	0.5		U
MVS-052-XRF	2.050	0.021		37	0		28	2		78	3		2.3	0.5	J	0.4	0.2	U
MVS-054-XRF	1.670			22		J	12		J	46			1.3		J	1.8		J
MVS-055-XRF	1.161			13		J	4		J	25		J	1.6		J	0.4		U
MVS-056-XRF	1.295			14		J	6		J	28			ND		U	0.9		U

Project: ENVVEST Metals Verification Study (Project No. 43043)
Samples Received: 9/4/2003
Metals Reported: Fe, Cu, Pb, Zn, Cd, Ag

Rapid Screening Method: EDXRF (wet) (concentrations in mg/kg, except where noted; not blank corrected)

Sample ID	Fe (%)	Stdev	Q	Cu	Stdev	Q	Pb	Stdev	Q	Zn	Stdev	Q	Cd	Stdev	Q	Ag	Stdev	Q
MVS-057-XRF	1.852			21		J	10		J	38			0.3		U	0.7		U
MVS-058-XRF	2.262			27		J	14		J	47			2.1		J	ND		U
MVS-059-XRF	2.009			32			6		J	53			1.5		J	ND		U
MVS-060-XRF	2.070			86			41			109			0.9		U	0.3		U
MVS-061-XRF	1.967			36			13		J	53			0.1		U	1.0		J
MVS-062-XRF	2.141			60			32			87			0.3		U	ND		U
MVS-063-XRF	2.266	0.020		62	3		39	5		96	4		0.4	0.4	U	0.9	0.7	U
MVS-064-XRF	2.772			209			157			431			2.1		J	ND		U
MVS-065-XRF	2.368			84			49			102			0.3		U	1.2		J
MVS-066-XRF	2.040			21		J	12		J	52			0.2		U	0.6		U
MVS-067-XRF	1.669			15		J	11		J	42			ND		U	ND		U
MVS-068-XRF	2.101			45			31			76			ND		U	0.8		U
MVS-069-XRF	2.064			74			31			91			1.6		J	1.2		J
MVS-070-XRF	2.322			81			45			105			ND		U	0.8		U
MVS-071-XRF	2.052			65			36			95			ND		U	0.4		U
MVS-072-XRF	2.771	0.022		247	22		171	9		417	29		1.1	1.2	J	0.8	0.2	U
MVS-073-XRF	1.854			23		J	13		J	42			0.1		U	0.6		U
MVS-074-XRF	2.053			69			43			101			1.2		J	1.7		J
MVS-075-XRF	2.943			63			102			260			0.5		U	0.9		U
MVS-076-XRF	2.034			70			34			90			ND		U	1.2		J
MVS-077-XRF	2.278			63			34			84			0.2		U	2.6		J
MVS-078-XRF	1.610			16		J	9		J	40			1.1		J	ND		U
MVS-079-XRF	1.859			33			16			51			ND		U	0.3		U
MVS-080-XRF	2.163	0.020		43	5		28	3		79	2		0.4	0.6	U	0.5	0.5	U
MVS-081-XRF	2.289			78			55			100			1.6		J	ND		U
MVS-082-XRF	2.280			65			43			92			1.8		J	0.8		U
MVS-083-XRF	2.175			114			44			131			1.5		J	ND		U
MVS-084-XRF	1.843			62			31			79			0.3		U	ND		U
MVS-085-XRF	2.249	0.023		66	12		38	4		99	1		0.3	0.5	U	1.5	0.6	J
MVS-086-XRF	2.095			71			33			106			1.5		J	1.3		J
MVS-087-XRF	2.256			88			44			100			ND		U	0.1		U
MVS-088-XRF	2.307			75			47			102			1.4		J	0.9		U
MVS-089-XRF	2.502			134			80			181			2.2		J	2.2		J
MVS-090-XRF	2.205			68			41			105			1.5		J	1.7		J
MVS-091-XRF	2.281			87			45			99			1.6		J	0.7		U
MVS-092-XRF	2.372			152			117			280			1.4		J	2.4		J
MVS-093-XRF	2.409			105			50			115			0.2		U	2.2		J
MVS-094-XRF	2.372	0.015		152	25		98	15		247	18		2.0	0.6	J	1.0	0.4	J
MVS-095-XRF	2.248			69			43			104			0.9		U	0.2		U
MVS-096-XRF	2.450			65			31			87			1.1		J	1.9		J
MVS-097-XRF	2.171			69			43			103			0.3		U	1.9		J
MVS-098-XRF	2.291			99			55			142			ND		U	ND		U
MVS-099-XRF	2.450			51			28			83			1.8		J	0.9		U
MVS-100-XRF	2.151			92			38			113			0.2		U	ND		U
MVS-101-XRF	2.325	0.013		83	8		45	2		101	4		1.0	1.1	J	0.7	0.8	U
MVS-102-XRF	2.468			100			52			129			0.0		U	0.1		U
MVS-103-XRF	2.309			80			51			110			1.6		J	1.2		J
MVS-104-XRF	2.335			83			41			106			0.3		U	ND		U
MVS-105-XRF	2.831			58			28			88			2.4		J	0.0		U
MVS-106-XRF	2.398			62			30			91			1.4		J	1.0		J
MVS-107-XRF	2.207	0.035		92	2		45	3		110	6		1.9	1.1	J	1.7	0.6	J
MVS-108-XRF	2.077			73			40			116			ND		U	0.7		U
MVS-109-XRF	2.071			100			46			102			1.1		J	0.7		U
MVS-110-XRF	2.270			118			70			197			ND		U	1.1		J

Project: **ENVVEST Metals Verification Study (Project No. 43043)**
Samples Received: **9/4/2003**
Metals Reported: **Fe, Cu, Pb, Zn, Cd, Ag**

Rapid Screening Method: EDXRF (wet) (concentrations in mg/kg, except where noted; not blank corrected)

Sample ID	Fe (%)	Stdev	Q	Cu	Stdev	Q	Pb	Stdev	Q	Zn	Stdev	Q	Cd	Stdev	Q	Ag	Stdev	Q
MVS-111-XRF	2.220			100			87			177			1.2		J	ND		U
MVS-112-XRF	2.441			133			65			188			2.2		J	ND		U
MVS-113-XRF	2.504			133			92			286			1.7		J	1.8		J
MVS-114-XRF	2.308	0.018		85	4		46	4		113	6		0.0	0.0	U	0.9	0.6	U
MVS-115-XRF	2.226			106			49			148			2.6		J	ND		U
MVS-116-XRF	2.256			58			34			87			2.4		J	0.7		U
MVS-117-XRF	2.444			105			56			133			0.4		U	0.6		U
MVS-118-XRF	2.405			84			45			125			0.3		U	0.4		U
MVS-119-XRF	2.383			146			102			166			2.3		J	1.1		J
MVS-120-XRF	2.250			78			31			85			ND		U	ND		U
MVS-121-XRF	2.447	0.011		108	19		66	2		138	8		0.0	0.1	U	1.3	0.9	J
MVS-122-XRF	2.411			78			43			108			1.1		J	1.1		J
MVS-123-XRF	2.207			94			48			96			1.7		J	1.0		J
MVS-124-XRF	2.279			135			64			168			1.8		J	0.6		U
MVS-125-XRF	2.475			106			59			129			1.0		J	2.4		J
MVS-126-XRF	2.481			97			63			131			0.1		U	0.6		U
MVS-127-XRF	2.436			131			66			173			0.7		U	1.4		J
MVS-128-XRF	2.324			138			66			147			1.4		J	1.9		J
MVS-129-XRF	2.162			192			107			253			0.0		U	0.0		U
MVS-130-XRF	2.125	0.031		122	12		42	2		134	2		0.6	1.1	U	0.6	0.9	U
MVS-131-XRF	2.301			63			31			89			0.8		U	0.5		U
MVS-132-XRF	2.128			129			67			558			1.2		J	1.4		J
MVS-133-XRF	2.123			79			48			103			1.9		J	0.5		U
MVS-134-XRF	2.290			122			61			166			1.5		J	0.5		U
MVS-135-XRF	2.158			87			66			249			2.0		J	0.7		U
MVS-136-XRF	1.975			75			167			191			0.1		U	0.1		U
MVS-137-XRF	2.177			79			50			117			1.2		J	0.1		U
MVS-138-XRF	2.429			146			107			250			0.3		U	0.9		U
MVS-139-XRF	2.337	0.029		78	4		49	5		102	4		1.5	0.9	J	0.9	0.5	U
MVS-140-XRF	2.318			108			49			120			2.1		J	1.6		J
MVS-141-XRF	2.282			149			113			279			1.5		J	ND		U
MVS-142-XRF	2.091			126			75			291			1.1		J	1.2		J
MVS-143-XRF	2.348			87			41			105			0.6		U	0.1		U
MVS-144-XRF	2.359	0.011		88	4		51	2		114	4		0.9	0.3	U	1.2	0.4	J
MVS-145-XRF	2.405			211			140			283			1.9		J	0.4		U
MVS-146-XRF	2.413			66			39			92			0.7		U	0.8		U
MVS-147-XRF	2.160			67			48			109			1.4		J	0.2		U
MVS-148-XRF	2.158			99			52			137			2.7		J	1.4		J
MVS-149-XRF	2.067	0.020		71	3		41	5		104	10		1.1	1.1	J	0.3	0.3	U
MVS-150-XRF	1.863			49			27			61			ND		U	ND		U
MVS-151-XRF	2.394			181			94			425			0.7		U	1.3		J
MVS-152-XRF	2.155			88			44			99			0.8		U	0.6		U
MVS-153-XRF	2.394			98			55			132			ND		U	0.6		U
MVS-154-XRF	1.993			79			39			96			2.6		J	1.0		J
MVS-155-XRF	2.362			89			47			125			0.8		U	0.6		U
MVS-156-XRF	2.502			49			29			81			2.2		J	0.6		U
MVS-157-XRF	2.423			68			36			97			0.1		U	1.4		J
MVS-158-XRF	2.192			57			31			76			ND		U	0.1		U
MVS-159-XRF	2.193			114			60			151			2.2		J	1.5		J
MVS-160-XRF	2.018			78			39			100			1.4		J	1.3		J
MVS-161-XRF	2.210			80			43			93			0.3		U	0.1		U
MVS-162-XRF	1.889			76			39			114			1.3		J	ND		U
MVS-163-XRF	2.149			79			44			101			0.5		U	0.1		U
MVS-164-XRF	2.345			46			25			76			1.6		J	0.1		U

Project: **ENVVEST Metals Verification Study (Project No. 43043)**
Samples Received: **9/4/2003**
Metals Reported: **Fe, Cu, Pb, Zn, Cd, Ag**

Rapid Screening Method: EDXRF (wet) (concentrations in mg/kg, except where noted; not blank corrected)

Sample ID	Fe (%)	Stdev	Q	Cu	Stdev	Q	Pb	Stdev	Q	Zn	Stdev	Q	Cd	Stdev	Q	Ag	Stdev	Q
MVS-165-XRF	2.233			75			46			97			1.7		J	0.8		U
MVS-166-XRF	2.280			67			41			124			1.3		J	ND		U
MVS-167-XRF	2.277			74			45			112			0.8		U	ND		U
MVS-168-XRF	2.192			85			44			94			0.5		U	0.2		U
MVS-169-XRF	2.263			69			49			114			ND		U	0.2		U
MVS-170-XRF	2.276			92			45			102			1.6		J	1.2		J
Method Detection Limit (M	**0.005**			**9**			**4**			**8**			**1**			**1**		
Limit of Quantitation (LOQ	**0.017**			**29**			**15**			**27**			**4**			**3**		

Data Qualifiers (Q):
U: The value was less than MDL or the analyte was not detected.
J: Estimated value (MDL < measured value < LOQ)

Project: **ENVVEST Metals Verification Study (Project No. 43043)**
Samples Received: **9/4/2003 (Dyes Inlet, Ostrich Bay, Port Orchard Passage, Rich Passage)**
Metals Reported: **Fe, Cu, Pb, Zn, Cd, Ag**

Data Quality Criteria

1. Accuracy

SRMs

		Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
PACS-1	EDXRF value	4.627		410		375		725		3.0	J	2.0	J
PACS-1	certified value	NA		452		404		824		2.38		ND	
PACS-1	range	NA		± 16		± 20		± 22		± 0.20		NA	
	% difference	**NA**		**9%**		**7%**		**12%**		**25%**		**NA**	
		NA											

		Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
PACS-2	EDXRF value	4.126		315		180		394		2.3	J	1.4	J
PACS-2	certified value	NA		310		183		364		2.11		1.22	
PACS-2	range	NA		± 12		± 8		± 23		± 0.15		± 0.14	
	% difference	**NA**		**2%**		**1%**		**8%**		**9%**		**12%**	

2. Precision

SAMPLE TRIPLICATE (for samples triplicates only, instrument precision)

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-003	A	MVS-003-A	2.045		42		25		83		0.6	U	0.0	U
MVS-003	B	MVS-003-B	2.074		46		33		80		0.4	U	0.3	U
MVS-003	C	MVS-003-C	2.093		49		31		88		0.4	U	0.6	U
		mean	2.071		46		30		84		0.5	U	0.3	U
		stdev	0.024		3		4		4		0.1		0.3	
		%RSD	**1**		**8**		**14**		**5**		**27**		**98**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-007	A	MVS-007-A	2.170		59		41		98		0.0	U	0.8	U
MVS-007	B	MVS-007-B	2.240		61		36		97		0.4	U	1.4	J
MVS-007	C	MVS-007-C	2.215		51		41		97		1.2	J	0.1	U
		mean	2.208		57		39		97		0.6	U	0.7	U
		stdev	0.035		5		3		1		0.6		0.6	
		%RSD	**2**		**9**		**8**		**1**		**114**		**85**	

Project: ENVVEST Metals Verification Study (Project No. 43043)
Samples Received: 9/4/2003 (Dyes Inlet, Ostrich Bay, Port Orchard Passage, Rich Passage)
Metals Reported: Fe, Cu, Pb, Zn, Cd, Ag

Data Quality Criteria

SAMPLE TRIPLICATE (cont'd)

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-010	A	MVS-010-A	2.059		47		29		88		0.2	U	0.0	U
MVS-010	B	MVS-010-B	2.075		48		35		95		0.9	U	0.0	U
MVS-010	C	MVS-010-C	2.086		47		28		90		0.5	U	0.6	U
		mean	2.073		47		31		91		0.5	U	0.2	U
		stdev	0.014		1		4		3		0.3		0.3	
		%RSD	**1**		**2**		**12**		**4**		**61**		**173**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-015	A	MVS-015-A	3.000		30		10	J	63		0.0	U	0.7	U
MVS-015	B	MVS-015-B	3.105		30		10	J	58		0.0	U	0.0	U
MVS-015	C	MVS-015-C	2.992		24	J	8	J	55		0.0	U	0.5	U
		mean	3.032		28	J	9	J	59		0.0	U	0.4	U
		stdev	0.063		3		1		4		0.0		0.4	
		%RSD	**2**		**11**		**11**		**7**		**NA**		**89**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-016	A	MVS-016-A	2.442		39		14	J	64		1.1	J	0.0	U
MVS-016	B	MVS-016-B	2.446		31		13	J	64		0.7	U	0.0	U
MVS-016	C	MVS-016-C	2.479		32		14	J	65		0.3	U	0.2	U
		mean	2.456		34		14	J	65		0.7	U	0.1	U
		stdev	0.020		4		1		0		0.4		0.1	
		%RSD	**1**		**12**		**4**		**1**		**55**		**150**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-021	A	MVS-021-A	1.970		49		23		79		0.7	U	1.6	J
MVS-021	B	MVS-021-B	2.044		41		27		72		0.0	U	1.2	J
MVS-021	C	MVS-021-C	1.991		48		29		65		2.3	J	1.2	J
		mean	2.002		46		26		72		1.0	J	1.3	J
		stdev	0.038		4		3		7		1.2		0.2	
		%RSD	**2**		**9**		**11**		**10**		**119**		**18**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-025	A	MVS-025-A	2.009		52		30		66		0.0	U	0.1	U
MVS-025	B	MVS-025-B	1.968		38		24		77		0.9	U	0.4	U
MVS-025	C	MVS-025-C	1.980		41		30		71		1.1	J	0.9	U
		mean	1.986		44		28		71		0.7	U	0.5	U
		stdev	0.021		8		3		5		0.6		0.4	
		%RSD	**1**		**17**		**12**		**7**		**87**		**95**	

Project: ENVVEST Metals Verification Study (Project No. 43043)
Samples Received: 9/4/2003 (Dyes Inlet, Ostrich Bay, Port Orchard Passage, Rich Passage)
Metals Reported: Fe, Cu, Pb, Zn, Cd, Ag

Data Quality Criteria

SAMPLE TRIPLICATE (cont'd)

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-027	A	MVS-027-A	2.090		55		25		80		1.3	J	0.0	U
MVS-027	B	MVS-027-B	2.072		51		35		69		0.3	U	0.0	U
MVS-027	C	MVS-027-C	2.086		45		30		81		0.8	U	0.9	U
		mean	2.083		50		30		77		0.8	U	0.3	U
		stdev	0.009		5		5		7		0.5		0.5	
		%RSD	**0**		**11**		**18**		**9**		**65**		**168**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-042	A	MVS-042-A	1.991		25	J	15		53		1.9	J	0.4	U
MVS-042	B	MVS-042-B	1.985		28	J	16		53		0.1	U	0.6	U
MVS-042	C	MVS-042-C	1.921		24	J	24		50		0.0	U	0.0	U
		mean	1.966		25	J	18		52		0.7	U	0.3	U
		stdev	0.039		2		5		2		1.1		0.3	
		%RSD	**2**		**7**		**27**		**3**		**159**		**92**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-045	A	MVS-045-A	2.065		34		23		64		0.5	U	0.0	U
MVS-045	B	MVS-045-B	2.026		41		23		59		1.0	J	0.0	U
MVS-045	C	MVS-045-C	1.991		29		22		61		0.1	U	0.6	U
		mean	2.027		35		23		62		0.5	U	0.2	U
		stdev	0.037		6		1		2		0.5		0.4	
		%RSD	**2**		**18**		**4**		**4**		**85**		**173**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-052	A	MVS-052-A	2.059		37		27		80		2.6	J	0.5	U
MVS-052	B	MVS-052-B	2.026		37		30		75		1.8	J	0.2	U
MVS-052	C	MVS-052-C	2.064		37		27		79		2.7	J	0.4	U
		mean	2.050		37		28		78		2.3	J	0.4	U
		stdev	0.021		0		2		3		0.5		0.2	
		%RSD	**1**		**0**		**6**		**3**		**21**		**48**	

Data Qualifiers (Q):
U: The value was less than MDL or the analyte was not detected.
J: Estimated value (MDL < measured value < LOQ)

Project: ENVVEST Metals Verification Study (Project No. 43043)
Samples Received: 11/20/2003 (Sinclair Inlet OU B Marine monitoring composites)
Metals Reported: Fe, Cu, Pb, Zn, Cd, Ag

Data Quality Criteria

1. Accuracy

SRMs

		Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
PACS-1	EDXRF value	4.673		417		376		722		3.6	J	1.8	J
PACS-1	certified value			452		404		824		2.38		ND	
PACS-1	range			± 16		± 20		± 22		± 0.20		NA	
	% difference	**#REF!**		**8%**		**7%**		**12%**		**49%**		**NA**	
		NA											

		Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
PACS-2	EDXRF value	4.182		312		180		394		2.8	J	1.1	J
PACS-2	certified value	NA		310		183		364		2.11		1.22	
PACS-2	range	NA		± 12		± 8		± 23		± 0.15		± 0.14	
	% difference	**NA**		**1%**		**2%**		**8%**		**33%**		**8%**	

2. Precision

SAMPLE TRIPLICATE (for samples triplicates only, instrument precision)

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-063	A	MVS-063-A	2.272		59		43		97		0.0	U	0.2	U
MVS-063	B	MVS-063-B	2.282		60		34		92		0.8	U	1.6	J
MVS-063	C	MVS-063-C	2.244		66		41		100		0.5	U	0.8	U
		mean	2.266		62		39		96		0.4	U	0.9	U
		stdev	0.020		3		5		4		0.4		0.7	
		%RSD	**1**		**6**		**12**		**4**		**93**		**87**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-072	A	MVS-072-A	2.788		271		172		444		1.1	J	0.5	U
MVS-072	B	MVS-072-B	2.779		227		161		387		2.3	J	0.9	U
MVS-072	C	MVS-072-C	2.747		243		179		418		0.0	U	0.9	U
		mean	2.771		247		171		417		1.1	J	0.8	U
		stdev	0.022		22		9		29		1.2		0.2	
		%RSD	**1**		**9**		**6**		**7**		**103**		**30**	

Project: ENVVEST Metals Verification Study (Project No. 43043)
Samples Received: 11/20/2003 (Sinclair Inlet OU B Marine monitoring composites)
Metals Reported: Fe, Cu, Pb, Zn, Cd, Ag

Data Quality Criteria

SAMPLE TRIPLICATE (cont'd)

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-080	A	MVS-080-A	2.185		44		32		79		1.2	J	0.9	U
MVS-080	B	MVS-080-B	2.159		47		25		81		0.0	U	0.0	U
MVS-080	C	MVS-080-C	2.145		38		28		77		0.1	U	0.5	U
		mean	2.163		43		28		79		0.4	U	0.5	U
		stdev	0.020		5		3		2		0.6		0.5	
		%RSD	**1**		**11**		**12**		**3**		**146**		**100**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-085	A	MVS-085-A	2.233		56		36		98		0.0	U	1.4	J
MVS-085	B	MVS-085-B	2.239		63		35		99		0.0	U	1.0	J
MVS-085	C	MVS-085-C	2.275		79		43		100		0.9	U	2.1	J
		mean	2.249		66		38		99		0.3	U	1.5	J
		stdev	0.023		12		4		1		0.5		0.6	
		%RSD	**1**		**18**		**12**		**1**		**159**		**39**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-094	A	MVS-094-A	2.388		180		85		243		1.5	J	1.1	J
MVS-094	B	MVS-094-B	2.359		143		114		267		1.7	J	0.5	U
MVS-094	C	MVS-094-C	2.370		131		94		232		2.6	J	1.2	J
		mean	2.372		152		98		247		2.0	J	1.0	J
		stdev	0.015		25		15		18		0.6		0.4	
		%RSD	**1**		**17**		**15**		**7**		**31**		**38**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-101	A	MVS-101-A	2.313		74		42		104		0.0	U	1.6	J
MVS-101	B	MVS-101-B	2.323		87		46		102		2.2	J	0.0	U
MVS-101	C	MVS-101-C	2.339		89		46		96		0.8	U	0.4	U
		mean	2.325		83		45		101		1.0	J	0.7	U
		stdev	0.013		8		2		4		1.1		0.8	
		%RSD	**1**		**10**		**5**		**4**		**113**		**125**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-107	A	MVS-107-A	2.189		95		47		107		1.9	J	2.2	J
MVS-107	B	MVS-107-B	2.247		91		42		116		0.9	U	1.8	J
MVS-107	C	MVS-107-C	2.184		90		45		105		3.0	J	1.1	J
		mean	2.207		92		45		110		1.9	J	1.7	J
		stdev	0.035		2		3		6		1.1		0.6	
		%RSD	**2**		**3**		**6**		**5**		**57**		**34**	

Project: ENVVEST Metals Verification Study (Project No. 43043)
Samples Received: 11/20/2003 (Sinclair Inlet OU B Marine monitoring composites)
Metals Reported: Fe, Cu, Pb, Zn, Cd, Ag

Data Quality Criteria

SAMPLE TRIPLICATE (cont'd)

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-114	A	MVS-114-A	2.290		87		50		112		0.0	U	0.4	U
MVS-114	B	MVS-114-B	2.310		87		47		119		0.0	U	1.6	J
MVS-114	C	MVS-114-C	2.325		80		42		107		0.0	U	0.7	U
		mean	2.308		85		46		113		0.0	U	0.9	U
		stdev	0.018		4		4		6		0.0		0.6	
		%RSD	**1**		**5**		**9**		**5**		**NA**		**66**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-121	A	MVS-121-A	2.436		95		66		132		0.0	U	0.5	U
MVS-121	B	MVS-121-B	2.457		130		63		136		0.0	U	1.1	J
MVS-121	C	MVS-121-C	2.448		99		68		147		0.1	U	2.2	J
		mean	2.447		108		66		138		0.0	U	1.3	J
		stdev	0.011		19		2		8		0.1		0.9	
		%RSD	**0**		**18**		**4**		**6**		**173**		**68**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-130	A	MVS-130-A	2.105		117		41		132		1.9	J	1.7	J
MVS-130	B	MVS-130-B	2.110		114		45		133		0.0	U	0.0	U
MVS-130	C	MVS-130-C	2.161		136		42		136		0.0	U	0.2	U
		mean	2.125		122		42		134		0.6	U	0.6	U
		stdev	0.031		12		2		2		1.1		0.9	
		%RSD	**1**		**10**		**5**		**1**		**173**		**145**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-139	A	MVS-139-A	2.334		80		55		100		2.4	J	0.9	U
MVS-139	B	MVS-139-B	2.310		74		45		100		1.4	J	0.3	U
MVS-139	C	MVS-139-C	2.368		82		46		107		0.6	U	1.4	J
		mean	2.337		78		49		102		1.5	J	0.9	U
		stdev	0.029		4		5		4		0.9		0.5	
		%RSD	**1**		**5**		**11**		**4**		**61**		**61**	

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-144	A	MVS-144-A	2.348		92		50		114		0.6	U	0.8	U
MVS-144	B	MVS-144-B	2.370		85		51		118		1.0	J	1.5	J
MVS-144	C	MVS-144-C	2.360		88		54		110		1.2	J	1.2	J
		mean	2.359		88		51		114		0.9	U	1.2	J
		stdev	0.011		4		2		4		0.3		0.4	
		%RSD	**0**		**4**		**4**		**3**		**31**		**32**	

Project: ENVVEST Metals Verification Study (Project No. 43043)
Samples Received: 11/20/2003 (Sinclair Inlet OU B Marine monitoring composites)
Metals Reported: Fe, Cu, Pb, Zn, Cd, Ag

Data Quality Criteria

SAMPLE TRIPLICATE (cont'd)

Sample ID			Fe	Q	Cu	Q	Pb	Q	Zn	Q	Cd	Q	Ag	Q
MVS-149	A	MVS-149-A	2.053		69		40		102		2.1	J	0.1	U
MVS-149	B	MVS-149-B	2.090		71		47		115		1.3	J	0.2	U
MVS-149	C	MVS-149-C	2.058		75		37		95		0.0	U	0.7	U
		mean	2.067		71		41		104		1.1	J	0.3	U
		stdev	0.020		3		5		10		1.1		0.3	
		%RSD	**1**		**4**		**13**		**10**		**93**		**95**	

Data Qualifiers (Q):

U: The value was less than MDL or the analyte was not detected.

J: Estimated value (MDL < measured value < LOQ)

APPENDIX B

INDUCTIVELY-COUPLED PLASMA-MASS SPECTROSCOPY DATA REPORT

PROJECT: MVS Sediment Confirmatory Analyses

PARAMETER: Metals

LABORATORY: Battelle Marine Sciences Laboratory, Sequim, Washington

MATRIX: Surface sediments

SAMPLE CUSTODY AND PROCESSING: One hundred and sixty-eight sediment samples were received in two batches at MSL. The samples were archived frozen until a subset of forty samples for confirmatory metals analyses was selected and analyzed at MSL. All samples were assigned a Battelle Central File (CF) identification number (2087) and were entered into Battelle's log-in and custody tracking system.

The following lists information on sample receipt and processing activities:

Lab Sample IDs: Description:	2087*1 thru 57 Sediment Batch 1	2087*58 thru 168 Sediment Batch 2
Sample collection dates	August 2003	October 2003
Laboratory arrival date	09/03/03	01/30/04
Digestion (Boric Acid - Al)	03/15/04	
Digestion (Sed Evap – Ag, Cr, Ni, Cu, Zn, As, Cd, Pb)	03/31/04	
GFAA Analysis (Ag)	04/09/04	
ICP-MS Analysis (Cr, Ni, Cu, Zn, As, Cd, Pb)	04/06/04	
ICP-MS Analysis (Al only)	03/18/04	

DATA QUALITY OBJECTIVES:

Analyte	Analytical Method	Spike Range of Recovery	SRM Accuracy	Relative Precision	Achieved Detection Limit (1) (µg/g dry wt.)	Reporting Limit (2) (µg/g dry wt.)
Ag	GFAA	70-130%	≤20% PD	≤30% RPD	0.00579	0.0184
Al	ICP-MS	70-130%	≤20% PD	≤30% RPD	14.3	45.5
As	ICP-MS	70-130%	≤20% PD	≤30% RPD	0.188	0.598
Cd	ICP-MS	70-130%	≤20% PD	≤30% RPD	0.0587	0.187
Cr	ICP-MS	70-130%	≤20% PD	≤30% RPD	0.07	0.3
Cu	ICP-MS	70-130%	≤20% PD	≤30% RPD	0.13	0.41
Ni	ICP-MS	70-130%	≤20% PD	≤30% RPD	0.0491	0.156
Pb	ICP-MS	70-130%	≤20% PD	≤30% RPD	0.0348	0.111
Zn	ICP-MS	70-130%	≤20% PD	≤30% RPD	1.02	3.24

(1) Reported from the 2003 Sediment MDL summary, Al MDL is corrected for 100x dilution.
(2) Determined as 3.18 times achieved MDL.

METHODS: Sediment samples were analyzed for silver (Ag), aluminum (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni) and zinc (Zn). Samples were freeze-dried and homogenized using a ball-mill prior to digestion according to Battelle SOP MSL-C-003, *Percent Dry Weight and Homogenizing Dry Sediment, Soil and Tissue*. Sediment samples were digested using two procedures.

Digestion 1: Boric Acid in accordance with Battelle SOP MSL-I-006, *Mixed Acid Sediment Digestion*. An approximately 200-mg (dry weight) aliquot of each sample was combined with nitric, hydrochloric, and hydrofluoric acids in a Teflon bomb and heated in an oven at 130ºC (±10ºC) for a minimum of eight hours. After cooling, boric acid was added to the digestate to neutralize the hydrofluoric acid and deionized water was added to achieve analysis volume. Digested samples were submitted for Al analysis by ICP-MS.

Digestion 2: Sed Evap according to Battelle SOP MSL-I-004, *Sediment Evaporation Digestion*. An approximately 200-mg (dry weight) aliquot of each sample was combined with nitric acid, hydrofluoric acids and peroxide in a Teflon vessel and heated in an oven at 130ºC (±10ºC) for a minimum of 8 hours. The digested samples were taken to dryness and reconstituted with dilute nitric acid. Digestates were submitted for analysis by ICP-MS and GFAA (Ag).

Sed Evap sample digestates were analyzed for Ag using graphite furnace atomic absorption (GFAA) according to Battelle SOP MSL-I-029, *Determination of Metals in Aqueous and Digestate Samples by GFAA.*

Boric Acid sample digestates were analyzed for Al and Sed Evap samples were analyzed for As, Cd, Cr, Cu, Ni, Pb, and Zn using inductively coupled plasma-mass spectrometry (ICP-MS) according to Battelle SOP MSL-I-022, *Determination of Elements in Aqueous and Digestate Samples by ICP/MS*. All results were reported in units of µg/g on a dry-weight basis.

HOLDING TIMES: The recommended holding time for the reported analytes in sediment is 6 months from sample collection. This holding time was exceeded as screening results were used to select samples for confirmatory analyses. The samples were stored frozen and freeze dried, which is an accepted preservation method. Therefore, exceeding this holding time did not significantly impact the quality of the sample data.

DETECTION LIMITS: Analytical results were reported to laboratory achieved detection limits derived from the 2003 MDL study. Data were evaluated and flagged in accordance to the following criteria:

U Analyte not detected at or above laboratory achieved detection limit, MDL reported

J Value reported is below the RL, but above the MDL.

& Accuracy results outside QC criteria of ≤20% PD (SRM).

* Precision results outside QC criteria of ≤30% RPD.

N Spiked sample recovery not within the QC limits of 70-130%.

B Analyte detected in the method blank above the RL, sample concentration < 10 times detected blank value.

D Data reported from the second analysis with a dilution of 100x (all other samples are diluted 10x).

METHOD BLANKS:	Two method blanks were analyzed with the sediment samples. The average blank was less than the RL for all metals, except Al. The Al data were not flagged "B" because the sample concentrations were all greater than 10 times the average method blank. Data are not blank corrected.
LABORATORY CONTROL SAMPLE ACCURACY:	Two laboratory control samples were analyzed with the samples. LCS recoveries ranged from 90% to 115% and were within the QC acceptance criterion of ± 30% recovery, with the exception of one LCS sample for Al (840%). No corrective action was taken as the low level spike from this batch and the alternate high level spike were within the QC criterion.
STANDARD REFERENCE MATERIAL ACCURACY:	Two marine sediment reference materials for trace metals (SRMs) were analyzed with the sediment samples: MESS-3 and PACS-2. SRM accuracy is expressed as the percent difference (PD) between the certified and measured concentrations. Two replicates of MESS-3 were analyzed with the samples. The percent differences ranged from 0% to 12% and were within the QC acceptance criteria of PD ± 20%, with one exception. One replicate for Al (21%) was outside the QC criteria. No corrective action was taken as the alternate batch specific, SRM (PACS), was within QC criterion. Two replicates of PACS-2 were analyzed with the samples. The percent differences ranged from 2% to 20% and were within the QC acceptance criterion for all metals.
MATRIX SPIKE ACCURACY:	Two sediment samples were selected and spiked in duplicate. Matrix spike recoveries ranged from 77% to 122% and were within the QC acceptance criterion of 70-130% recovery for all metals. Since the crustal abundance of Al is 5-8% (~60,000ppm), the samples were not spiked for Al. Analytical accuracy was evaluated by LCS and SRM samples.
LABORATORY PRECISION:	Laboratory precision was evaluated using two sets of duplicates and is expressed as the relative percent difference (RPD) of replicate results. The RPD values ranged from 1% to 8% and were within the QC criterion of ≤30% RPD.

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MSL Code	Station or OUB Grid Cell	Sponsor Code	Collection Date	Percent Moisture	**Ag**	**Al**	**Cr**	**Ni**	**Cu**	**Zn**	**As**	**Cd**	**Pb**
				Analysis Batch ID	*T040904A*	*031804-6100A*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*
				CAS No.	7440-22-4	7429-90-5	7440-47-3	7440-02-0	7440-50-8	7440-66-6	7440-38-2	7440-43-9	7439-92-1
2087-3	MVS-019	MVS-019-ARC	08/28/03	55.9	0.156	51700	75.7	31.6	25.7	66.1	6.38	0.631	17.6
2087-10r1	MVS-024	MVS-024-ARC	08/28/03	63.0	0.484	56900	95.9	41.2	54.6	113	10.4	0.986	41.7
2087-10r2	MVS-024	MVS-024-ARC	08/28/03	63.0	0.448	56600	95.1	41.5	52.7	116	10.5	0.966	41.2
2087-11	MVS-025	MVS-025-ARC	08/28/03	69.5	0.544	55100	91.1	43.1	58.7	118	11.2	1.17	43.6
2087-12	MVS-026	MVS-026-ARC	08/28/03	61.1	0.489	57200	100	41.6	52.7	112	10.6	1.15	39.4
2087-18	MVS-002	MVS-002-ARC	08/29/03	28.0	0.120	52400	60.0	22.8	16.4	46.6	4.17	0.783	12.2
2087-20	MVS-007	MVS-007-ARC	08/29/03	70.7	0.790	55900	96.8	49.0	78.8	159	14.8	1.26	63.8
2087-25	MVS-013	MVS-013-ARC	08/29/03	65.3	0.609	55400	98.7	45.6	63.0	140	12.3	1.07	52.9
2087-31	MVS-022	MVS-022-ARC	08/29/03	62.6	0.681	57200	113	45.9	65.6	132	11.8	1.80	45.4
2087-32	MVS-027	MVS-027-ARC	08/29/03	64.9	0.611	55100	102	44.2	62.3	126	10.9	1.53	44.0
2087-33	MVS-028	MVS-028-ARC	08/29/03	27.8	0.127	48700	67.4	30.5	17.6	50.9	5.60	0.525	12.2
2087-36	MVS-047	MVS-047-ARC	08/30/03	67.6	0.534	59700	81.3	43.7	58.8	126	13.4	0.846	41.6
2087-40	MVS-056	MVS-056-ARC	08/30/03	29.5	0.0798	58800	46.7	15.7	11.8	43.4	4.29	0.656	8.69
2087-43	MVS-039	MVS-039-ARC	08/30/03	19.7	0.0559	53800	43.4	27.3	11.8	47.9	4.04	0.136	11.1
2087-45	MVS-043	MVS-043-ARC	08/30/03	25.5	0.0556	53800	52.1	19.1	9.56	37.9	3.83	0.184	11.1
2087-52	MVS-034	MVS-034-ARC	08/31/03	25.2	0.0635	54300	71.7	24.3	10.4	41.1	3.64	0.206	9.50
2087-63	OOUB-G 24	MVS-065-ARC	10/28/03	67.2	0.705	59100	87.4	45.4	107	162	13.8	0.797	72.0
2087-70	OUBM-G 52	MVS-072-ARC	10/24/03	62.7	1.07	57000	119	79.1	398 D	785 D	36.1	1.30	279
2087-73	OOUB-G 01	MVS-075-ARC	10/30/03	29.8	0.175	50300	114	97.0	102	547 D	15.3	0.479	198
2087-76	OOUB-G 26	MVS-078-ARC	10/29/03	25.9	0.0420	58500	83.6	27.0	11.7	45.4	2.67	0.193	8.53
2087-83	OOUB-G 28	MVS-085-ARC	10/28/03	68.1	0.500	57000	84.5	42.6	76.1	141	12.3	0.778	58.4
2087-85r1	OOUB-G 18	MVS-087-ARC	10/30/03	69.6	0.943	59600	96.4	47.7	117	159	15.9	1.04	75.1
2087-85r2	OOUB-G 18	MVS-087-ARC	10/30/03	69.6	0.925	56300	97.9	48.4	118	164	16.0	1.03	76.1
2087-86	OOUB-G 21	MVS-088-ARC	10/30/03	67.9	0.715	60800	99.7	48.6	102	159	15.9	1.32	71.8
2087-90	OUBM-G 59	MVS-092-ARC	10/03/03	69.5	0.712	55900	102	52.9	272	736	23.1	3.17	439 D

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MSL Code	Station or OUB Grid Cell	Sponsor Code	Collection Date	Percent Moisture	**Ag**	**Al**	**Cr**	**Ni**	**Cu**	**Zn**	**As**	**Cd**	**Pb**
				Analysis Batch ID	*T040904A*	*031804-6100A*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*
				CAS No.	7440-22-4	7429-90-5	7440-47-3	7440-02-0	7440-50-8	7440-66-6	7440-38-2	7440-43-9	7439-92-1
2087-92	OUBM-G 34	MVS-094-ARC	10/23/03	54.7	2.38	53000	91.8	45.4	171	391	20.2	1.51	132
2087-96	OUBM-G 40	MVS-098-ARC	10/22/03	13.9	0.709	58500	108	49.9	135	208	12.1	1.33	84.9
2087-100	OUBM-G 42	MVS-102-ARC	10/22/03	65.0	0.688	61000	103	77.2	180	188	13.1	1.06	77.8
2087-105	OOUB-G 07	MVS-107-ARC	10/30/03	71.1	1.35	58600	109	53.4	130	177	17.2	2.47	72.3
2087-111	OUBM-G 46	MVS-113-ARC	10/23/03	40.4	0.495	52000	105	40.1	142	428 D	15.8	0.621	155
2087-113	OUBM-G 43	MVS-115-ARC	10/23/03	65.5	0.588	56700	84.0	51.4	155	241	15.8	1.12	74.3
2087-114	OOUB-G 27	MVS-116-ARC	10/28/03	68.2	0.417	59300	84.8	42.5	72.5	128	11.7	1.04	55.4
2087-115	OUBM-G 36	MVS-117-ARC	10/23/03	68.7	0.838	61300	99.6	59.5	150	185	14.9	1.09	86.3
2087-130	OUBM-G 68	MVS-132-ARC	10/27/03	68.6	0.762	56600	103	54.7	217	526 D	20.6	1.72	144
2087-132	OUBM-G 56	MVS-134-ARC	10/03/03	71.0	0.691	59900	99.9	47.5	194	324 D	19.6	1.54	105
2087-133	OUBM-G 66	MVS-135-ARC	10/02/03	66.8	0.547	55400	101	46.1	227	428 D	15.2	1.71	159
2087-139	OUBM-G 64	MVS-141-ARC	10/02/03	69.7	0.777	57800	98.1	51.7	230	425 D	19.9	1.85	209
2087-140	OUBM-G 60	MVS-142-ARC	10/03/03	64.1	0.642	46800	85.7	45.5	200	1480 D	19.7	2.01	180
2087-143	OUBM-G 67	MVS-145-ARC	10/03/03	62.2	1.03	56700	104	479	710 D	547 D	43.0	1.53	204
2087-149	OUBM-G 39	MVS-151-ARC	10/23/03	45.3	1.11	51000	84.1	40.6	173	288	11.9	1.39	128
2087-157	OUBM-G 45	MVS-159-ARC	10/22/03	60.3	0.740	55400	88.7	48.4	154	238	13.1	1.44	90.0
2087-167	OOUB-G 13	MVS-169-ARC	10/30/03	72.5	0.971	60800	98.0	48.0	116	164	14.6	1.30	83.8

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MSL Code	Station or OUB Grid Cell	Sponsor Code	Collection Date	Percent Moisture	**Ag**	**Al**	**Cr**	**Ni**	**Cu**	**Zn**	**As**	**Cd**	**Pb**
				Analysis Batch ID	*T040904A*	*031804-6100A*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*
				CAS No.	7440-22-4	7429-90-5	7440-47-3	7440-02-0	7440-50-8	7440-66-6	7440-38-2	7440-43-9	7439-92-1
Detection Limits													
Laboratory Achieved Detection Limits					0.00579	14.3 [1]	0.07	0.0491	0.13	1.02	0.188	0.0587	0.0348
Reporting Limit (3.18 * MDL)					0.0184	45.5	0.3	0.156	0.41	3.24	0.598	0.187	0.111
Procedural Blank													
Blank R1		MB			0.0144 J	105	0.242	0.0491 U	0.13 U	1.02 U	0.188 U	0.0587 U	0.0348 U
Blank R2		MB			0.0111 J	65.8	0.200 J	0.0491 U	0.296 J	1.02 U	0.188 U	0.0587 U	0.0348 U
Mean Blank					0.0128 J	85.4	0.221 J	0.0491 U	0.148 J	1.02 U	0.188 U	0.0587 U	0.0348 U
Laboratory Control Sample Results (Blank Spike)													
LCS R1		LCS			2.04	185	2.02	2.05	2.04	2.08	2.03	2.00	2.12
LCS R2		LCS			2.02	925	2.08	2.11	2.13	2.29	2.09	2.04	2.09
Mean Blank					0.0128 J	85.4	0.221 J	0.0491 U	0.148 J	1.02 U	0.188 U	0.0587 U	0.0348 U
Spike Concentration					2.0	100	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Percent Recovery, R1					**101%**	**100%**	**90%**	**103%**	**95%**	**104%**	**102%**	**100%**	**106%**
Percent Recovery, R2					**101%**	**840%** N	**93%**	**106%**	**99%**	**115%**	**105%**	**102%**	**105%**

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MSL Code	Station or OUB Grid Cell	Sponsor Code	Collection Date	Percent Moisture	**Ag**	**Al**	**Cr**	**Ni**	**Cu**	**Zn**	**As**	**Cd**	**Pb**
				Analysis Batch ID	*T040904A*	*031804-6100A*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*
				CAS No.	7440-22-4	7429-90-5	7440-47-3	7440-02-0	7440-50-8	7440-66-6	7440-38-2	7440-43-9	7439-92-1
<u>Standard Reference Material (SRM)</u>													
MESS-3 R1		SRM			0.165	77700	103	44.7	36.3	149	22.2	0.217	21.3
MESS-3 R2		SRM			0.170	68100	100	41.9	33.9	142	21.8	0.211	21.1
Certified Value					0.18	85900	105	46.9	33.9	159	21.2	0.24	21.1
Range					± 0.02	± 2300	± 4	± 2.2	± 1.6	± 8	± 1.1	± 0.01	± 0.7
PD					**8%**	**10%**	**2%**	**5%**	**7%**	**6%**	**5%**	**10%**	**1%**
PD					**5%**	**21%** &	**5%**	**11%**	**0%**	**11%**	**3%**	**12%**	**0%**
PACS R1		SRM			0.993	62500	81.8	36.5	275	340	27.4	2.07	173
PACS R2		SRM			0.978	57800	85.4	38.8	291	356	29.0	2.07	173
Certified Value					1.22	66200	90.7	39.5	310	364	26.2	2.11	183
Range					± 0.14	± 3200	± 4.6	± 2.3	± 12	± 23	± 1.5	± 0.2	± 8
PD					**19%**	**6%**	**10%**	**8%**	**11%**	**7%**	**5%**	**2%**	**5%**
PD					**20%**	**13%**	**6%**	**2%**	**6%**	**2%**	**11%**	**2%**	**5%**

BATTELLE MARINE SCIENCES LABORATORIES

Jill Brandenberger, Project Manager

1529 West Sequim Bay Rd.

Sequim, Washington 98382

(360) 681-4564

MSL Code	Station or OUB Grid Cell	Sponsor Code	Collection Date	Percent Moisture	**Ag**	**Al**	**Cr**	**Ni**	**Cu**	**Zn**	**As**	**Cd**	**Pb**
				Analysis Batch ID	*T040904A*	*031804-6100A*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*
				CAS No.	7440-22-4	7429-90-5	7440-47-3	7440-02-0	7440-50-8	7440-66-6	7440-38-2	7440-43-9	7439-92-1
Matrix Spike/Matrix Spike Duplicate Results													
2087-3 MS	MVS-019	MVS-019-ARC	08/28/03	55.9	4.79	NS	115	78.9	73.9	265	60.3	5.59	66.3
2087-3 MSD	MVS-019	MVS-019-ARC	08/28/03	55.9	5.05	NS	135	76.4	71.1	257	58.3	5.76	63.1
2087-3	MVS-019	MVS-019-ARC	08/28/03	55.9	0.156	NS	75.7	31.6	25.7	66.1	6.38	0.631	17.6
Spike Concentration, MS					4.98		51.3	51.3	51.3	205	51.3	4.98	51.3
Spike Concentration, MSD					5.13		48.8	48.8	48.8	195	48.8	5.13	48.8
Percent Recovery, MS					**93%**	**NA**	**77%**	**92%**	**94%**	**97%**	**105%**	**100%**	**95%**
Percent Recovery, MSD					**95%**	**NA**	**122%**	**92%**	**93%**	**98%**	**106%**	**100%**	**93%**
2087-83 MS	OOUB-G 28	MVS-085-ARC	10/28/03	68.1	5.04	NS	137	91.3	124	330	65.9	5.70	104
2087-83 MSD	OOUB-G 28	MVS-085-ARC	10/28/03	68.1	4.99	NS	140	91.9	125	329	66.5	5.61	106
2087-83	OOUB-G 28	MVS-085-ARC	10/28/03	68.1	0.500	NA	84.5	42.6	76.1	141	12.3	0.778	58.4
Spike Concentration, MS					4.90		49.3	49.3	49.3	197	49.3	4.90	49.3
Spike Concentration, MSD					4.83		49.8	49.8	49.8	199	49.8	4.83	49.8
Percent Recovery, MS					**93%**	NA	**107%**	**99%**	**97%**	**96%**	**109%**	**100%**	**93%**
Percent Recovery, MSD					**93%**	NA	**112%**	**99%**	**98%**	**94%**	**109%**	**100%**	**96%**

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MSL Code	Station or OUB Grid Cell	Sponsor Code	Collection Date	Percent Moisture	**Ag**	**Al**	**Cr**	**Ni**	**Cu**	**Zn**	**As**	**Cd**	**Pb**
				Analysis Batch ID	*T040904A*	*031804-6100A*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*	*040604-6100*
				CAS No.	7440-22-4	7429-90-5	7440-47-3	7440-02-0	7440-50-8	7440-66-6	7440-38-2	7440-43-9	7439-92-1
Replicate Analysis Results													
2087-10r1	MVS-024	MVS-024-ARC	08/28/03	63.0	0.484	56900	95.9	41.2	54.6	113	10.4	0.986	41.7
2087-10r2	MVS-024	MVS-024-ARC	08/28/03	63.0	0.448	56600	95.1	41.5	52.7	116	10.5	0.966	41.2
MEAN					0.466	56750	95.5	41.4	53.7	115	10.5	0.976	41.5
RPD					**8%**	**1%**	**1%**	**1%**	**4%**	**3%**	**1%**	**2%**	**1%**
2087-85r1	OOUB-G 18	MVS-087-ARC	10/30/03	69.6	0.943	59600	96.4	47.7	117	159	15.9	1.04	75.1
2087-85r2	OOUB-G 18	MVS-087-ARC	10/30/03	69.6	0.925	56300	97.9	48.4	118	164	16.0	1.03	76.1
MEAN					0.934	57950	97.2	48.1	118	162	16.0	1.04	75.6
RPD					**2%**	**6%**	**2%**	**1%**	**1%**	**3%**	**1%**	**1%**	**1%**

[1] Sed Evap MDL, adjusted for 100x dilution

D Reported from dilution analysis (100x)

U Concentration less than the MDL reported

J Estimated concentration > MDL, but less than the RL

B Blank >RL and sample concentration < 10 times detected blank.

NA Not applicable/available

NS Not spiked

N Spiked sample recovery outside QC criterion of ±30%

& Accuracy outside QC criterion of ±20% difference (SRMs)

* Precision outside QC criterion of ≤30% RPD