THEA FOSS AND WHEELER-OSGOOD WATERWAYS REMEDIATION PROJECT

YEAR 0 BASELINE MONITORING

ANNUAL OPERATIONS, MAINTENANCE, AND MONITORING REPORT

FEBRUARY 28, 2007

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY

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FLOYD|SNIDER

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ACRONYMS AND ABBREVIATIONS

Annual Report	Annual Operations, Maintenance, and Monitoring Report
AOC	Administrative Order on Consent
CD	Consent Decree
CDF	Confined Disposal Facility (i.e., St. Paul Waterway CDF)
City	City of Tacoma
CQAP	Construction Quality Assurance Plan
EPA	U.S. Environmental Protection Agency
Foss Project	Thea Foss and Wheeler-Osgood Waterways Remediation Project
ICP	Institutional Controls Plan
LHOF	Log Haul Out Facility
LWD	Large Woody Debris
MLLW	Mean Lower Low Water
MTCA	Model Toxics Control Act
OMMP	Operation, Maintenance and Monitoring Plan
PAH	Polycyclic Aromatic Hydrocarbon
QAPP	Quality Assurance Project Plan
RA	Remedial Area or Remediation Area
RACR	Remedial Action Construction Report
RAO	Remedial Action Objective
ROD	Record of Decision
SOW	Statement of Work
SPI	Sediment Profile Imagery
SQO	Sediment Quality Objective
TCU	Temporary Containment Unit

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1.0 INTRODUCTION

1.1 Purpose and Objectives of Operations, Maintenance, and Monitoring Plan Activities

This document presents a summary of baseline operations, maintenance, and monitoring activities performed for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (Foss Project). Operations, maintenance, and monitoring activities were performed for remedial action and habitat areas within the Foss Project site (Figure 1-1). The work was performed in accordance with the Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006). Remediation construction was completed in 2006 by the City of Tacoma (City) under a Consent Decree (CD) issued by the U.S. Environmental Protection Agency (EPA).

The OMMP describes the baseline and long-term qualitative, physical, and chemical monitoring to be completed at the site and sets forth specific performance standards for planned monitoring activities to demonstrate that the long-term objectives for the project are met. The OMMP also details the process for contingency planning and presents possible response actions in the event that performance standards are not achieved.

Figure 1-2 shows the remedial actions completed by the City in the Thea Foss and Wheeler-Osgood Waterways. The area in which the City performed remedial actions as part of the Foss Project is identified as the City's work area. Also identified on Figure 1-2 is the Utilities' work area at the head of the Thea Foss Waterway. In this area, monitoring will be performed by the Utilities in accordance with the Head of the Thea Foss Waterway Remediation Project, Operations, Maintenance and Monitoring Plan (PacifiCorp 2003). The City will work cooperatively with the Utilities work group as needed to respond to any incidences of recontamination.

The OMMP was prepared in compliance with the Record of Decision (ROD) (EPA 1989), Administrative Order on Consent (AOC) / Statement of Work (SOW) (EPA 1994)for pre-remedial design investigation and remedial design, Explanation of Significant Difference (ESD) (EPA 1997), 2000 ESD, 2004 ESD, and the CD/SOW (EPA 2003) for remediation construction. The work completed in accordance with the OMMP is also in compliance with these documents.

The OMMP establishes an integrated program designed to evaluate and ensure the effectiveness of the remedial actions relative to the project Remedial Action Objectives (RAO). Work being performed under the OMMP is intended to ensure that the completed remedial actions performed at the site achieve the performance objectives as specified in the ROD and subsequent ESDs as related to the protection of surface sediment, surface water, and biological and physical habitat quality.

The RAO for the cleanup is stated in the ROD as:

- The objective of the selected remedy is to achieve acceptable sediment quality in a reasonable timeframe.

Additional language in the ROD states that the remedy was designed to incorporate the following:

- Natural recovery considerations are used to identify sediment remedial action levels that delineate sediments that are allowed to recover naturally from those that require active sediment cleanup;
- The sediment quality objective also applies to source control requirements. Monitoring sources and sediments will be used to determine the effectiveness of source controls; and
- Habitat function and enhancement of fisheries resources will also be incorporated as part of the overall project cleanup objectives.

The OMMP was developed and results will be evaluated to ensure that the RAOs for the site are achieved.

1.2 Scope of the Baseline Operations, Maintenance, and Monitoring Report

The monitoring tasks and information comprising Baseline Year 0 and included in this report are the following:

- Cap integrity monitoring through low tide slope cap inspections and post-construction hydrographic surveys of capped areas to ensure that constructed caps remain intact;
- Subtidal hydrographic survey of capped areas performed as part of construction verification;
- Cap area chemical performance monitoring through post-construction collection and analysis of surface samples to verify compliance with performance criteria;
- Natural recovery and enhanced natural recovery area monitoring through collection and analysis of post-construction and supplemental natural recovery area samples to provide the baseline for evaluating progress toward natural recovery;
- Determination of the hydrogeologic conditions at the St. Paul Waterway Confined Disposal Facility (CDF) and identification of groundwater wells to be used to establish baseline conditions for the site;
- Habitat mitigation area monitoring performed in 2006; and
- Status of additional project related tasks that include the following:
    - Implementation of tasks required under the Institutional Controls Plan (ICP);
    - Ongoing stormwater source control activities;
    - Response to recontamination in the head of the Thea Foss Waterway work area;
    - Initiation of deauthorization of the navigational channel in encroachment areas;
    - Tracking of Simpson Log Haul Out Facility (LHOF) operations, maintenance, and monitoring; and
    - Tracking of Tacoma Metals management of waste material in the Temporary Containment Unit (TCU).

Table 1-1 summarizes the overall monitoring schedule for OMMP activities to be performed.

1.3 Organization of the Baseline OMMP Report

For each monitoring year, an Annual Operations, Maintenance, and Monitoring Report (Annual Report) will be prepared presenting the final, comprehensive information and data for monitoring

activities completed in the previous year. The Annual Report will also document any decisions and/or contingency actions, planned or implemented.

The structure of the Annual Report for Year 0 Baseline Monitoring, and subsequent Annual Reports, follows the outline of the OMMP to provide a consistent presentation and placement of information generated to monitor remedial actions performed as part of the Foss Project.

The following topics are presented in the Annual Report:

- Section 1.0 – Introduction;
- Section 2.0 – Sediment Remediation Area Performance Monitoring;
- Section 3.0 – Early Warning Monitoring for Recontamination;
- Section 4.0 – Benthic Recolonization Monitoring;
- Section 5.0 – Confined Disposal Facility Monitoring;
- Section 6.0 – Habitat Mitigation Area Monitoring; and
- Section 7.0 – Additional Project Related Activities.

The Annual Report also includes the following appendices:

- Appendix A – Physical Cap Integrity Monitoring
- Appendix B – Sediment and Cap Performance Monitoring
- Appendix C – Benthic Recolonization Monitoring
- Appendix D – Confined Disposal Facility Monitoring
- Appendix E – Habitat Mitigation Area Monitoring
- Appendix F – Health and Safety Plan
- Appendix G – Additional Project Related Activities

During monitoring years when any of these tasks are not required, placeholders will be maintained in the report so that information for a specific activity will consistently be in a specific section. For example, Habitat Mitigation Area Monitoring will consistently be found in Section 6.0 and Appendix E of the Annual Reports.

TABLES

1-1 – Monitoring Schedule

FIGURES

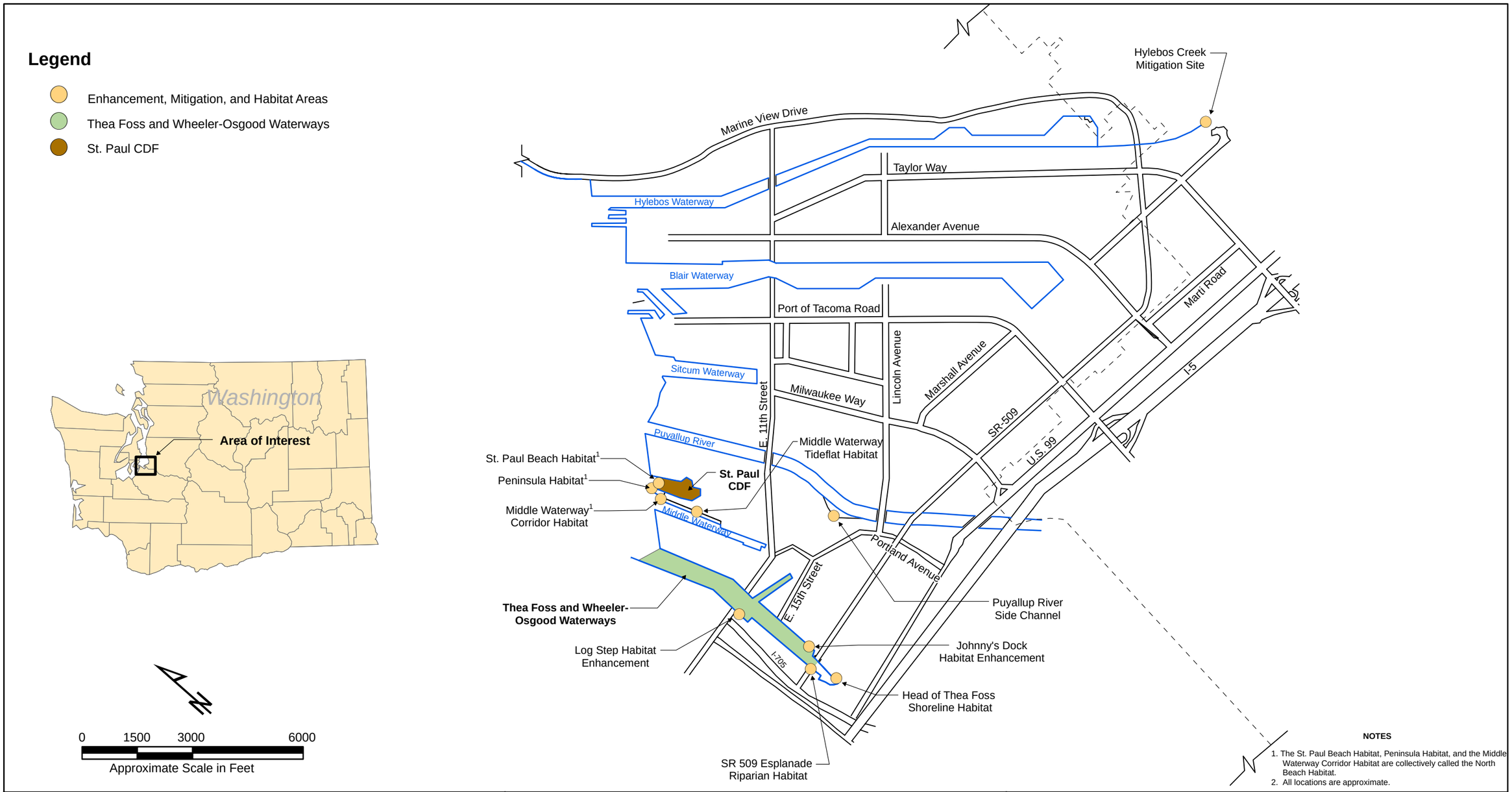
1-1 – Project Location Map

1-2 – Completed Remedial Actions

Table 1-1
Monitoring Schedule

Activity	Monitoring Year (Calendar Year)										
	Year 0 (2006)	Year 1 (2007)	Year 2 (2008)	Year 3 (2009)	Year 4 (2010)	Year 5 (2011)	Year 6 (2012)	Year 7 (2013)	Year 8 (2014)	Year 9 (2015)	Year 10 (2016)
1) Sediment Remediation Area Performance Monitoring											
Supplemental Data Collection for Natural Recovery Area Sediment Quality	X										
Sediment Quality (0 to 10 cm) Performance Monitoring of Cap and Natural Recovery Areas			X		X			X			X
Low Tide Slope Cap Inspection for Cap Integrity	X		X		X			X			X
Subtidal Cap Hydrographic Survey for Cap Integrity			X		X			X			X
2) Early Warning Monitoring for Recontamination											
Sediment Quality (0 to 2 cm) Monitoring			X		X			X			X
3) Benthic Recolonization Monitoring											
Sediment Profile Imaging and Archive Sediment Sample (0 to 10 cm) Collection			X		X			X			X
4) Confined Disposal Facility Monitoring											
72-Hour Tidal Study and Slug Tests	X										
Baseline Monitoring		4 Q	4 Q								
Performance Monitoring				TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
5) Habitat Mitigation Area Monitoring											
Qualitative Ground Surveys	X	X	X	X	X	X	X	X	X	X	X
Quantitative Vegetation Surveys		X	X		X			X			X
Photo Documentation	X	X	X		X			X			X
Elevation Monitoring[1, 2]	X	X	X	X		X		X			X
Brackish Marsh Salinity Monitoring	X	X									
Juvenile Salmonid Monitoring		X		X							
Invertebrate Monitoring		X		X							
Water Surface Elevation Monitoring	X			X		X		X			X

Notes:
4 Q Four quarters.
TBD To be determined.
1 The vertical datum used during the construction phase of the project was MLLW. Due to the length of the OMMP monitoring period and the fact that MLLW changes over time, the vertical datum to be used during this phase has been designated as NGVD 29.
2 Survey transects of the channels at Hylebos Creek will be performed annually while monitoring of elevation stakes at other locations will be performed on the schedule shown.



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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 1-1
Project Location Map

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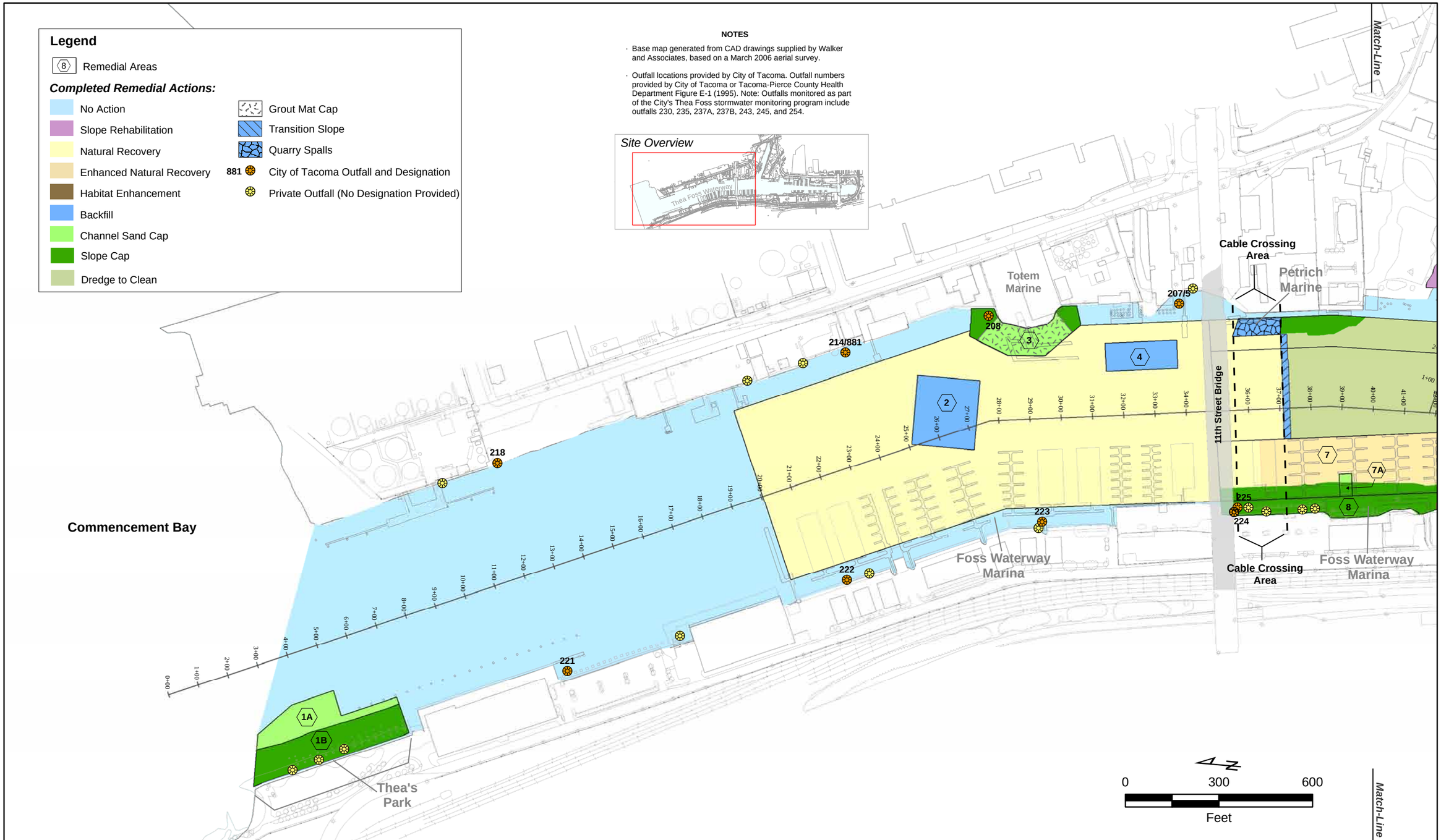

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Year 0 Baseline OMMP Report

Figure 1-2 (Page 1 of 2)
Completed Remedial Actions

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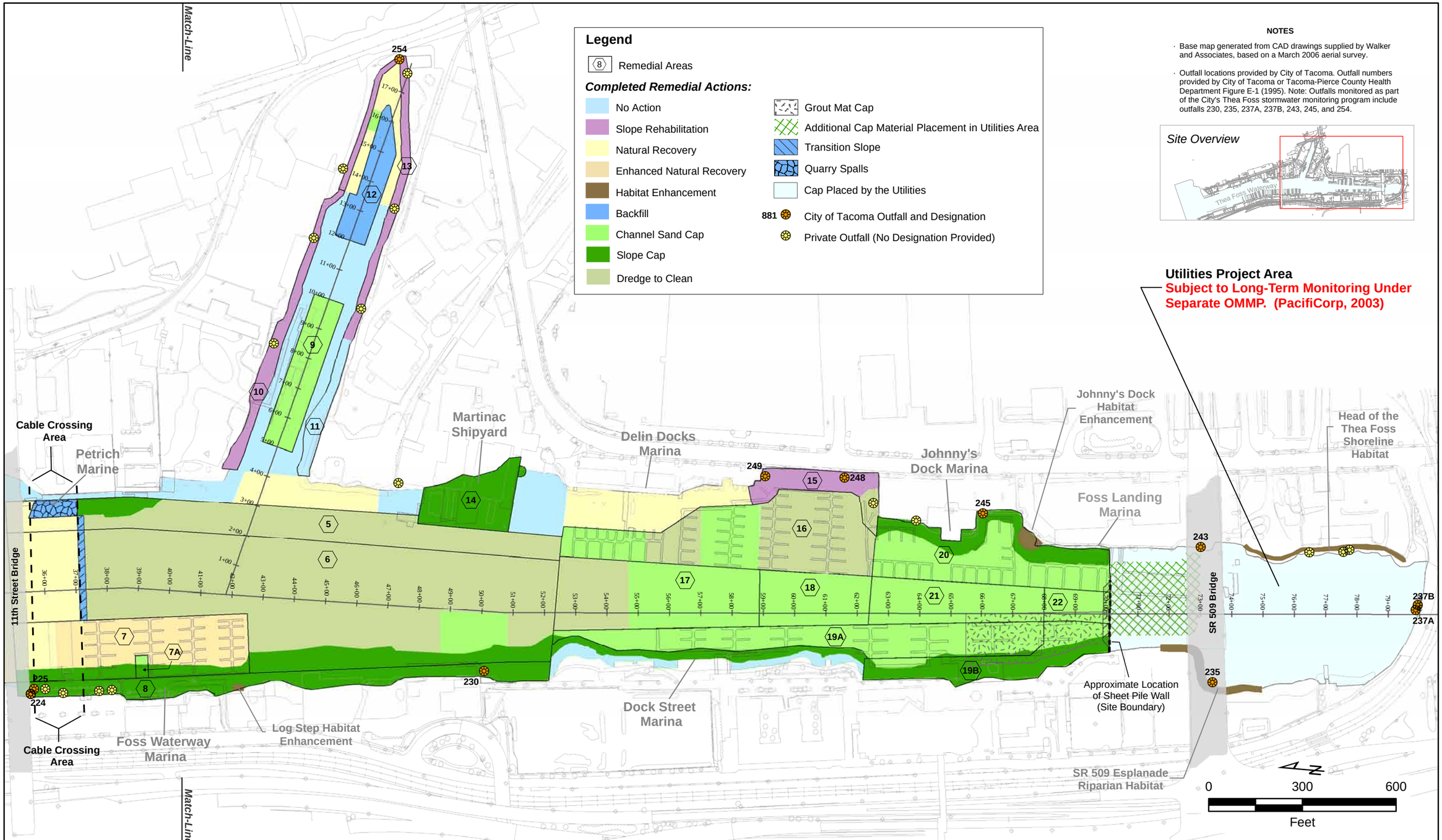

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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 1-2 (Page 2 of 2)
Completed Remedial Actions

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2.0 SEDIMENT REMEDIATION AREA PERFORMANCE MONITORING

2.1 Introduction

Sediment remediation area performance monitoring is designed to achieve the following objectives:

- Ensure sediment caps provide effective containment, both physically and chemically, of contaminated underlying sediments, and provide a substrate that promotes colonization by aquatic organisms; and
- Confirm that within natural recovery areas chemical concentrations will attenuate to below Sediment Quality Objectives (SQO) within the 0 to 10 cm compliance interval within 10 years of completion of remediation construction (i.e., by 2016).

Performance monitoring tasks completed as part of Year 0 Baseline Monitoring to evaluate compliance with the project objectives include the following:

- Performing low tide slope cap inspections to establish baseline conditions for the intertidal portions of the slope caps and to identify areas needing maintenance;
- Compiling the post-construction hydrographic survey data to serve as the baseline for the subtidal cap integrity conditions;
- Compiling existing construction verification surface sample data collected from final cap surfaces and within natural recovery areas to serve as the baseline conditions; and
- Conducting supplemental surface sampling within natural recovery and enhanced natural recovery areas. Supplemental sampling data will be combined with construction verification data to establish a comprehensive natural recovery baseline.

The following sections discuss the results of baseline sediment remediation area performance monitoring tasks.

2.2 Cap Area Performance Monitoring

The purpose of cap area performance monitoring is to verify cap integrity and performance (through effective containment of the underlying contaminated sediments). The cap performance monitoring program is designed to detect and evaluate long-term changes in cap thickness, and surface sediment quality to ensure compliance with performance criteria. Cap area performance monitoring includes cap integrity monitoring and cap area chemical performance monitoring.

2.2.1 Cap Integrity Monitoring

Cap integrity monitoring consists of low tide slope cap inspections and hydrographic surveys and is designed to verify the physical integrity of caps constructed as part of the Thea Foss and Wheeler-Osgood Waterways Remediation Project (Foss Project). Low tide inspections of slope caps ensure that the intertidal portions of slope caps are intact and that underlying contaminated materials are contained or identify areas needing maintenance if disturbances of the slope caps are present. Hydrographic surveys of capped areas detect and evaluate long-term changes in cap thickness to ensure compliance with performance criteria and confirm that

underlying contaminated materials are contained. As described in Section 2.0 of the Operations, Maintenance, and Monitoring Plan for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (OMMP) (City of Tacoma 2006), cap integrity performance monitoring is separated into baseline (Year 0) and long-term (Years 2, 4, 7, and 10) performance monitoring.

2.2.1.1 Baseline Low Tide Slope Cap Inspections

Baseline performance monitoring to evaluate the physical integrity of intertidal slope cap areas consisted of performing low tide inspections of the slope caps in Remedial Area (RA) 1, RA 3, RA 8, RA 14, RA 19A, RA 19B, and RA 20 during Year 0. Additionally, baseline monitoring included a low tide cap inspection of the Sheen Source Removal Area located in the Wheeler-Osgood Waterway in accordance with the OMMP. The results of low tide slope cap monitoring were presented in the Year 0 Baseline Monitoring, Low Tide Slope Cap Inspection Preliminary Findings Memorandum (City of Tacoma 2006).

The results of the low tide slope cap inspection are presented below to characterize the baseline conditions for the intertidal portions of capped areas and identify areas needing maintenance. The outcome of the Year 0 low tide slope cap inspection provides the baseline for evaluating the results of subsequent, long-term monitoring. The results of subsequent low tide slope cap inspections will be evaluated to identify whether the intertidal portions of slope caps remain intact, that coverage has been maintained, and that underlying contaminated material is contained.

Summary of Field Activities

Baseline low tide slope cap inspections were completed between July 2006 and October 2006. Initial inspections were performed on July 10-12, 2006, in RA 1, RA 3, RA 8, RA 14, RA 19A, RA 19B, and RA 20. Supplemental inspections were performed in select areas on August 9, 2006, to delineate areas of cap disturbance and take additional photographs for several monitoring intervals where photographs did not turn out (i.e., were too dark) or did not provide adequate coverage of specific areas. A low tide slope cap inspection was also performed in the Sheen Source Removal Area on October 3, 2006. The requirement for low tide inspection of the Sheen Source Removal Area was added to monitoring activities during finalization of the OMMP in September 2006.

Baseline low tide slope cap inspections were performed on the exposed shoreline portion of slope caps and the Sheen Source Removal Area when tidal elevations were at or below 0.0 feet Mean Lower Low Water (MLLW). Standardized field forms and photographs were used to document observations of slope caps at approximate 100-foot monitoring intervals along the designated shoreline areas. The inspections documented the following observations;

- Slope cap surface characteristics (i.e., rip rap, quarry spalls, habitat mix, etc.);
- Area of slope cap coverage;
- Presence/absence of habitat mix;
- Any areas of exposed sediment due to washout of the slope cap;
- Any areas of sediment accretion;
- Evidence of groundwater seepage;

- Any apparent loss of slope cap material;
- Any apparent down-slope movement of cap materials;
- Presence of debris on the cap surface;
- Indicators of potential contamination (i.e., sheen or staining) within the surface sediment; and
- Verification that grout mat slope cap areas are effectively containing the underlying contaminated sediments.

Figure 2-1 presents the monitoring interval locations for low tide slope cap inspections.

Baseline low tide slope cap inspections were performed in accordance with the Physical Cap Integrity Operations Manual presented in the OMMP.

Summary of Preliminary Findings

This section presents a summary of the results of baseline low tide slope cap inspections in the Thea Foss and Wheeler-Osgood Waterways and identifies slope areas requiring maintenance. The detailed results of the baseline low tide slope cap inspections, including field forms and photographs for each inspection interval, are presented in the Year 0 Baseline Monitoring, Low Tide Slope Cap Inspection Preliminary Findings Memorandum (City of Tacoma 2006) provided in Attachment A-1 in Appendix A. A summary of the findings from the low tide slope cap inspection includes the following:

- No disturbances to the cap were identified upon inspection of the five intervals in RA 1, six intervals in RA 14, eight intervals in RA 19B, and the one interval in the Sheen Source Removal Area;
- No disturbances to the cap were identified in two of four monitoring intervals in RA 3. Two areas are present in monitoring intervals 2 and 3 of RA 3 where geotextile or metal and foundry slag material are present at the surface of the capped area. The two areas 3 have been identified as slope areas requiring maintenance (Table 2-1 and Figure 2-2). Photographs of the areas 3 where geotextile or slag material is present at the cap surface are presented in Attachment B of the Low Tide Slope Cap Inspection Preliminary Findings Memorandum.
- No disturbances to the cap were identified upon inspection of 15 of 17 monitoring intervals in RA 8. Two areas are present in monitoring intervals 14 and 16 of RA 8 where piling or debris is present at the surface of the capped area. Photographs of the areas in RA 8 where piling or debris is at the cap surface are presented in Attachment B of the Low Tide Slope Cap Inspection Preliminary Findings Memorandum. The areas are identified as slope areas requiring maintenance (Table 2-1 and Figure 2-2).
- No disturbances were identified upon inspection of 10 of 11 monitoring intervals in RA 19A. Two depressions are present at the surface of the shoreline in monitoring interval 2 and the adjacent habitat enhancement area. The depressions will be monitored as part of subsequent low tide slope cap inspections to identify whether changes are occurring in the cap surface. A piling is present at the surface of the existing, adjacent habitat enhancement area. Photographs of the piling protruding above the habitat surface are presented in Attachment B of the Low Tide Slope Cap Inspection Preliminary Findings Memorandum. Although the piling is not present within a capped area, it has

been identified to be included in maintenance activities to be performed for slope cap areas in the Thea Foss Waterway (Table 2-1 and Figure 2-2).

- No disturbances were identified upon inspection of 9 of 10 monitoring intervals in RA 20. A piling is present at the surface of the slope cap in monitoring interval 9 and has been identified as a slope area requiring maintenance (Table 2-1 and Figure 2-2). Photographs of the piling at the cap surface in RA 20 are presented in Attachment B of the Low Tide Slope Cap Inspection Preliminary Findings Memorandum.
- A thin layer of sediment accretion and/or fines from capping material was present on relatively flat, enclosed portions of the slope cap areas at elevations generally below 5.0 feet MLLW. This is to be anticipated, and no action is necessary as a result of the presence of sediment accretion and/or fines on slope caps. Cap area chemical performance monitoring which includes collection and analysis of samples from slope cap areas will be performed in Year 2 in accordance with the OMMP to evaluate chemical concentrations and compliance with performance criteria.

Subsequent to performance of the low tide slope cap integrity monitoring, an inspection of stormwater outfalls in the Thea Foss and Wheeler-Osgood Waterways was performed on January 2, 2007, as part of stormwater source control activities. The inspection included outfalls in slope cap areas of the Thea Foss Waterway.

During outfall inspections, fabric was observed to be present at the surface of the capped area south and adjacent to Outfall 230. Additionally, the armoring of the outfall apron appeared to have settled or moved down slope. The fabric and apparent settlement of outfall apron armoring were not observed during the low tide slope cap inspection of monitoring interval 2 in RA 8 (i.e., the location of Outfall 230) performed in July 2006 (Figure 2-1). Source control staff informed the Foss O&M team of this issue.

A supplemental low tide inspection was performed by the Foss O&M team at Outfall 230 on January 17, 2007, to further evaluate the integrity of the slope cap and outfall apron. The fabric blanket was observed at the slope cap surface during the supplemental inspection. Additionally, concrete debris was observed at the slope cap surface up to 12 feet south of Outfall 230. The armoring for the apron in front of Outfall 230 also appeared to have settled or moved down slope. The field notes and photographs from the supplemental inspection of Outfall 230 are provided in Attachment A-3 in Appendix A. Table 2-1 and Figure 2-2 include this slope area as an area requiring maintenance.

Slope Area Maintenance Plan

As described above, specific areas needing maintenance have been identified based on the results of low tide inspections. A Slope Area Maintenance Plan has been prepared to present the objectives and procedures for performing all maintenance of remedial actions constructed on shoreline slopes. The Slope Area Maintenance Plan is provided in Attachment A-2 of Appendix A.

A total of seven shoreline slope areas in RA 3, RA 8, RA 20, and the existing habitat adjacent to RA 19A have been identified for maintenance based on results of the low tide slope cap inspections. The shoreline slope areas and the reasons for the performance of maintenance are summarized in Table 2-1. The general location (i.e., monitoring interval in which a cap disturbance is located) of areas requiring maintenance are shown on Figure 2-2.

Maintenance activities will be performed by the City or a City contractor in accordance with the objectives and procedures described in the Slope Area Maintenance Plan. The scope of the plan includes activities to maintain shoreline slope areas where remedial construction was performed as part of the Foss Project.

2.2.1.2 Baseline Hydrographic Surveys of Capped Areas

Baseline performance monitoring to evaluate the physical integrity of subtidal cap areas includes compiling the post-construction hydrographic survey data to serve as the baseline for the subtidal cap integrity conditions. Post-construction hydrographic surveys were conducted upon the completion of the placement of caps in RA 1, RA 3, RA 6, RA 7A, RA 8, RA 9, RA 14, RA 16, RA 17, RA 18, RA 19A, RA 19B, RA 20, RA 21, and RA 22 as part of construction verification procedures. The results of construction verification surveys are presented in the Remedial Action Construction Reports (RACR) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2003 and 2006). The results of the post-construction hydrographic surveys are presented below to characterize the baseline conditions for capped areas.

The results of post-construction subtidal hydrographic surveys characterize baseline cap area conditions and provide a basis for evaluating the results of subsequent, long-term (Years 2, 4, 7, and 10) cap integrity performance monitoring of subtidal capped areas. Hydrographic surveys will be performed in subtidal slope, grout mat, and channel sand cap areas to evaluate changes (scour/erosion, deposition, or settlement) in cap thickness as indicated by changes in elevation over time. The performance criteria for baseline cap integrity monitoring in capped areas is maintenance of a minimum cap thickness of three feet, as per the Record of Decision (ROD) (EPA 1989). A loss of six inches or more of cap thickness as determined from the cap integrity hydrographic surveys will trigger evaluation of potential response actions.

Summary of Field Activities

Multibeam hydrographic surveys were completed in capped areas following the completion of remedial actions. The surveys were performed in accordance with the Construction Quality Assurance Plan for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (CQAP) (City of Tacoma 2002).

The documentation from post-construction hydrographic surveys are presented in the RACRs for the Foss Project. Table 2-2 summarizes the timing of completion of cap construction in each RA and the post-construction hydrographic survey events for capped areas. The type of cap constructed in each area and timing of cap construction and survey events are also discussed in the following section.

Summary of Hydrographic Surveys

This section summarizes baseline cap area hydrographic surveys completed in RA 1, RA 3, RA 6, RA 7A, RA 8, RA 9, RA 14, RA 16, RA 17, RA 18, RA 19A, RA 19B, RA 20, RA 21, and RA 22 in the Thea Foss and Wheeler-Osgood Waterways. Cap construction performed in each RA is summarized in the following sections and the baseline bathymetry for surveys completed in capped areas is presented in Figures 2-3 through 2-12. Remedial actions performed in each RA are described in more detail in the RACRs (City of Tacoma 2003 and 2006).

Remedial Area 1 – RA 1 is located on the west side of the mouth of the Thea Foss Waterway between approximate Stations 02+00 and 07+00 (Figure 2-3). A thick slope cap was constructed on the shoreline slope in RA 1 from the base or toe of the slope up to the base of an existing rip rap slope. The eastern portion of RA 1, adjacent to the base of the shoreline slope cap, was capped with channel sand cap material. Cap construction in RA 1 was completed on February 14, 2003. The post-construction hydrographic survey was completed on February 20, 2003. Figure 2-4 presents the post-construction bathymetric conditions in RA 1.

Remedial Area 3 – RA 3 is located north of the 11th Street Bridge, on the east side of the Thea Foss Waterway between approximate Stations 27+00 and 31+00 (Figure 2-3). A thick slope cap and grout mat cap were constructed on the shoreline slope in RA 3 from the base of the slope to the top of the bank. The western portion of RA 3, adjacent to the base of the shoreline slope cap and grout mat cap, was capped with channel sand cap material. Cap construction in RA 3 was completed on February 7, 2003. The post-construction hydrographic survey was completed on February 19, 2003. Figure 2-5 presents the post-construction bathymetric conditions in RA 3.

Remedial Area 5 –RA 5 is comprised of the eastern portion of the Thea Foss Waterway navigation channel from approximate Station 52+34 on its southern boundary to Station 34+91 on the north (Figure 2-3). A thick slope cap was constructed from the base of the shoreline slope to the base of the existing dock structure (i.e., the dock at Petrich Marine). Cap construction in RA 5 was completed on October 27, 2005. The post-construction hydrographic survey was performed on December 22, 2005. Figure 2-6 presents the post-construction bathymetric conditions in RA 5.

Remedial Area 6 – RA 6 is comprised of the channel area between approximate Station 34+90 (approximately the center of the 11th Street Bridge) on the north and Station 52+34 on the south (Figure 2-3). A cap comprised of channel sand cap material was placed in the southwestern portion of RA 6, at the base of the shoreline slope, between approximate Stations 48+75 and 50+80 . Cap construction in RA 6 was completed on January 21, 2006. Post-construction hydrographic surveys were performed on December 22, 2005 and February 12, 2006. Figure 2-7 presents the post-construction bathymetric conditions in the capped area of RA 6.

Remedial Area 7A – RA 7A is within the harbor area located along the western portion of the Thea Foss Waterway (Figure 2-3) beneath the Foss Waterway Marina. A cap comprised of channel sand cap material was placed in RA 7A, at the base of the shoreline slope, between approximate Stations 38+75 and 39+25. Cap construction in RA 7A was completed on November 11, 2005. The post-construction hydrographic survey was performed on December 21, 2005 and February 12, 2006. Figure 2-8 presents the post-construction bathymetric conditions in RA 7A.

Remedial Area 8 –RA 8 is comprised of the western shoreline of the Thea Foss Waterway from approximate Station 52+34 on its southern boundary to Station 34+91 on the north (Figure 2-3). Thick slope and quarry spall caps were constructed from the base of the shoreline slope to the top of the bank or up to the base of existing structures (i.e., the sheet pile wall at Johnny's Seafood, waterward face of Colonial Fruit, Esplanade at the Foss Waterway Marina, etc.). Cap construction in RA 8 was completed on December 7, 2005. Post-construction hydrographic surveys were performed on December 21-22, 2005 and February 12, 2006. Figures 2-7 and 2-8 present the post-construction bathymetric conditions in RA 8.

Remedial Area 9 – RA 9 is located at the mouth of the Wheeler-Osgood Waterway between Stations 5+00 and 10+00 (Figure 2-3). RA 9 was capped with channel sand cap material as part of remedial activities. Cap construction in RA 9 was completed on November 10, 2005. Post-construction hydrographic surveys were performed on December 22, 2005 and February 12, 2006. Figure 2-9 presents the post-construction bathymetric conditions in RA 9.

Remedial Area 14 – RA 14 is located on the east side of the Thea Foss Waterway under and adjacent to the J.M. Martinac Shipbuilding facility (Figure 2-3). Thick slope and quarry spall caps were constructed from the base of the shoreline slope up to the base of existing structures (i.e., bulkheads and shipways). Cap construction in RA 14 was completed on January 4, 2006. Post-construction hydrographic surveys were performed on December 22, 2005 and February 12, 2006. Figure 2-10 presents the post-construction bathymetric conditions in RA 14.

Remedial Area 16 – RA 16 is a harbor area located on the east side of the Thea Foss Waterway between approximate Stations 52+50 and 62+50 (Figure 2-3) beneath Delin Docks. Two areas within RA 16 were capped as part of remedial construction. The northern portion of RA 16 from approximate Stations 52+50 to 55+25 and the central portion of RA 16 from Stations 57+00 to 58+85 were capped with channel sand cap material. Capping of the northern and central portions of RA 16 were completed on October 19, 2005. The post-construction hydrographic survey was completed on December 22, 2005. Figure 2-11 presents the post-construction bathymetric conditions in the capped areas of RA 16.

Remedial Area 17 – RA 17 is located within the channel of the Thea Foss Waterway between approximate Stations 52+35 and 58+85 (Figure 2-3). The southern portion of RA 17 between Stations 54+85 and 58+85 was capped with channel sand cap material. Cap construction in RA 17 was completed on February 4, 2006. Post-construction hydrographic surveys were performed on December 22, 2005 and February 12, 2006. Figure 2-11 presents the post-construction bathymetric conditions in the capped area of RA 17.

Remedial Area 18 – RA 18 is located within the channel of the Thea Foss Waterway between approximate Stations 58+85 and 62+40 (Figure 2-3). RA 18 was capped with channel sand cap material as part of remedial activities. Cap construction in RA 18 was completed on January 20, 2006. Post-construction hydrographic surveys were performed on December 21-22, 2005 and February 12, 2006. Figure 2-11 presents the post-construction bathymetric conditions in RA 18.

Remedial Area 19A – RA 19A is comprised of the harbor area located on the southwestern shoreline of the Thea Foss Waterway between approximate Stations 52+50 and 68+00 (Figure 2-3) beneath the Dock Street Marina. A thick slope cap was constructed in the northern portion of RA 19A from the base of the shoreline slope to the base of an existing habitat area. Channel sand cap material was placed in RA 19A from the base of the shoreline slope to the channel line. The channel sand cap was constructed over the grout mat cap placed in the southern portion of RA 19A. Construction of the grout mat, thick slope, and channel sand caps in RA 19A was performed in 2004. Additional channel sand cap material was also placed in the southern portion of RA 19A between approximate Stations 66+40 and 70+10 in 2005. Cap construction was completed in RA 19A on December 17, 2005. Post-construction hydrographic surveys were performed on December 21-22, 2005 and February 12, 2006. Figures 2-11 and 2-12 present the post-construction bathymetric conditions in RA 19A.

Remedial Area 19B – RA 19B is comprised of the harbor area on the southwestern shoreline of the Thea Foss Waterway between approximate Stations 62+20 and 70+10 (Figure 2-3) beneath the Dock Street Marina. A thick slope cap was constructed in RA 19B from the base of the shoreline slope to the top of the bank or to the base of existing structures (i.e., sheet pile walls). Channel sand cap material was placed in RA 19B from the base of the shoreline slope to the channel line. The slope cap and channel sand cap were constructed over the grout mat cap placed in RA 19B. Construction of the grout mat, thick slope, and channel sand caps in RA 19B was performed in 2004. Additional channel sand cap material was also placed in RA 19B in 2005. Cap construction in RA 19B was completed on December 17, 2005. Post-construction hydrographic surveys were performed on December 21-22, 2005. Figure 2-12 presents the post-construction bathymetric conditions in RA 19B.

Remedial Area 20 – RA 20 is comprised of the harbor area located on the southeastern shoreline of the Thea Foss Waterway between approximate Stations 62+50 and 70+10 (Figure 2-3) beneath the Johnny's Dock Marina. Thick slope caps were constructed in RA 20 from the base of the shoreline slope to the top of the bank or to the base of existing structures (i.e., sheet pile walls and waterward face of Johnny's Seafood Restaurant). Channel sand cap material was placed in RA 20 from the base of the shoreline slope to the channel line. Cap construction in RA 20 was completed on January 18, 2006. Post-construction hydrographic surveys were performed on December 22, 2005 and February 12, 2006. Figure 2-12 presents the post-construction bathymetric conditions in RA 20.

Remedial Area 21 – RA 21 is located within the channel of the Thea Foss Waterway between approximate Stations 62+40 and 68+00 (Figure 2-3). All of RA 21 was capped with channel sand cap material as part of remedial activities. Cap construction in RA 21 was completed on January 13, 2006. Post-construction hydrographic surveys were performed on December 21-22, 2005 and February 12, 2006. Figure 2-12 presents the post-construction bathymetric conditions in RA 21.

Remedial Area 22 – RA 22 is located within the channel of the Thea Foss Waterway at the southern end of the site between Stations 68+00 and 70+10 (Figure 2-3). All of RA 22 was capped with channel sand cap material as part of remedial activities. Cap construction in RA 22 was completed on December 17, 2005. Post-construction hydrographic surveys were performed on December 21-22, 2005. Figure 2-12 presents the post-construction bathymetric conditions in RA 22.

2.2.1.3 Schedule of Cap Integrity Monitoring

No additional low tide inspections or hydrographic surveys are required to characterize baseline conditions in capped areas. Cap integrity monitoring is scheduled to occur in 2008 as part of Year 2 cap area performance monitoring. The schedule for OMMP activities to be performed as part of the Foss Project is presented in Table 1-1. The scope of cap integrity monitoring, including low tide inspections and hydrographic surveys, to be conducted in Year 2 is described in the OMMP.

2.2.2 Cap Area Chemical Performance Monitoring

Cap area chemical performance monitoring is designed to evaluate the long-term effectiveness of caps constructed as part of the Foss Project. Chemical performance monitoring activities consist of collection and analysis of surface samples (0 to 10 cm) from constructed caps to

verify compliance with cleanup criteria and confirm that underlying contaminated materials are contained. As described in Section 2.0 of the OMMP, cap performance monitoring is separated into baseline (Year 0) and long-term (Years 2, 4, 7, and 10) performance monitoring.

Baseline cap area chemical performance monitoring consists of compiling existing construction verification data for samples collected from the final surface of areas capped with channel sand cap material. Surface samples (0 to 10 cm) were collected and analyzed upon the completion of the placement of channel sand cap material in RA 1, RA 6, RA 9, RA 16, RA 17, RA 18, RA 19A, RA 19B, RA 20, RA 21, and RA 22 as part of construction verification procedures. The results of construction verification sampling and analysis are presented in the RACRs and are presented below to characterize the baseline conditions for areas capped with channel sand cap material.

Summary of Field Activities

Construction verification samples were collected from the surface (0 to 10 cm) of channel sand capped areas following the completion of remedial actions. The surface samples were collected at approximate 150-foot intervals within each RA. Figure 2-13 identifies the cap area construction verification sample locations. The samples were collected and analyzed in accordance with the EPA-approved Quality Assurance Project Plan and Sediment Verification Plan (Lloyd & Associates, Inc. 2003) developed for the 2002-2003 Thea Foss and Wheeler-Osgood Waterways Remediation Project, and the Sediment Verification Quality Assurance Project Plan for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (Parametrix 2003) developed for remedial activities performed between 2003 and 2006.

Samples of areas capped with channel sand cap material were collected using a vessel deployed grab sampler (i.e., Van Veen or Eikman surface sampler) or by a diver. Field forms were completed and photographs taken to document observations during each sampling event. The samples were submitted to the laboratory under approved sample handling and chain-of-custody procedures for the following analyses:

- Semivolatile organic compounds (SVOCs);
- Polychlorinated biphenyls (PCBs);
- Pesticides (i.e., 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT);
- Metals (i.e., mercury, lead, zinc, and copper);
- Total organic carbon (TOC); and
- Total solids.

Documentation of field sampling activities and sample analyses performed are presented in construction correspondence memorandums and reports submitted as part of the remedial actions. Table 2-3 identifies each construction verification sampling event and associated construction memorandum or report for samples collected in cap areas. The timing of sampling events and results of cap sampling in each RA are discussed in the following section.

Summary of Preliminary Findings

The analytical results for samples collected from capped areas in each RA are presented in the following sections and summarized in Tables 2-4 through 2-14. The results for the samples

collected from the final surface of capped areas are compared to the SQOs. The performance criteria for construction verification in capped areas was the SQOs. The point of compliance is the top 10 centimeters (i.e., from 0 to 10 cm) of the cap surface which correspond to the biological mixing zone for benthic organisms, per the ROD. Additionally, summary statistics for each chemical are presented in the results tables where more than one sample was collected and analyzed from the RA. Remedial actions performed in each RA are described in more detail in the RACRs.

Remedial Area 1 – RA 1 is located on the west side of the mouth of the Thea Foss Waterway between approximate Stations 02+00 and 07+00 (Figure 2-13). The eastern portion of RA 1, adjacent to the base of the shoreline slope, was capped with channel sand cap material.

Two cap verification samples and a sample duplicate (i.e., TF1A-001-CVSS, TF1A-002-CVSS, and TF1A-002-CVSS Field Duplicate) were collected from the final cap surface in RA 1 on February 19, 2003, to verify compliance with the SQOs. Several metals and SVOCs, and TOC were detected in cap verification samples, however, the detected chemical concentrations and detection limits for metals and SVOCs were less than the SQOs in the verification samples collected from RA 1 (Table 2-4).

Remedial Area 6 – RA 6 is comprised of the channel area between approximate Station 34+90 (approximately the center of the 11th Street Bridge) on the north and Station 52+34 on the south (Figure 2-13). A cap was placed in the southwestern portion of RA 6, at the base of the shoreline slope, between approximate Stations 48+75 and 50+80.

A cap verification sample and sample duplicate (i.e., RA-06-041-060123-G and RA-06-042-060123-G) were collected from the final cap surface on January 23, 2006. Only metals and TOC were detected in the cap verification samples, and the detected chemical concentrations and detection limits for metals were less than the SQOs in the cap verification samples collected from RA 6 (Table 2-5).

Remedial Area 9 – RA 9 is located at the mouth of the Wheeler-Osgood Waterway between Stations 5+00 and 10+00 (Figure 2-13). All of RA 9 was capped with channel sand cap material.

Three cap verification samples (i.e., RA-09-011-051214-G, RA-09-012-051214-G, and RA-09-013-051214-G) were collected from the final cap surface in RA 9 on December 14, 2005. Several metals and SVOCs, and TOC were detected in the cap verification samples, however, the detected chemical concentrations and detection limits for metals and SVOCs were less than the SQOs in the cap verification samples collected from RA 9 (Table 2-6).

Remedial Area 16 – RA 16 is a harbor area located on the east side of the Thea Foss Waterway between approximate Stations 52+50 and 62+50 (Figure 2-13). Two areas within RA 16 were capped as part of remedial construction. The northern portion of RA 16 from approximate Stations 52+50 to 55+25 and the central portion of RA 16 from Stations 57+00 to 58+85 were capped with channel sand cap material.

A cap verification sample and sample duplicate were collected from the final cap surface in each of the two capped areas to verify compliance with the SQOs. A cap verification sample and sample duplicate were collected from the northern capped area on October 19, 2005 (i.e., RA-16-020-051019-G and RA-16-022-051019-G) and from the central portion of RA 16 on October

24, 2005 (i.e., RA-16-024-051024-G and RA-16-025-051024-G). TOC, Metals, SVOCs, pesticides, and PCBs were detected in the cap verification samples, however, the detected chemical concentrations and detection limits for metals, SVOCs, pesticides, and PCBs were less than the SQOs in the cap verification samples collected from RA 16 (Table 2-7).

Remedial Area 17 – RA 17 is located within the channel of the Thea Foss Waterway between approximate Stations 52+35 and 58+85 (Figure 2-13). The southern portion of RA 17 between Stations 54+85 and 58+85 was capped with channel sand cap material as part of remedial activities.

Two cap verification samples and a sample duplicate were collected from the final cap surface in RA 17 on January 23, 2006 (i.e., RA-17-021-060123-G) and February 6, 2006 (i.e., RA-17-031-060206-G and RA-17-032-060206-G). Only metals and TOC were detected in the cap verification samples, and the detected concentrations and detection limits for metals were less than the SQOs in the cap verification samples collected from RA 17 (Table 2-8).

Remedial Area 18 – RA 18 is located within the channel of the Thea Foss Waterway between approximate Stations 58+85 and 62+40 (Figure 2-13). All of RA 18 was capped with channel sand cap material as part of remedial activities.

Two cap verification samples (i.e., RA-18-021-060120-G and -18-021-060120-G) were collected from the final cap surface in RA 18 on January 20, 2006, to verify compliance with the SQOs. Only metals and TOC were detected in the cap verification samples, and the detected chemical concentrations and detection limits for metals were less than the SQOs in the cap verification samples collected from RA 18 (Table 2-9).

Remedial Area 19A – RA 19A is comprised of the harbor area located on the southwestern shoreline of the Thea Foss Waterway between approximate Stations 52+50 and 68+00 (Figure 2-13). Channel sand cap material was placed in RA 19A from the base of the shoreline slope to the channel line including over the grout mat cap placed in the southern portion of RA 19A. Construction of the grout mat and channel sand cap in RA 19A was performed in 2004. Additional cap material was also placed in the southern portion of RA 19A between approximate Stations 66+40 and 70+10 in 2005.

Supplemental cap verification sampling was performed in 2005 to evaluate chemical concentrations at the surface of the cap in RA 19A. Additionally, cap verification sampling was performed in 2005 to evaluate chemical concentrations at the surface of the additional channel sand cap material placed between Stations 66+40 and 70+10. A confirmation sample and sample duplicate (i.e., RA-19A-034-060104-G and RA-19A-035-060104-G) were collected from the surface of the additional cap material placed in RA 19A on January 4, 2006. Eight supplemental cap verification samples (i.e., RA-19A-026-051012-G through RA-19A-033-051012-G) were collected on October 12, 2005. TOC, metals, SVOCs, pesticides, and PCBs were detected in the cap verification samples, however, the detected concentrations and detection limits for metals, SVOCs, pesticides, and PCBs were less than the SQOs in the cap verification samples collected from RA 19A (Table 2-10).

Remedial Area 19B – RA 19B is comprised of the harbor area on the southwestern shoreline of the Thea Foss Waterway between approximate Stations 62+20 and 70+10 (Figure 2-13). Channel sand cap material was placed over the grout mat in RA 19B from the base of the

shoreline slope to the channel line. Construction of the grout mat and channel sand cap in RA 19B was performed in 2004. Additional cap material was also placed in RA 19B in 2005.

Two cap verification samples (i.e., RA-19B-010-060104-G and RA-19B-011-060104-G) were collected from the surface of the additional cap material placed in RA 19B on January 4, 2006. Several metals and SVOCs, and TOC were detected in cap verification samples, however, the detected concentrations and detection limits for metals and SVOCs were less than the SQOs in the cap verification samples collected from RA 19B (Table 2-11).

Remedial Area 20 – RA 20 is comprised of the harbor area located on the southeastern shoreline of the Thea Foss Waterway between approximate Stations 62+50 and 70+10 (Figure 2-13). Channel sand cap material was placed in RA 20 from the base of the shoreline slope to the channel line.

Four cap verification samples and a sample duplicate were collected from the final cap surface on January 4, 2006 (i.e., RA-20-021-060104-G and RA-20-022-060104-G) and January 16, 2006 (i.e., RA-20-023-060116-G, RA-20-024-060116-G, and RA-20-025-060116-G) to verify compliance with SQOs. Metals, bis(2-ethylhexyl)phthalate, and TOC were detected in the cap verification samples, however, the detected chemical concentrations and detection limits for metals and bis(2-ethylhexyl)phthalate were less than the SQOs in the cap verification samples collected from RA 20 (Table 2-12).

Remedial Area 21 – RA 21 is located within the channel of the Thea Foss Waterway between approximate Stations 62+40 and 68+00 (Figure 2-13). All of RA 21 was capped with channel sand cap material as part of remedial activities.

Three cap verification samples were collected from the final cap surface on January 4, 2006 (i.e., RA-21-021-060104-G) and January 20, 2006 (i.e., RA-21-022-060120-G and -21-023-060120-G). Several metals and SVOCs, and TOC were detected in cap verification samples, however, the detected chemical concentrations and detection limits for metals and SVOCs were less than the SQOs in the cap verification samples collected from RA 21 (Table 2-13).

Remedial Area 22 – RA 22 is located within the channel of the Thea Foss Waterway at the southern end of the site between Stations 68+00 and 70+10 (Figure 2-13). All of RA 22 was capped with channel sand cap material as part of remedial activities.

A cap verification sample (i.e., RA-22-021-060104-G) was collected from the final cap surface in RA 22 on January 4, 2006, to verify compliance with SQOs. Several metals, SVOCs, and TOC were detected in cap verification samples, however, the detected chemical concentrations and detection limits for metals and SVOCs were less than the SQOs in the cap verification sample collected from RA 22 (Table 2-14).

2.2.2.1 Schedule for Cap Area Chemical Performance Monitoring Activities

No additional cap area chemical performance monitoring is required to characterize baseline conditions in capped areas. Cap area chemical performance monitoring, including collection and analysis of samples from areas capped with channel sand cap material and from slope caps, is scheduled to occur in 2008 as part of Year 2 cap area performance monitoring. The schedule for OMMP activities to be performed as part of the Thea Foss and Wheeler-Osgood

Waterways Remediation Project is presented in Table 1-1. The scope of cap area performance monitoring to be conducted in Year 2 is described in the OMMP.

2.3 Baseline Natural Recovery and Enhanced Natural Recovery Monitoring

Natural recovery and enhanced natural recovery performance monitoring is designed to verify that surface sediments in natural recovery areas satisfy performance criteria within the allowed 10-year time frame. Natural recovery and enhanced natural recovery performance monitoring consists of collection and analysis of surface samples (0 to 10 cm) from natural recovery and enhanced natural recovery areas to evaluate chemical concentration trends to determine whether natural recovery is likely to be achieved within the compliance period.

As described in Section 2.0 of the OMMP, natural recovery and enhanced natural recovery performance monitoring is separated into baseline (Year 0) and long-term (Years 2, 4, 7, and 10) performance monitoring. Baseline natural recovery and enhanced natural recovery performance monitoring consists of compiling the results of existing construction verification and supplemental surface (0 to 10 cm) sediment samples collected from natural recovery and enhanced natural recovery areas. Natural recovery and enhanced natural recovery areas to be monitored include the northern portions of RA 5 and RA 6, all of RA 7, most of the area north of the 11th Street Bridge to Station 20+00, the head of the Wheeler-Osgood Waterway located between RA 12 and RA 13, an area east of RA 16 and north of RA 15, and an area located east of RA 5 near the mouth of the Wheeler-Osgood Waterway extending from Stations 41+50 to 46+50 (Figure 2-14). Additionally, slopes in the Wheeler-Osgood Waterway comprising RA 10, RA 11, and RA 13 were designated for natural recovery and slope rehabilitation during the Remedial Design phase of the project and will be monitored as part of the OMMP.

Construction verification surface samples collected within the natural recovery areas adjacent to RA 2 and RA 4 and within the northern portions of RA 5, RA 6, and RA 7 are used to characterize natural recovery baseline conditions in these areas. The results of construction verification surface samples used as baseline for natural recovery areas were presented in the RACR. In addition, supplemental baseline samples were required within designated natural recovery and enhanced natural recovery areas as part of Year 0 monitoring where there was insufficient existing construction verification data to complete the baseline characterization. Supplemental baseline natural recovery area monitoring was performed in October 2006. The results of supplemental samples that establish the baseline for natural recovery and enhanced natural recovery areas were presented in the Supplemental Baseline Natural Recovery Monitoring Preliminary Findings Memorandum (City of Tacoma 2007). Figure 2-14 identifies the baseline natural recovery and enhanced natural recovery area sample locations.

The results of construction confirmation and supplemental surface samples collected from natural recovery and enhanced natural recovery areas provide the baseline for evaluating the results of subsequent, long-term natural recovery monitoring. The results of subsequent natural recovery sampling and analysis will be compared to the baseline results to evaluate trends in chemical concentrations to identify if natural recovery and enhanced natural recovery areas will satisfy or have satisfied performance criteria within the allowed 10-year time frame.

Summary of Construction Verification Field Activities

Construction verification surface sediment samples were collected from 0 to 10 cm within the natural recovery area adjacent to RA 2 and RA 4 and within the northern portions of RA 5, RA 6,

and RA 7 as part of remedial activities. The actual construction verification sample locations are shown on Figure 2-14. The samples were collected and analyzed in accordance with the Sediment Verification Quality Assurance Project Plan for the Thea Foss and Wheeler-Osgood Waterways Remediation Project.

Samples collected from natural recovery areas as part of construction verification were collected using a vessel deployed grab sampler (i.e., Van Veen or Eikman surface sampler). Field forms were completed and photographs taken to document observations during each sampling event. The sediment samples were stored in a cooler containing ice and submitted to the laboratory under a chain-of-custody for the following analyses:

- SVOCs;
- PCBs;
- Pesticides (i.e., 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT);
- Metals (i.e., copper, mercury, lead, and zinc);
- TOC; and
- Total solids.

Documentation of field sampling activities and the analytical results for construction verification samples collected from natural recovery areas are presented in construction correspondence memoranda submitted as part of the remedial actions. Table 2-15 summarizes the construction verification sampling events for natural recovery areas. The timing of sampling events and results of natural recovery sampling in each area are discussed below.

Summary of Supplemental Baseline Field Activities

Supplemental baseline natural recovery monitoring consisted of collection and analysis of surface samples (0 to 10 cm) from natural recovery and enhanced natural recovery areas where there was insufficient existing construction verification data to complete the baseline characterization. The samples were collected and analyzed in accordance with the Sediment Sampling Operation Manual developed as part of the OMMP.

A vessel deployed Van Veen grab sampler was used on October 23-24, 2006, to collect surface samples from the natural recovery and enhanced natural recovery areas north of the 11th Street Bridge, in RA 7, at the head of the Wheeler-Osgood Waterway between RA 12 and RA 13, in the area east of RA 16 and north of RA 15, and the area located east of RA 5 near the mouth of the Wheeler-Osgood Waterway. Samples of shoreline areas in the Wheeler-Osgood Waterway comprising RA 10, RA 11, and RA 13 were collected using a stainless steel spoon and bowl when the sample locations were exposed at a low tide on October 25, 2006. The actual supplemental sample locations are shown on Figure 2-14.

Samples collected from the shoreline of the Wheeler-Osgood Waterway are composites comprised of subsamples collected from three locations in each RA (i.e., RA 10, RA 11, and RA 13). The locations of the shoreline subsamples were established by installing stakes at each sample location prior to sample collection. Shoreline sample locations were established at the approximate mid-point of the slope at three evenly spaced locations within each RA (Figure 2-14).

Sediment samples were stored in a cooler containing ice and submitted to the laboratory under a chain-of-custody for the following analyses:

- SVOCs;
- PCBs;
- Pesticides (i.e., 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT);
- Metals (i.e., antimony, arsenic, cadmium, copper, lead, mercury, nickel, silver, and zinc);
- TOC; and
- Total solids.

Documentation of field sampling activities and analytical results for samples collected from natural recovery and enhanced natural recovery areas as part of supplemental baseline natural recovery monitoring are presented in the Supplemental Baseline Natural Recovery Monitoring Preliminary Findings Memorandum. Table 2-15 summarizes the supplemental sampling events for natural recovery areas. The timing of sampling events and results of natural recovery sampling in each area are discussed below.

Summary of Monitoring Results

The analytical results for samples collected from natural recovery and enhanced natural recovery areas are presented in the following sections and summarized in Tables 2-16 through 2-23. The results for samples collected from natural recovery areas are compared to the SQOs. Additionally, summary statistics for each chemical are presented in the summary tables where more than one sample was collected and analyzed from a natural recovery area. Construction verification and supplemental sampling in natural recovery and enhanced natural recovery areas is described in more detail in the RACR and in the Supplemental Baseline Natural Recovery Monitoring Preliminary Findings Memorandum.

Area North of 11th Street Bridge – The channel and harbor areas north of the 11th Street Bridge extending to Station 20+00, excluding the areas comprising RA 2, RA 3, and RA 4 are a natural recovery area (Figure 2-14). Dredge boundary verification sampling was completed in the areas adjacent to RA 2 and RA 4 as part of remedial activities performed in 2004. Additionally, supplemental baseline natural recovery area monitoring was performed in October 2006 to provide additional data to complete the baseline characterization for the natural recovery area north of the 11th Street Bridge.

Dredge boundary verification samples were collected from surface sediment located on each side of RA 2. The four dredge boundary samples (RA-02-006-041022-G, RA-02-007-041022-G, RA-02-008-041022-G, and RA-02-009-041022-G) were collected on October 22, 2004. A field duplicate sample (RA-02-004-041022-G) was also collected for quality control. Neither the detected concentrations nor analytical detection limits exceeded the SQOs in the dredge boundary samples collected adjacent to RA 2 (Table 2-16).

Dredge boundary verification samples were collected from surface sediment located on each side of RA 4. The four dredge boundary samples (RA-04-005-041115-G, RA-04-006-041115-G, RA-04-007-041115-G, and RA-04-008-041115-G) were collected on November 15, 2004. The detected concentrations and analytical detection limits in the dredge boundary samples were less than the SQOs for all chemicals but zinc in one sample at one station, RA 4-006 (RA-04-

006-041115-G). Additional surface sampling was performed east of RA 4 in response to the detected zinc concentration.

Two offset boundary surface samples (RA-04-009-041229-G and RA-04-011-041229-G) were collected 50 feet north and south of Station RA 4-006 on December 29, 2004. Additionally, Station RA 4-006 was re-sampled (RA-04-010-041229-G) on December 29, 2004. This co-located sample station is identified as Station RA 4-010 in the offset confirmation sampling results. A field duplicate sample (RA-02-012-041229-G) was also collected for quality control.

Zinc was detected in all four offset samples but at concentrations less than 1/3 of the zinc SQO (Table 2-16). The results for offset samples and the additional sample at the original sample location verify that the original sample with the zinc concentration greater than the SQO was an anomaly and is not representative of zinc concentrations in or adjacent to RA 4. Supplemental surface samples (i.e., NR-06-Y0-D, NR07-Y0-D, and NR-11-Y0-D) were collected from three locations in the natural recovery area north of the 11th Street Bridge on October 23, 2006. The detected chemical concentrations and detection limits of all but two analytes in two samples were less than the SQOs (Table 2-16). In sample NR-11-Y0-D, bis(2-ethylhexyl)phthalate (BEHP) was detected at a concentration that was approximately 1.5 times the SQO. Benzyl alcohol was not detected in sample NR-11-Y0-D, but the detection limit was greater than the SQO. Similarly, in sample NR-07-Y0-D, benzyl alcohol was not detected, but the reporting limit was greater than the SQO.

Northern Portion of RA 5 – The northern portion of RA 5 from Stations 37+10 to 35+00 is a natural recovery area (Figure 2-14).

Two construction verification samples and a sample duplicate were collected from surface sediment in the natural recovery area in RA 5 as part of remedial activities performed in 2005. A post-dredge verification sample was collected on September 23, 2005 (i.e., RA-05-002-050923-G) and a dredge boundary verification sample and sample duplicate were collected on December 15, 2005 (i.e., RA-05-009-051215-G and RA-05-010-051215-G). The detected chemical concentrations and detection limits were less than the SQOs in the post-dredge verification sample collected from the natural recovery area in RA 5 (Table 2-17). Only one analyte, BEHP, was detected at concentrations greater than the SQO in the dredge boundary verification sample and sample duplicate. The BEHP concentrations that were detected were slightly greater than the SQO.

Northern Portion of RA 6 – The northern portion of RA 6 from approximate Stations 37+10 to 35+00 is a natural recovery area (Figure 2-14).

Three samples were collected from surface sediment in the natural recovery area in RA 6 as part of remedial activities performed in 2005. A sample was collected from RA 6 on June 29, 2005 (i.e., RA-06-001-050629-G) as part of the Remedial Action Modification Evaluation and two dredge boundary verification samples were collected on December 15, 2005 (i.e., RA-06-017-051215-G and RA-06-015-051215-G). The detected chemical concentrations and detection limits were less than the SQOs in the Remedial Action Modification Evaluation and dredge boundary verification samples collected from the natural recovery area in RA 6 (Table 2-18).

Remedial Area 7 – RA 7 is the harbor area located on the west side of the Thea Foss Waterway between approximate Stations 42+50 and 35+00 (Figure 2-14). In the portion of RA

7 extending from the southern RA boundary at approximate Stations 42+50 to 36+20, six-inches of channel sand cap material was placed to enhance natural recovery as part of remedial construction performed in 2005. The northern portion of RA 7 from approximate Stations 36+20 to 35+00 is a natural recovery area.

Two samples were collected from surface sediment and channel sand cap material in RA 7 as part of remedial activities performed in 2005 and 2006. A sample was collected from the natural recovery area in the northern portion of RA 7 on June 29, 2005 (i.e., RA-07-001-050629-G) as part of the Remedial Action Modification Evaluation and a supplemental baseline sample was collected from the enhanced natural recovery area in RA 7 on October 23, 2006 (i.e., NR-16-Y0-D). The detected chemical concentrations and detection limits were less than the SQOs in the both the Remedial Action Modification Evaluation sample collected from the natural recovery area and the supplemental baseline sample collected from the enhanced natural recovery area in RA 7 (Table 2-19).

Area at the Mouth of the Wheeler-Osgood Waterway – The area located east of RA 5 at the mouth of the Wheeler-Osgood Waterway extending from approximate Stations 42+00 to 46+50 is a natural recovery area (Figure 2-14).

A supplemental baseline sample was collected from the natural recovery area at the mouth of the Wheeler-Osgood Waterway on October 23, 2006 (i.e., NR-17-Y0-D). One chemical was detected at a concentration greater than the SQO in the sample. Pyrene was detected at a concentration approximately 1.25 times the SQO (Table 2-20).

Shoreline of the Wheeler-Osgood Waterway – Shoreline slopes in the Wheeler-Osgood Waterway comprising RA 10, RA 11, and RA 13 were designated natural recovery areas during the remedial design phase (Figure 2-14).

Supplemental composite samples comprised of subsamples collected from three locations in each RA (i.e., RA 10, RA 11, and RA 13) were collected from the shorelines of the Wheeler-Osgood Waterway. The locations of the shoreline subsamples were established by installing stakes at each sample location prior to sample collection. Stakes were installed at the sample locations during low tides on October 18-19, 2006. Three composite sediment samples and a sample duplicate were collected October 25, 2006 (i.e., SR-10-Y0-D, SR-11-Y0-D, SR-11-Y0-D4, SR-13-Y0-D). The detected chemical concentrations and detection limits were less than the SQOs in the supplemental baseline samples collected from the shoreline natural recovery areas in the Wheeler-Osgood Waterway (Table 2-21).

Head of the Wheeler-Osgood Waterway – The head of the Wheeler-Osgood Waterway between RA 12 and RA 13 is a natural recovery area (Figure 2-14).

Two supplemental baseline samples and a sample duplicate were collected from the natural recovery area at the head of the Wheeler-Osgood Waterway on October 23, 2006 (i.e., NR-19-Y0-D, NR-20-Y0-D, and NR-20-Y0-D1). Three chemicals were detected at concentrations greater than the SQOs in the sample collected in the natural recovery area located in the head of the Wheeler-Osgood Waterway, north of RA 12 (i.e., NR-19-Y0-D). Benzo(a)anthracene, pyrene, and N-nitrosodiphenylamine were detected at concentrations that were at or below two times the SQOs (Table 2-22).

Three chemicals were detected at concentrations exceeding the SQOs in both the parent sample and sample duplicate collected from the natural recovery area located in the head of the Wheeler-Osgood Waterway, east of RA 12 (i.e., NR-20-Y0-D and NR-20-Y0-D1). BEHP, 1,2-dichlorobenzene, and PCBs were detected in both samples at similar concentrations, concentrations less than two times the SQOs. Multiple polycyclic aromatic hydrocarbons (PAH) were detected in the parent sample at concentrations exceeding the SQOs but were not detected in the sample duplicate at similar concentrations. PAH concentrations detected in the duplicate sample were generally less than one-half the SQOs. The similarity in chemical concentrations between the parent sample and sample duplicate, except for the concentrations of PAHs, indicates that the PAHs were likely present in a subcomponent of the sample, a piece of creosote treated wood for example, and not homogenous within the sediment matrix. Additionally, benzyl alcohol was qualified as not detected at a concentration that was greater than the SQO in the parent sample because benzyl alcohol was detected in the associated laboratory method blank sample (Table 2-22).

Harbor Area Adjacent to RA 15 and RA 16 – The harbor area east of RA 16 and north of RA 15 extending from approximate Stations 52+50 to 58+50 is a natural recovery area (Figure 2-14).

A supplemental baseline natural recovery sample and a sample duplicate were collected from the natural recovery area on October 24, 2006 (i.e., NR-25-Y0-D and NR-25-Y0-D1). Mercury, PAHs, butylbenzyl phthalate, and BEHP were detected in both samples at concentrations exceeding the SQOs. The detected concentrations of mercury, PAHs, and butylbenzyl phthalate were at or below two times the SQOs for these chemicals. The detected concentration of BEHP was between two and three times the SQO (Table 2-23).

Summary of Baseline Natural Recovery and Enhanced Natural Recovery Monitoring

The following summarizes the results for baseline natural recovery and enhanced natural recovery area sampling and analysis performed in the Thea Foss and Wheeler-Osgood Waterways:

- No chemicals were detected at concentrations greater than the SQOs in the samples collected from natural recovery and enhanced natural recovery areas located in RA 6, RA 7, and the shoreline of the Wheeler-Osgood Waterway (i.e., RA 10, RA 11, and RA 13);
- Only one chemical was identified to be present in one sample at a concentration greater than the SQO in 15 samples collected from the natural recovery area north of the 11th Street Bridge;
- Chemical concentrations that were greater than the SQO in samples collected from natural recovery areas were predominantly at or below two times the SQO; and
- The results of analyses of the sample and sample duplicate collected from the head of the Wheeler-Osgood Waterway east of RA 12 were similar except for PAHs that were detected in the parent sample at concentrations exceeding the SQOs but were not detected at concentrations exceeding the SQOs in the duplicate sample. The detected concentrations of PAHs in the parent sample were likely present in a subcomponent of the sample, a piece of creosote treated wood for example, and not homogenous within the sediment matrix.

The results of natural recovery and enhanced natural recovery sampling and analysis characterize the baseline for the areas sampled. The results of baseline natural recovery monitoring will be used as the basis for comparison to the results of subsequent, long-term natural recovery and enhanced natural recovery performance monitoring conducted in accordance with the OMMP.

2.3.1 Schedule of Natural Recovery and Enhanced Natural Recovery Monitoring Activities

No additional natural recovery or enhanced natural recovery monitoring is required to characterize baseline conditions in natural recovery or enhanced natural recovery areas. Natural recovery and enhanced natural recovery area monitoring and chemical concentration trend analysis is scheduled to occur in 2008 as part of Year 2 natural recovery and enhanced natural recovery monitoring. The schedule for OMMP activities to be performed as part of the Foss Project is presented in Table 1-1. The scope of natural recovery and enhanced natural recovery area monitoring to be conducted in Year 2 is described in the OMMP.

TABLES

2-1 – Summary of Slope Areas Requiring Maintenance

2-2 – Summary of Subtidal Cap Area Hydrographic Survey Events Used for Baseline

2-3 – Summary of Cap Verification Sampling Events Used as Baseline

2-4 – Summary of RA 1 Cap Verification Sample Results

2.5 – Summary of RA 6 Cap Verification Sample Results

2-6 – Summary of RA 9 Cap Verification Sample Results

2-7 – Summary of RA 16 Cap Verification Sample Results

2-8 – Summary of RA 17 Cap Verification Sample Results

2-9 – Summary of RA 18 Cap Verification Sample Results

2-10 – Summary of RA 19A Cap Verification Sample Results

2-11 – Summary of RA 19B Cap Verification Sample Results

2-12 – Summary of RA 20 Cap Verification Sample Results

2-13 – Summary of RA 21 Cap Verification Sample Results

2-14 – Summary of RA 22 Cap Verification Sample Results

2-15 – Summary of Natural Recovery Area Sampling Events Used as Baseline

2-16 – Summary of Baseline Natural Recovery Sample Results for the Area North of 11th Street Bridge

2-17 – Summary of Baseline Natural Recovery Sample Results for the Northern Portion of RA 5

2-18 – Summary of Baseline Natural Recovery Sample Results for the Northern Portion of RA 6

2-19 – Summary of Baseline Natural Recovery and Enhanced Natural Recovery Sample Results for RA 7

2-20 – Summary of Baseline Natural Recovery Sample Results for the Area at the Mouth of the Wheeler-Osgood Waterway

2-21 – Summary of Baseline Natural Recovery Sample Results for the Shoreline of the Wheeler-Osgood Waterway

2-22 – Summary of Baseline Natural Recovery Sample Results for the Head of the Wheeler-Osgood Waterway

2-23 – Summary of Baseline Natural Recovery Sample Results for the Harbor Area Adjacent to RA 15 and RA 16

FIGURES

2-1 – Low Tide Slope Cap Inspection Monitoring Intervals

2-2 – Slope Areas Requiring Maintenance

2-3 – Subtidal Hydrographic Survey Areas

2-4 – RA 1 Baseline Subtidal Hydrographic Survey Results

2-5 – RA 3 Baseline Subtidal Hydrographic Survey Results

2-6 – RA 5 Baseline Subtidal Hydrographic Survey Results

2-7 – RA 6 and Southern Portion of RA 8 Baseline Subtidal Hydrographic Survey Results

2-8 – RA 7A and Northern Portion of RA 8 Baseline Subtidal Hydrographic Survey Results

2-9 – RA 9 Baseline Subtidal Hydrographic Survey Results

2-10 – RA 14 Baseline Subtidal Hydrographic Survey Results

2-11 – RA 16, RA 17, RA 18, and the Northern Portion of RA 19A Baseline Subtidal Hydrographic Survey Results

2-12 – Southern Portion of RA 19A, RA 19B, RA 20, RA 21, and RA 22 Baseline Subtidal Hydrographic Survey Results

2-13 – Baseline Cap Area Sampling Locations

2-14 – Baseline Natural Recovery Sample Locations

Table 2-1
Summary of Slope Areas Requiring Maintenance

Remediation Area	Monitoring Interval	Cap Disturbance Observed	Approximate Elevation Range
RA 3	2	Geotextile exposed at the surface of the slope cap or observed through slope cap material. Exposed geotextile likely the result of downslope movement of the slope cap material.	+17 to +13 feet MLLW
	3	Metal / foundry slag protruding through surface of the slope cap. Metal / foundry slag protruding through slope cap likely the result of the settlement of slope cap material.	+13 to +10 feet MLLW
RA 8	2	Fabric and concrete debris exposed at the surface of the slope cap. Exposed fabric and concrete likely the result of settlement or downslope movement of slope cap material and outfall apron armoring adjacent to City Outfall 230.	+4 to 0 feet MLLW
	14	Two creosote-treated timber piling protruding through the surface of the slope cap. Protruding piling were not likely cut off at an elevation that allowed complete coverage by cap material.	+2.5 and -3.0 feet MLLW
	16	Debris protruding through surface of the slope cap. Debris protruding through cap likely the result of settlement or downslope movement of slope cap material.	+2.0 feet MLLW
Habitat Area Adjacent to RA 19A	2	One creosote-treated timber piling protruding through the habitat area surface.	+5.0 feet MLLW
RA 20	9	One creosote-treated timber piling protruding through the surface of the slope cap. Protruding piling was likely not cut off at an elevation that allowed complete coverage by cap material.	-2.5 feet MLLW

Table 2-2
Summary of Subtidal Cap Area Hydrographic Survey Events Used for Baseline

Remediation Area	Figure Name	Figure No.	Type of Cap(s)	Construction Completion Date	Baseline Hydrographic Survey Date
RA 1	RA 1 Baseline Subtidal Hydrographic Survey Results	2-4	Thick Slope Cap and Channel Sand Cap	2/14/2003	2/20/2003
RA 3	RA 3 Baseline Subtidal Hydrographic Survey Results	2-5	Thick Slope Cap, Grout Mat Cap, and Channel Sand Cap	2/7/2003	2/19/2003
RA 5	RA 5 Baseline Subtidal Hydrographic Survey Results	2-6	Thick Slope Cap	10/27/2005	12/22/2005
RA 6	RA 6 and the Southern Portion of RA 8 Baseline Subtidal Hydrographic Survey Results	2-7	Channel Sand Cap	1/21/2006	12/22/2005 and 2/12/2006
RA 7A	RA 7A and the Northern Portion of RA 8 Baseline Subtidal Hydrographic Survey Results	2-8	Channel Sand Cap	11/11/2005	12/21/2005
RA 8	RA 6 and the Southern Portion of RA 8 Baseline Subtidal Hydrographic Survey Results	2-9	Thick Slope Cap and Quarry Spall Cap	12/7/2005	12/21-22/2005 and 2/12/2006
	RA 7A and the Northern Portion of RA 8 Baseline Subtidal Hydrographic Survey Results	2-10			
RA 9	RA 9 Baseline Subtidal Hydrographic Survey Results	2-11	Channel Sand Cap	11/10/2005	12/22/2005 and 2/12/2006
RA 14	RA 14 Baseline Subtidal Hydrographic Survey Results	2-12	Thick Slope Cap and Quarry Spall Cap	1/4/2006	12/22/2005 and 2/12/2006
RA 16	RA 16, RA 17, RA 18, and the Northern Portion of RA 19A Baseline Subtidal Hydrographic Survey Results	2-13	Channel Sand Cap	10/19/2005	12/22/2005
RA 17			Channel Sand Cap	2/4/2006	12/22/2005 and 2/12/2006
RA 18			Channel Sand Cap	1/20/2006	12/21-22/2005 and 2/12/2006
RA 19A			Thick Slope Cap, Grout Mat Cap, and Channel Sand Cap	12/17/2005	12/21-22/2005 and 2/12/2006
RA 19B	Southern Portion of RA 19A, RA 19B, RA 20, RA 21, and RA 22 Baseline Subtidal Hydrographic Survey Results	2-14	Thick Slope Cap, Grout Mat Cap, and Channel Sand Cap	12/17/2005	12/21-22/2005
RA 20			Thick Slope Cap, Quarry Spall Cap, and Channel Sand Cap	1/18/2006	12/22/2005 and 2/12/2006
RA 21			Channel Sand Cap	1/13/2006	12/21-22/2005 and 2/12/2006
RA 22			Channel Sand Cap	12/17/2005	12/21-22/2005

Table 2-3
Summary of Cap Verification Sampling Events Used as Baseline

Remediation Area	Sampling Event Type	Results Table Name	Table No.	Event Date	Station	Sample	Report/Memorandum
RA 1	Cap Verification	Summary of RA 1 Cap Verification Sample Results	2-4	2/19/2003	TF1A-001	TF1A-001-CVSS	Thea's Park Cap Sampling Report (April 10, 2003)
					TF1A-002	TF1A-002-CVSS	
						TF1A-002-CVSS (dup)	
RA 6	Cap Verification	Summary of RA 6 Cap Verification Sample Results	2-5	1/23/2006	RA-06-041	RA-06-041-060123-G	Construction Coorespondance (CR) - 2294 (February 17,
						RA-06-042-060123-G (dup)	
RA 9	Cap Verification	Summary of RA 9 Cap Verification Sample Results	2-6	12/14/2005	RA-09-011	RA-09-011-051214-G	CR - 2244 (January 23, 2006)
					RA-09-012	RA-09-012-051214-G	
					RA-09-013	RA-09-013-051214-G	
RA 16	Cap Verification	Summary of RA 16 Cap Verification Sample Results	2-7	10/19/2005	RA-16-020	RA-16-020-051019-G	CR - 2187 (December 19, 2005)
						RA-16-022-051019-G (dup)	
				10/24/2005	RA-16-024	RA-16-024-051024-G	
						RA-16-025-051024-G (dup)	
RA 17	Cap Verification	Summary of RA 17 Cap Verification Sample Results	2-8	1/23/2006	RA-17-021	RA-17-021-060123-G	CR - 2294 (February 17, 2006)
				2/6/2006	RA-17-031	RA-17-031-060206-G	CR-2318 (March 13, 2006)
						RA-17-032-060206-G (dup)	
RA 18	Cap Verification	Summary of RA 18 Cap Verification Sample Results	2-9	1/20/2006	RA-18-021	RA-18-021-060120-G	CR - 2286 (February 10, 2006)
					RA-18-022	RA-18-022-060120-G	
RA 19A	Supplemental Cap Verification	Summary of RA 19A Cap Verification Sample Results	2-10	10/12/2005	RA-19A-026	RA-19A-026-051012-G	CR - 2144 (December 6, 2005)
					RA-19A-027	RA-19A-027-051012-G	
					RA-19A-028	RA-19A-028-051012-G	
					RA-19A-029	RA-19A-029-051012-G	
					RA-19A-030	RA-19A-030-051012-G	
					RA-19A-031	RA-019A-031-051012-G	
					RA-19A-032	RA-019A-032-051012-G	
					RA-19A-033	RA-019A-033-051012-G	
	Post-Additional Cap Material Placement Verifcation			1/4/2006	RA-19A-034	RA-19A-034-060104-G	CR - 2245 (January 24, 2006)
						RA-19A-035-060104-G (dup)	
RA 19B	Post-Additional Cap Material Placement Verifcation	Summary of 19B Cap Verification Sample Results	2-11	1/4/2006	RA-19B-010	RA-19B-010-060104-G	CR - 2245 (January 24, 2006)
					RA-19B-011	RA-19B-011-060104-G	
RA 20	Cap Verification	Summary of RA 20 Cap Verification Sample Results	2-12	1/4/2006	RA-20-021	RA-20-021-060104-G	CR - 2245 (January 24, 2006)
					RA-20-022	RA-20-022-060104-G	
				1/16/2006	RA-20-023	RA-20-023-060116-G	CR - 2280 (February 9, 2006)
						RA-20-025-060116-G (dup)	
					RA-20-024	RA-20-024-060116-G	
RA 21	Cap Verification	Summary of RA 21 Cap Verification Sample Results	2-13	1/4/2006	RA-21-021	RA-21-021-060104-G	CR - 2245 (January 24, 2006)
				1/20/2006	RA-21-022	RA-21-022-060120-G	CR - 2286 (February 10, 2006)
					RA-21-023	RA-21-023-060120-G	
RA 22	Cap Verification	Summary of RA 22 Cap Verification Sample Results	2-14	1/4/2006	RA-22-021	RA-22-021-060104-G	CR - 2245 (January 24, 2006)

Notes: (dup) - Field duplicate sample

Table 2-4
Summary of RA 1 Cap Verification Sample Results

Parameter	Station		TF1A-001	TF1A-002		RA 1 Statistics		
	Sample ID		TF1A-001-CVSS	TF1A-002-CVSS	TF1A-002-CVSS (dup)[1]	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		2/19/2003	12/14/2005	12/14/2005			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm			
	Units	SQO						
Conventionals								
Total Organic Carbon	mg/kg	NA	587	388	430	388	587	468
Total Solids	%	NA	94.3	94.79	96.51	94.3	96.51	95.2
Metals								
Arsenic	mg/kg	57	1.32 J	1.97 U	1.84 U	1.32	1.32	1.32
Copper	mg/kg	390	6.38	8.83	8.26	6.38	8.83	7.82
Lead	mg/kg	450	2.07 U	1.97 U	1.84 U	NA	NA	NA
Zinc	mg/kg	410	13.6	11.3	12.5	11.3	13.6	12.5
Mercury	mg/kg	0.59	0.0342 UB	0.0202 UB	0.00848 UB	NA	NA	NA
Semi-volatile Organic Compounds								
LPAHs								
2-Methylnaphthalene	µg/kg	670	1.27 U	1.35 U	1.3 U	NA	NA	NA
Acenaphthene	µg/kg	500	1.27 U	1.35 U	1.3 U	NA	NA	NA
Acenaphthylene	µg/kg	1,300	1.27 U	1.35 U	1.3 U	NA	NA	NA
Anthracene	µg/kg	960	1.27 U	1.35 U	1.3 U	NA	NA	NA
Fluorene	µg/kg	540	1.27 U	1.35 U	1.3 U	NA	NA	NA
Naphthalene	µg/kg	2,100	1.27 U	1.35 U	1.3 U	NA	NA	NA
Phenanthrene	µg/kg	1,500	1.27 U	0.92 J	1.3 U	0.92	0.92	0.92
Total LPAH	µg/kg	5,200	1.27 U	0.92 J	1.3 U	0.92	0.92	0.92
HPAHs								
Benzo(a)anthracene	µg/kg	1,600	1.27 U	1.35 U	1.3 U	NA	NA	NA
Benzo(a)pyrene	µg/kg	1,600	1.27 U	1.35 U	1.3 U	NA	NA	NA
Benzofluoranthenes (total)	µg/kg	3,600	2.55 U	2.69 U	2.59 U	NA	NA	NA
Benzo(g,h,i)perylene	µg/kg	720	1.27 U	1.35 U	1.3 U	NA	NA	NA
Chrysene	µg/kg	2,800	1.27 U	1.35 U	1.3 U	NA	NA	NA
Dibenzo(a,h)anthracene	µg/kg	230	1.27 U	1.35 U	1.3 U	NA	NA	NA
Fluoranthene	µg/kg	2,500	1.27 U	2.96	1.52	1.52	2.96	2.24
Indeno(1,2,3-cd)pyrene	µg/kg	690	1.27 U	1.35 U	1.3 U	NA	NA	NA
Pyrene	µg/kg	3,300	1.27 U	2.3	1.27 J	1.27	2.3	1.8
Total HPAH	µg/kg	17,000	2.55 U	5.26	2.79 J	2.79	5.26	4.03
Other Semi-volatile Organic Compounds								
Dimethyl phthalate	µg/kg	160	12.7 U	13.5 U	13 U	NA	NA	NA
Diethylphthalate	µg/kg	200	12.7 U	13.5 U	13 U	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	12.7 U	13.5 U	13 U	NA	NA	NA
Butyl benzyl phthalate	µg/kg	900	12.7 U	13.5 U	13 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	15.7 UB	12.1 J	10.6 J	10.6	12.1	11.4
Di-n-octyl phthalate	µg/kg	6,200	12.7 U	13.5 U	13 U	NA	NA	NA

Parameter	Station		TF1A-001	TF1A-002		RA 1 Statistics		
	Sample ID		TF1A-001-CVSS	TF1A-002-CVSS	TF1A-002-CVSS (dup)[1]	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		2/19/2003	12/14/2005	12/14/2005			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm			
	Units	SQO						
Phenol	µg/kg	420	12.7 U	13.5 U	13 U	NA	NA	NA
2-Methylphenol	µg/kg	63	12.7 U	13.5 U	13 U	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	25.5 U	26.9 U	25.9 U	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	12.7 U	13.5 U	13 U	NA	NA	NA
Pentachlorophenol	µg/kg	360	12.7 U	13.5 U	13 U	NA	NA	NA
Benzyl alcohol	µg/kg	73	12.7 U	13.5 U	13 U	NA	NA	NA
Benzoic acid	µg/kg	650	63.7 U	67.3 U	64.8 U	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	12.7 U	13.5 U	13 U	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	12.7 U	13.5 U	13 U	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	12.7 U	13.5 U	13 U	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	12.7 U	13.5 U	13 U	NA	NA	NA
Hexachlorobenzene	µg/kg	22	2.07 U	2.01 U	1.96 U	NA	NA	NA
Dibenzofuran	µg/kg	540	12.7 U	13.5 U	13 U	NA	NA	NA
Hexachlorobutadiene	µg/kg	11	1.04 U	1.01 U	0.981 U	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	12.7 U	13.5 U	13 U	NA	NA	NA
Pesticides								
p,p'-DDD	µg/kg	16	2.07 U	2.01 U	1.96 U	NA	NA	NA
p,p'-DDE	µg/kg	9	2.07 U	2.01 U	1.96 U	NA	NA	NA
p,p'-DDT	µg/kg	34	2.07 U	2.01 U	1.96 U	NA	NA	NA
Polychlorinated Biphenyls (PCBs)								
PCB-1016	µg/kg	NA	10.4 U	10.1 U	9.81 U	NA	NA	NA
PCB-1221	µg/kg	NA	20.7 U	20.1 U	19.6 U	NA	NA	NA
PCB-1232	µg/kg	NA	10.4 U	10.1 U	9.81 U	NA	NA	NA
PCB-1242	µg/kg	NA	10.4 U	10.1 U	9.81 U	NA	NA	NA
PCB-1248	µg/kg	NA	10.4 U	10.1 U	9.81 U	NA	NA	NA
PCB-1254	µg/kg	NA	10.4 U	10.1 U	9.81 U	NA	NA	NA
PCB-1260	µg/kg	NA	10.4 U	10.1 U	9.81 U	NA	NA	NA
PCBs (total)	µg/kg	300	20.7 U	20.1 U	19.6 U	NA	NA	NA

Notes:

SQO Sediment Quality Objective.
NA Not Applicable.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.
1 Sample is a field duplicate of sample TF1A-002-CVSS.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-5
Summary of RA 6 Cap Verification Sample Results

Parameter	Station		RA-06-041		RA 6 Statistics		
	Sample ID		RA-06-041-060123-G	RA-06-042-060123-G[1]	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/23/2006	1/23/2006			
	Sample Depth		0-10 cm	0-10 cm			
	Units	SQO					
Conventionals							
Total Organic Carbon	mg/kg	NA	810	740	740	810	775
Total Solids	%	NA	97.2	96.7	96.7	97.2	97.0
Metals							
Arsenic	mg/kg	57	5	5 U	5	5	5
Copper	mg/kg	390	16.1	14.1	14.1	16.1	15.1
Lead	mg/kg	450	3	6	3	6	4.5
Zinc	mg/kg	410	27.9 J	33.5 J	27.9	33.5	30.7
Mercury	mg/kg	0.59	0.04 U	0.05 U	NA	NA	NA
Semi-volatile Organic Compounds							
LPAHs							
2-Methylnaphthalene	µg/kg	670	20 U	19 U	NA	NA	NA
Acenaphthene	µg/kg	500	20 U	19 U	NA	NA	NA
Acenaphthylene	µg/kg	1,300	20 U	19 U	NA	NA	NA
Anthracene	µg/kg	960	20 U	19 U	NA	NA	NA
Fluorene	µg/kg	540	20 U	19 U	NA	NA	NA
Naphthalene	µg/kg	2,100	20 U	19 U	NA	NA	NA
Phenanthrene	µg/kg	1,500	20 U	19 U	NA	NA	NA
Total LPAH	µg/kg	5,200	20 U	19 U	NA	NA	NA
HPAHs							
Benzo(a)anthracene	µg/kg	1,600	20 U	19 U	NA	NA	NA
Benzo(a)pyrene	µg/kg	1,600	20 U	19 U	NA	NA	NA
Benzofluoranthenes (total)	µg/kg	3,600	20 U	19 U	NA	NA	NA
Benzo(g,h,i)perylene	µg/kg	720	20 U	19 U	NA	NA	NA
Chrysene	µg/kg	2,800	20 U	19 U	NA	NA	NA
Dibenzo(a,h)anthracene	µg/kg	230	20 U	19 U	NA	NA	NA
Fluoranthene	µg/kg	2,500	20 U	19 U	NA	NA	NA
Indeno(1,2,3-cd)pyrene	µg/kg	690	20 U	19 U	NA	NA	NA
Pyrene	µg/kg	3,300	20 U	19 U	NA	NA	NA
Total HPAH	µg/kg	17,000	20 U	19 U	NA	NA	NA
Other Semi-volatile Organic Compounds							
Dimethyl phthalate	µg/kg	160	20 U	19 U	NA	NA	NA
Diethylphthalate	µg/kg	200	20 U	19 U	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	18 UJB	14 UJB	NA	NA	NA
Butyl benzyl phthalate	µg/kg	900	20 U	19 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	20 U	19 U	NA	NA	NA
Di-n-octyl phthalate	µg/kg	6,200	20 U	19 U	NA	NA	NA

Parameter	Station		RA-06-041		RA 6 Statistics		
	Sample ID		RA-06-041-060123-G	RA-06-042-060123-G[1]	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/23/2006	1/23/2006			
	Sample Depth		0-10 cm	0-10 cm			
	Units	SQO					
Phenol	µg/kg	420	20 U	19 U	NA	NA	NA
2-Methylphenol	µg/kg	63	20 U	19 U	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	20 U	19 U	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	20 U	19 U	NA	NA	NA
Pentachlorophenol	µg/kg	360	98 U	97 U	NA	NA	NA
Benzyl alcohol	µg/kg	73	20 UJ	19 U	NA	NA	NA
Benzoic acid	µg/kg	650	200 U	190 UJ	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	20 U	19 U	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	20 U	19 U	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	20 U	19 U	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	20 U	19 U	NA	NA	NA
Hexachlorobenzene	µg/kg	22	0.98 U	0.94 U	NA	NA	NA
Dibenzofuran	µg/kg	540	20 U	19 U	NA	NA	NA
Hexachlorobutadiene	µg/kg	11	0.98 U	0.94 U	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	20 U	19 U	NA	NA	NA
Pesticides							
p,p'-DDD	µg/kg	16	2 U	1.9 U	NA	NA	NA
p,p'-DDE	µg/kg	9	2 U	1.9 U	NA	NA	NA
p,p'-DDT	µg/kg	34	2 U	1.9 U	NA	NA	NA
Polychlorinated Biphenyls (PCBs)							
PCB-1016	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1221	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1232	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1242	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1248	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1254	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1260	µg/kg	NA	20 U	20 U	NA	NA	NA
PCBs (total)	µg/kg	300	20 U	20 U	NA	NA	NA

Notes:

SQO Sediment Quality Objective.
NA Not Applicable.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.
1 Sample is a field duplicate of Sample RA-06-041-060123-G.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated nume value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-6
Summary of RA 9 Cap Verification Sample Results

Parameter	Station		RA-09-011	RA-09-012	RA-09-013	RA 9 Statistics		
	Sample ID		RA-09-011-051214-G	RA-09-012-051214-G	RA-09-013-051214-G	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		12/14/2005	12/14/2005	12/14/2005			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm			
	Units	SQO						
Conventionals								
Total Organic Carbon	mg/kg	NA	690	400	3,000	400	3,000	1,300
Total Solids	%	NA	94.9	94.6	93.4	93.4	94.9	94.3
Metals								
Arsenic	mg/kg	57	5 U	6	5 U	6	6	6
Copper	mg/kg	390	15	17.6	13.2	13.2	17.6	15
Lead	mg/kg	450	3	2	2	2	3	2.3
Zinc	mg/kg	410	28	27.8	27.8	27.8	28	28
Mercury	mg/kg	0.59	0.04 U	0.04 U	0.04 U	NA	NA	NA
Semi-volatile Organic Compounds								
LPAHs								
2-Methylnaphthalene	µg/kg	670	20 U	20 U	19 U	NA	NA	NA
Acenaphthene	µg/kg	500	20 U	20 U	19 U	NA	NA	NA
Acenaphthylene	µg/kg	1,300	20 U	20 U	19 U	NA	NA	NA
Anthracene	µg/kg	960	20 U	20 U	19 U	NA	NA	NA
Fluorene	µg/kg	540	20 U	20 U	19 U	NA	NA	NA
Naphthalene	µg/kg	2,100	20 U	20 U	19 U	NA	NA	NA
Phenanthrene	µg/kg	1,500	20 U	20 U	12 J	12	12	12
Total LPAH	µg/kg	5,200	20 U	20 U	12 J	12	12	12
HPAHs								
Benzo(a)anthracene	µg/kg	1,600	20 U	12 J	10 J	10	12	11
Benzo(a)pyrene	µg/kg	1,600	20 U	12 J	16 J	12	16	14
Benzofluoranthenes (total)	µg/kg	3,600	20 U	11 J	13 J	11	13	12
Benzo(g,h,i)perylene	µg/kg	720	20 U	20 U	19 U	NA	NA	NA
Chrysene	µg/kg	2,800	20 U	15 J	12 J	12	15	14
Dibenzo(a,h)anthracene	µg/kg	230	20 U	20 U	19 U	NA	NA	NA
Fluoranthene	µg/kg	2,500	20 U	18 J	22	18	22	20
Indeno(1,2,3-cd)pyrene	µg/kg	690	20 U	20 U	19 U	NA	NA	NA
Pyrene	µg/kg	3,300	10 J	24	67	10	67	34
Total HPAH	µg/kg	17,000	10 J	92 J	140 J	10	140	81
Other Semi-volatile Organic Compounds								
Dimethyl phthalate	µg/kg	160	20 U	20 U	19 U	NA	NA	NA
Diethylphthalate	µg/kg	200	20 U	20 U	19 U	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	40	31 U	41 U	40	40	40
Butyl benzyl phthalate	µg/kg	900	20 U	20 U	19 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	20 U	36 U	120 U	NA	NA	NA
Di-n-octyl phthalate	µg/kg	6,200	20 U	20 U	19 U	NA	NA	NA

Parameter	Station		RA-09-011	RA-09-012	RA-09-013	RA 9 Statistics		
	Sample ID		RA-09-011-051214-G	RA-09-012-051214-G	RA-09-013-051214-G	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		12/14/2005	12/14/2005	12/14/2005			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm			
	Units	SQO						
Phenol	µg/kg	420	20 U	20 U	19 U	NA	NA	NA
2-Methylphenol	µg/kg	63	20 U	20 U	19 U	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	20 U	20 U	19 U	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	20 U	20 U	19 U	NA	NA	NA
Pentachlorophenol	µg/kg	360	98 U	98 U	97 U	NA	NA	NA
Benzyl alcohol	µg/kg	73	20 U	20 U	19 U	NA	NA	NA
Benzoic acid	µg/kg	650	200 U	200 U	190 U	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	20 U	20 U	19 U	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	20 U	20 U	19 U	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	20 U	20 U	19 U	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	20 U	20 U	19 U	NA	NA	NA
Hexachlorobenzene	µg/kg	22	0.97 U	0.98 U	0.98 U	NA	NA	NA
Dibenzofuran	µg/kg	540	20 U	20 U	19 U	NA	NA	NA
Hexachlorobutadiene	µg/kg	11	0.97 U	0.98 U	0.98 U	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	20 U	20 U	19 U	NA	NA	NA
Pesticides								
p,p'-DDD	µg/kg	16	1.9 U	2 U	2 U	NA	NA	NA
p,p'-DDE	µg/kg	9	1.9 U	2 U	2 U	NA	NA	NA
p,p'-DDT	µg/kg	34	1.9 U	2 U	2 U	NA	NA	NA
Polychlorinated Biphenyls (PCBs)								
PCB-1016	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1221	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1232	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1242	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1248	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1254	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1260	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCBs (total)	µg/kg	300	20 U	20 U	20 U	NA	NA	NA

Notes:

SQO Sediment Quality Objective.
NA Not Applicable.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-7
Summary of RA 16 Cap Verification Sample Results

Parameter	Station		RA-16-020		RA-16-024		RA 16 Statistics		
	Sample ID		RA-16-020-051019-G	RA-16-022-051019-G[1]	RA-16-024-051024-G	RA-16-025-051024-G[2]	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/19/2005	10/19/2005	10/24/2005	10/24/2005			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm	0-10 cm			
	Units	SQO							
Conventionals									
Total Organic Carbon	mg/kg	NA	1,700	2,400	530 J	1,200	530	2,400	1,500
Total Solids	%	NA	90.4	89	91.1	89	89	91.1	90
Metals									
Arsenic	mg/kg	57	0.65 J	0.78 J	0.59 J	2.1 J	0.59	2.1	1.0
Copper	mg/kg	390	10	9.4	10	12	9.4	12	10
Lead	mg/kg	450	2.7	3.8	1.3 J	1.6 J	1.3	3.8	2.4
Zinc	mg/kg	410	24 B	23 B	23 J	24 J	23	24	23.5
Mercury	mg/kg	0.59	0.019 U	0.011 J	0.019 U	0.018 U	0.011	0.011	0.011
Semi-volatile Organic Compounds									
LPAHs									
2-Methylnaphthalene	µg/kg	670	2.8	2.9	0.73 J	0.69 J	0.69	2.9	1.8
Acenaphthene	µg/kg	500	3.4	5.7	0.64 J	0.64 J	0.64	5.7	2.6
Acenaphthylene	µg/kg	1,300	2.4	3.2	0.51 J	2.2 U	0.51	3.2	2.0
Anthracene	µg/kg	960	7.8	9.5	1.3 J	1.8 J	1.3	9.5	5.1
Fluorene	µg/kg	540	2.6	5	0.63 J	0.85 J	0.63	5	2.3
Naphthalene	µg/kg	2,100	6.9 B	7.3	2.8	3.1	2.8	7.3	5.0
Phenanthrene	µg/kg	1,500	13	12	2.8	3.1	2.8	13	7.7
Total LPAH	µg/kg	5,200	39	46	9 J	10 J	9	46	26
HPAHs									
Benzo(a)anthracene	µg/kg	1,600	14	9.6	2.8	2.5	2.5	14	7
Benzo(a)pyrene	µg/kg	1,600	13 J	10 J	2.1 U	2.2 U	10	13	11.5
Benzofluoranthenes (total)	µg/kg	3,600	19	11	5.4	3.9 J	3.9	19	10
Benzo(g,h,i)perylene	µg/kg	720	8.2 J	4.6 J	2.1 U	2.2 U	4.6	8.2	6.4
Chrysene	µg/kg	2,800	14	11	3	2.3	2.3	14	7.6
Dibenzo(a,h)anthracene	µg/kg	230	2.3 J	1.3 J	2.1 U	2.2 U	1.3	2.3	1.8
Fluoranthene	µg/kg	2,500	30	26	5.2	4	4	30	16
Indeno(1,2,3-cd)pyrene	µg/kg	690	9 J	5.8 J	2.1 U	2.6	2.6	9	5.8
Pyrene	µg/kg	3,300	2.1 UJ	2.2 UJ	6.6	5.2	5.2	6.6	5.9
Total HPAH	µg/kg	17,000	110 J	79 J	27.6	24.6 J	24.6	110	60
Other Semi-volatile Organic Compounds									
Dimethyl phthalate	µg/kg	160	11 U	11 U	11 U	11 U	NA	NA	NA
Diethylphthalate	µg/kg	200	11 U	11 U	11 UJ	11 UJ	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	7.9 J	8.9 J	21 U	3.7 J	3.7	8.9	6.8
Butyl benzyl phthalate	µg/kg	900	7.2 J	8.6 J	11 U	11 U	7.2	8.6	7.9
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	22	26	21 UJ	22 UJ	22	26	24
Di-n-octyl phthalate	µg/kg	6,200	1.8 J	22 U	21 U	5.3 J	1.8	5.3	3.55
Phenol	µg/kg	420	5.3 UJ	5.5 UJ	5.4 U	5.5 U	NA	NA	NA
2-Methylphenol	µg/kg	63	5.3 U	0.53 J	5.4 U	5.5 U	0.53	0.53	0.53

Parameter	Station		RA-16-020		RA-16-024		RA 16 Statistics		
	Sample ID		RA-16-020-051019-G	RA-16-022-051019-G[1]	RA-16-024-051024-G	RA-16-025-051024-G[2]	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/19/2005	10/19/2005	10/24/2005	10/24/2005			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm	0-10 cm			
	Units	SQO							
3- & 4-Methylphenol	µg/kg	670	1.6 J	5.5 U	5.4 U	5.5 U	1.6	1.6	1.6
2,4-Dimethylphenol	µg/kg	29	0.37 J	2.2 U	2.1 U	2.2 U	0.37	0.37	0.37
Pentachlorophenol	µg/kg	360	11 U	11 U	11 U	11 U	NA	NA	NA
Benzyl alcohol	µg/kg	73	5.3 U	5.5 U	5.4 U	5.5 U	NA	NA	NA
Benzoic acid	µg/kg	650	64 UJ	66 UJ	64 U	66 U	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	5.3 U	5.5 U	5.4 U	5.5 U	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	5.3 U	5.5 U	5.4 U	5.5 U	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	5.3 U	5.5 U	5.4 U	5.5 U	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	5.3 U	5.5 U	5.4 U	5.5 U	NA	NA	NA
Hexachlorobenzene	µg/kg	22	1.3 U	0.99 U	1 U	1.1 U	NA	NA	NA
Dibenzofuran	µg/kg	540	1.2 J	1.5 J	0.48 J	0.46 J	0.46	1.5	0.9
Hexachlorobutadiene	µg/kg	11	1.3 U	0.99 U	1 U	1.1 U	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	1.8 J	0.78 J	5.4 U	5.5 U	0.78	1.8	1.3
Pesticides									
p,p'-DDD	µg/kg	16	0.38 J	0.22 J	2 U	2.2 U	0.22	0.38	0.30
p,p'-DDE	µg/kg	9	2.5 U	2 U	2 U	2.2 U	NA	NA	NA
p,p'-DDT	µg/kg	34	0.66 J	0.35 J	2 U	2.2 U	0.35	0.66	0.51
Polychlorinated Biphenyls (PCBs)									
PCB-1016	µg/kg	NA	49 U	48 U	54 U	55 U	NA	NA	NA
PCB-1221	µg/kg	NA	49 U	48 U	54 U	55 U	NA	NA	NA
PCB-1232	µg/kg	NA	49 U	48 U	54 U	55 U	NA	NA	NA
PCB-1242	µg/kg	NA	49 U	48 U	54 U	55 U	NA	NA	NA
PCB-1248	µg/kg	NA	49 U	48 U	54 U	55 U	NA	NA	NA
PCB-1254	µg/kg	NA	3 J	2.3 J	54 U	55 U	2.3	3	2.7
PCB-1260	µg/kg	NA	49 U	48 U	54 U	55 U	NA	NA	NA
PCBs (total)	µg/kg	300	3 J	2.3 J	54 U	55 U	2.3	3	2.7

Notes:

SQO Sediment Quality Objective.
NA Not Applicable.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.
1 Sample is a field duplicate of Sample RA-16-020-051019-G.
2 Sample is a field duplicate of Sample RA-16-024-051024-G.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-8
Summary of RA 17 Cap Verification Sample Results

Parameter	Station		RA-17-021	RA-17-031		RA 17 Statistics		
	Sample ID		RA-17-021-060123-G	RA-17-031-060206-G	RA-17-032-060206-G[1]	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/23/2006	2/6/2006	2/6/2006			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm			
	Units	SQO						
Conventionals								
Total Organic Carbon	mg/kg	NA	940	660	460	460	940	690
Total Solids	%	NA	94.3	96.7	96.7	94.3	96.7	95.9
Metals								
Arsenic	mg/kg	57	5 U	5 U	5 U	NA	NA	NA
Copper	mg/kg	390	14.4	18.1 J	12.9 J	12.9	18.1	15.1
Lead	mg/kg	450	2	2	2 U	2	2	2
Zinc	mg/kg	410	27.2 J	40.7 J	26.8 J	26.8	40.7	31.6
Mercury	mg/kg	0.59	0.04 U	0.05 U	0.05 U	NA	NA	NA
Semi-volatile Organic Compounds								
LPAHs								
2-Methylnaphthalene	µg/kg	670	19 U	20 U	19 U	NA	NA	NA
Acenaphthene	µg/kg	500	19 U	20 U	19 U	NA	NA	NA
Acenaphthylene	µg/kg	1,300	19 U	20 U	19 U	NA	NA	NA
Anthracene	µg/kg	960	19 U	20 U	19 U	NA	NA	NA
Fluorene	µg/kg	540	19 U	20 U	19 U	NA	NA	NA
Naphthalene	µg/kg	2,100	19 U	20 U	19 U	NA	NA	NA
Phenanthrene	µg/kg	1,500	19 U	20 U	19 U	NA	NA	NA
Total LPAH	µg/kg	5,200	19 U	20 U	19 U	NA	NA	NA
HPAHs								
Benzo(a)anthracene	µg/kg	1,600	19 U	20 U	19 U	NA	NA	NA
Benzo(a)pyrene	µg/kg	1,600	19 U	20 U	19 U	NA	NA	NA
Benzofluoranthenes (total)	µg/kg	3,600	19 U	20 U	19 U	NA	NA	NA
Benzo(g,h,i)perylene	µg/kg	720	19 U	20 U	19 U	NA	NA	NA
Chrysene	µg/kg	2,800	19 U	20 U	19 U	NA	NA	NA
Dibenzo(a,h)anthracene	µg/kg	230	19 U	20 U	19 U	NA	NA	NA
Fluoranthene	µg/kg	2,500	19 U	20 U	19 U	NA	NA	NA
Indeno(1,2,3-cd)pyrene	µg/kg	690	19 U	20 U	19 U	NA	NA	NA
Pyrene	µg/kg	3,300	19 U	20 U	19 U	NA	NA	NA
Total HPAH	µg/kg	17,000	19 U	20 U	19 U	NA	NA	NA
Other Semi-volatile Organic Compounds								
Dimethyl phthalate	µg/kg	160	19 U	20 U	19 U	NA	NA	NA
Diethylphthalate	µg/kg	200	19 U	20 U	19 U	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	18 UJB	20 U	19 U	NA	NA	NA
Butyl benzyl phthalate	µg/kg	900	19 U	20 U	19 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	19 U	20 U	19 U	NA	NA	NA
Di-n-octyl phthalate	µg/kg	6,200	19 U	20 U	19 U	NA	NA	NA

Parameter	Station		RA-17-021	RA-17-031		RA 17 Statistics		
	Sample ID		RA-17-021-060123-G	RA-17-031-060206-G	RA-17-032-060206-G[1]	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/23/2006	2/6/2006	2/6/2006			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm			
	Units	SQO						
Phenol	µg/kg	420	19 U	20 U	19 U	NA	NA	NA
2-Methylphenol	µg/kg	63	19 U	20 U	19 U	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	19 U	20 U	19 U	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	19 U	20 UJ	19 UJ	NA	NA	NA
Pentachlorophenol	µg/kg	360	97 U	98 U	97 U	NA	NA	NA
Benzyl alcohol	µg/kg	73	19 UJ	20 U	19 U	NA	NA	NA
Benzoic acid	µg/kg	650	190 U	200 U	190 U	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	19 U	20 U	19 U	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	19 U	20 U	19 U	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	19 U	20 U	19 U	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	19 U	20 U	19 U	NA	NA	NA
Hexachlorobenzene	µg/kg	22	0.98 U	1 U	0.97 U	NA	NA	NA
Dibenzofuran	µg/kg	540	19 U	20 U	19 U	NA	NA	NA
Hexachlorobutadiene	µg/kg	11	0.98 U	1 U	0.97 U	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	19 U	20 U	19 U	NA	NA	NA
Pesticides								
p,p'-DDD	µg/kg	16	2 U	2 U	2 U	NA	NA	NA
p,p'-DDE	µg/kg	9	2 U	2 U	2 U	NA	NA	NA
p,p'-DDT	µg/kg	34	2 U	2 U	2 U	NA	NA	NA
Polychlorinated Biphenyls (PCBs)								
PCB-1016	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1221	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1232	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1242	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1248	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1254	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCB-1260	µg/kg	NA	20 U	20 U	20 U	NA	NA	NA
PCBs (total)	µg/kg	300	20 U	20 U	20 U	NA	NA	NA

Notes:

SQO Sediment Quality Objective.
NA Not Applicable.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.
1 Sample is a field duplicate of Sample RA-17-031-060206-G.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-9
Summary of RA 18 Cap Verification Sample Results

Parameter	Station		RA-18-021	RA-18-022	RA 18 Statistics		
	Sample ID		RA-18-021-060120-G	RA-18-022-060120-G	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/20/2006	1/20/2006			
	Sample Depth		0-10 cm	0-10 cm			
	Units	SQO					
Conventionals							
Total Organic Carbon	mg/kg	NA	1,440	1,050	1,050	1,440	1,250
Total Solids	%	NA	96.5	92.6	92.6	96.5	94.6
Metals							
Arsenic	mg/kg	57	5 U	5 U	NA	NA	NA
Copper	mg/kg	390	22	14.9	14.9	22	19
Lead	mg/kg	450	3	3	3	3	3
Zinc	mg/kg	410	28.7	28.4	28.4	28.7	28.6
Mercury	mg/kg	0.59	0.04 U	0.04 U	NA	NA	NA
Semi-volatile Organic Compounds							
LPAHs							
2-Methylnaphthalene	µg/kg	670	20 U	20 U	NA	NA	NA
Acenaphthene	µg/kg	500	20 U	20 U	NA	NA	NA
Acenaphthylene	µg/kg	1,300	20 U	20 U	NA	NA	NA
Anthracene	µg/kg	960	20 U	20 U	NA	NA	NA
Fluorene	µg/kg	540	20 U	20 U	NA	NA	NA
Naphthalene	µg/kg	2,100	20 U	20 U	NA	NA	NA
Phenanthrene	µg/kg	1,500	20 U	20 U	NA	NA	NA
Total LPAH	µg/kg	5,200	20 U	20 U	NA	NA	NA
HPAHs							
Benzo(a)anthracene	µg/kg	1,600	20 U	20 U	NA	NA	NA
Benzo(a)pyrene	µg/kg	1,600	20 U	20 U	NA	NA	NA
Benzofluoranthenes (total)	µg/kg	3,600	20 U	20 U	NA	NA	NA
Benzo(g,h,i)perylene	µg/kg	720	20 U	20 U	NA	NA	NA
Chrysene	µg/kg	2,800	20 U	20 U	NA	NA	NA
Dibenzo(a,h)anthracene	µg/kg	230	20 U	20 U	NA	NA	NA
Fluoranthene	µg/kg	2,500	20 U	20 U	NA	NA	NA
Indeno(1,2,3-cd)pyrene	µg/kg	690	20 U	20 U	NA	NA	NA
Pyrene	µg/kg	3,300	20 U	20 U	NA	NA	NA
Total HPAH	µg/kg	17,000	20 U	20 U	NA	NA	NA
Other Semi-volatile Organic Compounds							
Dimethyl phthalate	µg/kg	160	20 U	20 U	NA	NA	NA
Diethylphthalate	µg/kg	200	20 U	20 U	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	20 U	20 U	NA	NA	NA
Butyl benzyl phthalate	µg/kg	900	20 U	20 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	20 U	20 U	NA	NA	NA
Di-n-octyl phthalate	µg/kg	6,200	20 U	20 U	NA	NA	NA
Phenol	µg/kg	420	20 U	20 U	NA	NA	NA

Parameter	Station		RA-18-021	RA-18-022	RA 18 Statistics		
	Sample ID		RA-18-021-060120-G	RA-18-022-060120-G	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/20/2006	1/20/2006			
	Sample Depth		0-10 cm	0-10 cm			
	Units	SQO					
2-Methylphenol	µg/kg	63	20 U	20 U	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	20 U	20 U	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	20 U	20 U	NA	NA	NA
Pentachlorophenol	µg/kg	360	97 U	98 U	NA	NA	NA
Benzyl alcohol	µg/kg	73	20 U	20 U	NA	NA	NA
Benzoic acid	µg/kg	650	200 U	200 U	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	20 U	20 U	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	20 U	20 U	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	20 U	20 U	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	20 U	20 U	NA	NA	NA
Hexachlorobenzene	µg/kg	22	0.99 U	0.99 U	NA	NA	NA
Dibenzofuran	µg/kg	540	20 U	20 U	NA	NA	NA
Hexachlorobutadiene	µg/kg	11	0.99 U	0.99 U	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	20 U	20 U	NA	NA	NA
Pesticides							
p,p'-DDD	µg/kg	16	2 U	2 U	NA	NA	NA
p,p'-DDE	µg/kg	9	2 U	2 U	NA	NA	NA
p,p'-DDT	µg/kg	34	2 U	2 U	NA	NA	NA
Polychlorinated Biphenyls (PCBs)							
PCB-1016	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1221	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1232	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1242	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1248	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1254	µg/kg	NA	20 U	20 U	NA	NA	NA
PCB-1260	µg/kg	NA	20 U	20 U	NA	NA	NA
PCBs (total)	µg/kg	300	20 U	20 U	NA	NA	NA

Notes:

SQO Sediment Quality Objective.
NA Not Applicable.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-10
Summary of RA 19A Cap Verification Sample Results

Parameter	Station		RA-19A-026	RA-19A-027	RA-19A-028	RA-19A-029	RA-19A-030	RA-19A-031	RA-19A-032	RA-19A-034		RA 19A Statistics		
	Sample ID		RA-19A-026-051012-G	RA-19A-027-051012-G	RA-19A-028-051012-G	RA-19A-029-051012-G	RA-19A-030-051012-G	RA-19A-031-051012-G	RA-19A-032-051012-G	RA-19A-034-060104-G	RA-19A-035-060104-G[1]	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/12/2005	10/12/2005	10/12/2005	10/12/2005	10/12/2005	10/12/2005	10/12/2005	1/4/2006	1/4/2006			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm			
	Units	SQO												
Conventionals														
Total Organic Carbon	mg/kg	NA	570	10,000	12,000	9,100	9,400	12,000	17,000	1,100 J	67 J	67	17,000	7,915
Total Solids	%	NA	96.4	83	79	83	85	77	66	96.9	97.4	66	97.4	85
Metals														
Arsenic	mg/kg	57	1.3 J	2.4 J	0.6 J	1.8 J	1.6 J	4.9 J	5.1 J	5 U	5 U	0.6	5.1	2.5
Copper	mg/kg	390	8.4	22	20	27	15	52	54	14.3	14.3	8.4	54	25
Lead	mg/kg	450	2.3	32	19	26	14	63	69	3	2	2	69	26
Zinc	mg/kg	410	23	48	35	63	27	94	110	29.5	27.7	23	110	57
Mercury	mg/kg	0.59	0.018 U	0.11	0.089	0.11	0.055	0.11	0.26	0.04 U	0.04 U	0.055	0.26	0.12
Semi-volatile Organic Compounds														
LPAHs														
2-Methylnaphthalene	µg/kg	670	2.1 UJ	10 J	14 J	8.8 J	24 J	22 J	60 J	20 U	19 U	8.8	60	23
Acenaphthene	µg/kg	500	2.1 U	12	14	8.8	22	31	150	20 U	19 U	8.8	150	40
Acenaphthylene	µg/kg	1,300	2.1 U	8.7	7.8	6.5	11	13	39	20 U	19 U	6.5	39	14
Anthracene	µg/kg	960	1 J	24	30	26	42	45	220	20 U	19 U	1	220	55
Fluorene	µg/kg	540	0.6 J	12	15	9.1	20	24	94	20 U	19 U	0.6	94	25
Naphthalene	µg/kg	2,100	2 J	32 J	51 J	35 J	86 J	78 J	190 J	20 U	19 U	2	190	68
Phenanthrene	µg/kg	1,500	2.1 U	46	57	33	75	99	420	20 U	19 U	33	420	122
Total LPAH	µg/kg	5,200	4 J	145 J	189 J	127 J	280 J	312 J	1,173 J	20 U	19 U	4	1,173	318
HPAHs														
Benzo(a)anthracene	µg/kg	1,600	1.8 J	49	56	32	65	76	200	20 U	19 U	1.8	200	69
Benzo(a)pyrene	µg/kg	1,600	4.1	50	55	35	70	77	190	20 U	19 U	4.1	190	69
Benzofluoranthenes (total)	µg/kg	3,600	3.7 J	92	100	52	110	120	260	20 U	19 U	3.7	260	105
Benzo(g,h,i)perylene	µg/kg	720	2.1 U	26	2.5 U	21	35	36	76	20 U	19 U	21	76	39.0
Chrysene	µg/kg	2,800	2.2	55	59	35	72	79	220	20 U	19 U	2.2	220	75
Dibenzo(a,h)anthracene	µg/kg	230	2.1 U	6.3	2.5 U	5.8	8.1	9.4	21	20 U	19 U	5.8	21	10.0
Fluoranthene	µg/kg	2,500	2.8	99	110	55	110	120	360	12 J	19 U	2.8	360	109
Indeno(1,2,3-cd)pyrene	µg/kg	690	2.1 U	3.3	2.5 U	4	3.8	4.2	7.1	20 U	19 U	3.3	7.1	3.9
Pyrene	µg/kg	3,300	3.1	100	120	61	130	150	420	16 J	19 U	3.1	420	125
Total HPAH	µg/kg	17,000	18 J	481	500	301	604	672 U	1,754	28 J	19 U	18	1,754	550
Other Semi-volatile Organic Compounds														
Dimethyl phthalate	µg/kg	160	10 U	1 J	1.5 J	12 U	1.7 J	13	3.7 J	20 U	19 U	1	13	4.2
Diethylphthalate	µg/kg	200	10 U	12 U	12 U	12 U	12 U	13 U	2.5 J	20 U	19 U	2.5	2.5	2.5
Di-n-butyl phthalate	µg/kg	1,400	21 U	8.3 J	8.2 J	6.1 J	8.9 J	7.2 J	8.9 J	20 U	19 U	6.1	8.9	7.9
Butyl benzyl phthalate	µg/kg	900	10 U	12	24	13	35	29	23	20 U	19 U	12	35	23
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	11 J	23 U	25 U	23 U	23 U	26 U	30 U	40 JB	39 JB	11	40	27
Di-n-octyl phthalate	µg/kg	6,200	21 U	23 U	25 U	23 U	23 U	26 U	30 U	20 U	19 U	NA	NA	NA
Phenol	µg/kg	420	5.2 UJ	3.5 J	5.3 J	5.8 UJ	5.1 J	6.4 UJ	19 J	20 U	19 U	3.5	19	8.2
2-Methylphenol	µg/kg	63	5.2 UJ	5.9 UJ	6.1 UJ	5.8 UJ	5.8 UJ	6.4 UJ	2.1 J	20 U	19 U	2.1	2.1	2.1
3- & 4-Methylphenol	µg/kg	670	5.2 UJ	11 J	11 J	9.9 J	7.5 J	6.3 J	31 J	20 U	19 U	6.3	31	13
2,4-Dimethylphenol	µg/kg	29	2.1 U	3	3.4	1.6 J	4.1	2.6 U	3 U	20 U	19 U	1.6	4.1	3.0
Pentachlorophenol	µg/kg	360	10 U	12 U	12 U	12 U	12 U	13 U	15 U	98 U	95 U	NA	NA	NA
Benzyl alcohol	µg/kg	73	5.2 U	5.9 U	1.2 J	5.8 U	1.1 J	1.8 J	7.5 U	20 UJ	19 UJ	1.1	1.8	1.4
Benzoic acid	µg/kg	650	62 UJ	70 UJ	74 UJ	70 UJ	70 UJ	77 UJ	90 UJ	200 U	190 U	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	5.2 UJ	5.9 UJ	6.1 UJ	5.8 UJ	5.8 UJ	6.4 UJ	7.5 UJ	20 U	19 U	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	5.2 UJ	5.9 UJ	6.1 UJ	5.8 UJ	5.8 UJ	6.4 UJ	7.5 UJ	20 U	19 U	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	5.2 U	7.5	8	2.8 J	3 J	1 J	1.2 J	20 U	19 U	1	8	4
1,2,4-Trichlorobenzene	µg/kg	51	5.2 UJ	5.9 UJ	6.1 UJ	5.8 UJ	5.8 UJ	6.4 UJ	7.5 UJ	20 U	19 U	NA	NA	NA

Parameter	Station		RA-19A-026	RA-19A-027	RA-19A-028	RA-19A-029	RA-19A-030	RA-19A-031	RA-19A-032	RA-19A-034		RA 19A Statistics		
	Sample ID		RA-19A-026-051012-G	RA-19A-027-051012-G	RA-19A-028-051012-G	RA-19A-029-051012-G	RA-19A-030-051012-G	RA-19A-031-051012-G	RA-19A-032-051012-G	RA-19A-034-060104-G	RA-19A-035-060104-G[1]	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/12/2005	10/12/2005	10/12/2005	10/12/2005	10/12/2005	10/12/2005	10/12/2005	1/4/2006	1/4/2006			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm			
	Units	SQO												
Hexachlorobenzene	µg/kg	22	1 U	0.18 J	0.25 J	0.2 J	0.28 J	0.27 J	0.61 J	1 U	0.95 U	0.18	0.61	0.3
Dibenzofuran	µg/kg	540	0.4 J	5.6 J	6.7	3.4 J	9.1	6.5	17	20 U	19 U	0.4	17	7.0
Hexachlorobutadiene	µg/kg	11	1 U	0.8 U	0.87 U	0.79 U	0.86 U	0.91 U	1.3 U	1 U	0.95 U	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	5.2 U	5.9 U	6.1 U	5.8 U	5.8 U	6.4 U	7.5 U	20 U	19 U	NA	NA	NA
Pesticides														
p,p'-DDD	µg/kg	16	2 U	2.1	1.8	1.2 J	1.4 J	2.2	5.7	2 U	1.9 U	1.2	5.7	2.4
p,p'-DDE	µg/kg	9	2 U	1.9	1.5 J	1.2 J	1.2 J	2	4.9	2 U	1.9 U	1.2	4.9	2.1
p,p'-DDT	µg/kg	34	2 UJ	3.7 J	3.9 J	2.7 J	3.3 J	4.3 J	9.1 J	2 U	1.9 U	2.7	9.1	4.5
Polychlorinated Biphenyls (PCBs)														
PCB-1016	µg/kg	NA	49 U	56 U	62 U	57 U	56 U	64 U	73 U	20 U	19 U	NA	NA	NA
PCB-1221	µg/kg	NA	49 U	56 U	62 U	57 U	56 U	64 U	73 U	20 U	19 U	NA	NA	NA
PCB-1232	µg/kg	NA	49 U	56 U	62 U	57 U	56 U	64 U	73 U	20 U	19 U	NA	NA	NA
PCB-1242	µg/kg	NA	49 U	56 U	62 U	57 U	56 U	64 U	73 U	20 U	19 U	NA	NA	NA
PCB-1248	µg/kg	NA	49 U	56 U	62 U	57 U	56 U	64 U	73 U	20 U	19 U	NA	NA	NA
PCB-1254	µg/kg	NA	49 U	29 J	28 J	17 J	19 J	32 J	78	20 U	19 U	17	78	34
PCB-1260	µg/kg	NA	49 U	56 U	62 U	57 U	56 U	64 U	73 U	20 U	19 U	NA	NA	NA
PCBs (total)	µg/kg	300	49 U	29 J	28 J	17 J	19 J	32 J	78	20 U	19 U	17	78	34

Notes:

SQO Sediment Quality Objective.
NA Not Available.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.
1 Sample is a field duplicate of Sample RA-19A-034-060104-G.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-11
Summary of RA 19B Cap Verification Sample Results

Parameter	Station		RA-19B-010	RA-19B-011	RA 19B Statistics		
	Sample ID		RA-19B-010-060104-G	RA-19B-011-060104-G	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/4/2006	1/4/2006			
	Sample Depth		0-10 cm	0-10 cm			
	Units	SQO					
Conventionals							
Total Organic Carbon	mg/kg	NA	840 J	760 J	760	840	800
Total Solids	%	NA	96.3	96.6	96.3	96.6	96.5
Metals							
Arsenic	mg/kg	57	5 U	5 U	NA	NA	NA
Copper	mg/kg	390	13.9	14.6	13.9	14.6	14.3
Lead	mg/kg	450	2	2	2	2	2
Zinc	mg/kg	410	28.5	30.3	28.5	30.3	29.4
Mercury	mg/kg	0.59	0.04 U	0.04 U	NA	NA	NA
Semi-volatile Organic Compounds							
LPAHs							
2-Methylnaphthalene	µg/kg	670	19 U	20 U	NA	NA	NA
Acenaphthene	µg/kg	500	19 U	20 U	NA	NA	NA
Acenaphthylene	µg/kg	1,300	19 U	20 U	NA	NA	NA
Anthracene	µg/kg	960	19 U	20 U	NA	NA	NA
Fluorene	µg/kg	540	19 U	20 U	NA	NA	NA
Naphthalene	µg/kg	2,100	19 U	20 U	NA	NA	NA
Phenanthrene	µg/kg	1,500	19 U	20 U	NA	NA	NA
Total LPAH	µg/kg	5,200	19 U	20 U	NA	NA	NA
HPAHs							
Benzo(a)anthracene	µg/kg	1,600	19 U	20 U	NA	NA	NA
Benzo(a)pyrene	µg/kg	1,600	19 U	20 U	NA	NA	NA
Benzofluoranthenes (total)	µg/kg	3,600	19 U	20 U	NA	NA	NA
Benzo(g,h,i)perylene	µg/kg	720	19 U	20 U	NA	NA	NA
Chrysene	µg/kg	2,800	19 U	20 U	NA	NA	NA
Dibenzo(a,h)anthracene	µg/kg	230	19 U	20 U	NA	NA	NA
Fluoranthene	µg/kg	2,500	13 J	13 J	13	13	13
Indeno(1,2,3-cd)pyrene	µg/kg	690	19 U	20 U	NA	NA	NA
Pyrene	µg/kg	3,300	12 J	11 J	11	12	11.5
Total HPAH	µg/kg	17,000	25 J	24 J	24	25	24.5
Other Semi-volatile Organic Compounds							
Dimethyl phthalate	µg/kg	160	19 U	20 U	NA	NA	NA
Diethylphthalate	µg/kg	200	19 U	12 UJ	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	19 U	20 U	NA	NA	NA
Butyl benzyl phthalate	µg/kg	900	19 U	20 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	60 JB	73 JB	60	73	67
Di-n-octyl phthalate	µg/kg	6,200	19 U	9.8 J	9.8	9.8	9.8

Parameter	Station		RA-19B-010	RA-19B-011	RA 19B Statistics		
	Sample ID		RA-19B-010-060104-G	RA-19B-011-060104-G	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/4/2006	1/4/2006			
	Sample Depth		0-10 cm	0-10 cm			
	Units	SQO					
Phenol	µg/kg	420	19 U	20 U	NA	NA	NA
2-Methylphenol	µg/kg	63	19 U	20 U	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	19 U	20 U	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	19 U	20 U	NA	NA	NA
Pentachlorophenol	µg/kg	360	97 U	98 U	NA	NA	NA
Benzyl alcohol	µg/kg	73	19 UJ	20 UJ	NA	NA	NA
Benzoic acid	µg/kg	650	190 U	200 U	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	19 U	20 U	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	19 U	20 U	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	19 U	20 U	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	19 U	20 U	NA	NA	NA
Hexachlorobenzene	µg/kg	22	0.97 U	0.98 U	NA	NA	NA
Dibenzofuran	µg/kg	540	19 U	20 U	NA	NA	NA
Hexachlorobutadiene	µg/kg	11	0.97 U	0.98 U	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	19 U	20 U	NA	NA	NA
Pesticides							
p,p'-DDD	µg/kg	16	1.9 U	2 U	NA	NA	NA
p,p'-DDE	µg/kg	9	1.9 U	2 U	NA	NA	NA
p,p'-DDT	µg/kg	34	1.9 U	2 U	NA	NA	NA
Polychlorinated Biphenyls (PCBs)							
PCB-1016	µg/kg	NA	19 U	20 U	NA	NA	NA
PCB-1221	µg/kg	NA	19 U	20 U	NA	NA	NA
PCB-1232	µg/kg	NA	19 U	20 U	NA	NA	NA
PCB-1242	µg/kg	NA	19 U	20 U	NA	NA	NA
PCB-1248	µg/kg	NA	19 U	20 U	NA	NA	NA
PCB-1254	µg/kg	NA	19 U	20 U	NA	NA	NA
PCB-1260	µg/kg	NA	19 U	20 U	NA	NA	NA
PCBs (total)	µg/kg	300	19 U	20 U	NA	NA	NA

Notes:

SQO Sediment Quality Objective.
NA Not Applicable.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-12
Summary of RA 20 Cap Verification Sample Results

Parameter	Station		RA-20-021	RA-20-022	RA-20-023		RA-20-024	RA 20 Statistics		
	Sample ID		RA-20-021-060104-G	RA-20-022-060104-G	RA-20-023-060116-G	RA-20-025-060116-G[1]	RA-20-024-060116-G	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/4/2006	1/4/2006	1/16/2006	1/16/2006	1/16/2006			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm			
	Units	SQO								
Conventionals										
Total Organic Carbon	mg/kg	NA	470 J	450 J	1,290	680	550	450	1,290	688
Total Solids	%	NA	95.5	96.6	92.2	91.1	95.5	91.1	96.6	94.2
Metals										
Arsenic	mg/kg	57	5 U	5 U	5 U	5 U	5 U	NA	NA	NA
Copper	mg/kg	390	12	11.6	13.4	12.6	13.3	11.6	13.4	12.6
Lead	mg/kg	450	2 U	2 U	3	3	2	2	3	2.7
Zinc	mg/kg	410	22.9	25	24.8 J	27.3 J	26.8 J	22.9	27.3	25.4
Mercury	mg/kg	0.59	0.04 U	0.04 U	0.04 U	0.05 U	0.05 U	NA	NA	NA
Semi-volatile Organic Compounds										
LPAHs										
2-Methylnaphthalene	µg/kg	670	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Acenaphthene	µg/kg	500	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Acenaphthylene	µg/kg	1,300	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Anthracene	µg/kg	960	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Fluorene	µg/kg	540	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Naphthalene	µg/kg	2,100	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Phenanthrene	µg/kg	1,500	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Total LPAH	µg/kg	5,200	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
HPAHs										
Benzo(a)anthracene	µg/kg	1,600	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Benzo(a)pyrene	µg/kg	1,600	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Benzofluoranthenes (total)	µg/kg	3,600	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Benzo(g,h,i)perylene	µg/kg	720	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Chrysene	µg/kg	2,800	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Dibenzo(a,h)anthracene	µg/kg	230	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Fluoranthene	µg/kg	2,500	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Indeno(1,2,3-cd)pyrene	µg/kg	690	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Pyrene	µg/kg	3,300	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Total HPAH	µg/kg	17,000	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Other Semi-volatile Organic Compounds										
Dimethyl phthalate	µg/kg	160	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Diethylphthalate	µg/kg	200	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	20 U	19 U	300 UB	300 UB	300 UB	NA	NA	NA
Butyl benzyl phthalate	µg/kg	900	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	28 UB	31 UB	53	33	19 U	33	53	43
Di-n-octyl phthalate	µg/kg	6,200	20 U	19 U	19 U	20 U	19 U	NA	NA	NA

Parameter	Station		RA-20-021	RA-20-022	RA-20-023		RA-20-024	RA 20 Statistics		
	Sample ID		RA-20-021-060104-G	RA-20-022-060104-G	RA-20-023-060116-G	RA-20-025-060116-G[1]	RA-20-024-060116-G	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/4/2006	1/4/2006	1/16/2006	1/16/2006	1/16/2006			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm			
	Units	SQO								
Phenol	µg/kg	420	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
2-Methylphenol	µg/kg	63	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Pentachlorophenol	µg/kg	360	97 U	96 U	96 U	98 U	95 U	NA	NA	NA
Benzyl alcohol	µg/kg	73	20 UJ	19 UJ	19 U	20 U	19 U	NA	NA	NA
Benzoic acid	µg/kg	650	200 U	190 U	190 U	200 U	190 U	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Hexachlorobenzene	µg/kg	22	0.97 U	0.96 U	0.96 U	0.98 U	0.96 U	NA	NA	NA
Dibenzofuran	µg/kg	540	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Hexachlorobutadiene	µg/kg	11	0.97 U	0.96 U	0.96 U	0.98 U	0.96 U	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	20 U	19 U	19 U	20 U	19 U	NA	NA	NA
Pesticides										
p,p'-DDD	µg/kg	16	1.9 U	1.9 U	1.9 U	2 U	1.9 U	NA	NA	NA
p,p'-DDE	µg/kg	9	1.9 U	1.9 U	1.9 U	2 U	1.9 U	NA	NA	NA
p,p'-DDT	µg/kg	34	1.9 U	1.9 U	1.9 U	2 U	1.9 U	NA	NA	NA
Polychlorinated Biphenyls (PCBs)										
PCB-1016	µg/kg	NA	19 U	19 U	19 U	20 U	19 U	NA	NA	NA
PCB-1221	µg/kg	NA	19 U	19 U	19 U	20 U	19 U	NA	NA	NA
PCB-1232	µg/kg	NA	19 U	19 U	19 U	20 U	19 U	NA	NA	NA
PCB-1242	µg/kg	NA	19 U	19 U	19 U	20 U	19 U	NA	NA	NA
PCB-1248	µg/kg	NA	19 U	19 U	19 U	20 U	19 U	NA	NA	NA
PCB-1254	µg/kg	NA	19 U	19 U	19 U	20 U	19 U	NA	NA	NA
PCB-1260	µg/kg	NA	19 U	19 U	19 U	20 U	19 U	NA	NA	NA
PCBs (total)	µg/kg	300	19 U	19 U	19 U	20 U	19 U	NA	NA	NA

Notes:

SQO Sediment Quality Objective.
NA Not Applicable.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.
1 Sample is a field duplicate of Sample RA-20-023-060116-G.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-13
Summary of RA 21 Cap Verification Sample Results

Parameter	Station		RA-21-021	RA-21-022	RA-21-023	RA 21 Statistics		
	Sample ID		RA-21-021-060104-G	RA-21-022-060120-G	RA-21-023-060120-G	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/4/2006	1/20/2006	1/20/2006			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm			
	Units	SQO						
Conventionals								
Total Organic Carbon	mg/kg	NA	1,260 J	860	6,530	860	6,530	2,880
Total Solids	%	NA	93.2	96	84.7	93.2	96	91
Metals								
Arsenic	mg/kg	57	5 U	5 U	6 U	NA	NA	NA
Copper	mg/kg	390	14	12.2	18.4	12.2	18.4	15
Lead	mg/kg	450	2 U	2	4	2	4	3
Zinc	mg/kg	410	28	26.4	27.8	26.4	28	27
Mercury	mg/kg	0.59	0.04 U	0.05 U	0.04 U	NA	NA	NA
Semi-volatile Organic Compounds								
LPAHs								
2-Methylnaphthalene	µg/kg	670	19 U	20 U	20 U	NA	NA	NA
Acenaphthene	µg/kg	500	19 U	20 U	20 U	NA	NA	NA
Acenaphthylene	µg/kg	1,300	19 U	20 U	20 U	NA	NA	NA
Anthracene	µg/kg	960	19 U	20 U	20 U	NA	NA	NA
Fluorene	µg/kg	540	19 U	20 U	20 U	NA	NA	NA
Naphthalene	µg/kg	2,100	19 U	20 U	20 U	NA	NA	NA
Phenanthrene	µg/kg	1,500	19 U	20 U	13 J	13	13	13
Total LPAH	µg/kg	5,200	19 U	20 U	13 J	13	13	13
HPAHs								
Benzo(a)anthracene	µg/kg	1,600	19 U	20 U	13 J	13	13	13
Benzo(a)pyrene	µg/kg	1,600	19 U	20 U	15 J	15	15	15
Benzofluoranthenes (total)	µg/kg	3,600	19 U	20 U	28	28	28	28
Benzo(g,h,i)perylene	µg/kg	720	19 U	20 U	13 J	13	13	13
Chrysene	µg/kg	2,800	19 U	20 U	20	20	20	20
Dibenzo(a,h)anthracene	µg/kg	230	19 U	20 U	20 U	NA	NA	NA
Fluoranthene	µg/kg	2,500	19 U	20 U	28	28	28	28
Indeno(1,2,3-cd)pyrene	µg/kg	690	19 U	20 U	12 J	12	12	12
Pyrene	µg/kg	3,300	19 U	20 U	32	32	32	32
Total HPAH	µg/kg	17,000	19 U	20 U	161 J	161	161	161
Other Semi-volatile Organic Compounds								
Dimethyl phthalate	µg/kg	160	19 U	20 U	20 U	NA	NA	NA
Diethylphthalate	µg/kg	200	19 U	20 U	20 U	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	19 U	20 U	20 U	NA	NA	NA
Butyl benzyl phthalate	µg/kg	900	19 U	20 U	20 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	35 JB	20 U	66	35	66	51
Di-n-octyl phthalate	µg/kg	6,200	19 U	20 U	20 U	NA	NA	NA

Parameter	Station		RA-21-021	RA-21-022	RA-21-023	RA 21 Statistics		
	Sample ID		RA-21-021-060104-G	RA-21-022-060120-G	RA-21-023-060120-G	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		1/4/2006	1/20/2006	1/20/2006			
	Sample Depth		0-10 cm	0-10 cm	0-10 cm			
	Units	SQO						
Phenol	µg/kg	420	19 U	20 U	20 U	NA	NA	NA
2-Methylphenol	µg/kg	63	19 U	20 U	20 U	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	19 U	20 U	20 U	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	19 U	20 U	20 U	NA	NA	NA
Pentachlorophenol	µg/kg	360	97 U	99 U	98 U	NA	NA	NA
Benzyl alcohol	µg/kg	73	19 UJ	20 U	20 U	NA	NA	NA
Benzoic acid	µg/kg	650	190 U	200 U	200 U	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	19 U	20 U	20 U	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	19 U	20 U	20 U	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	19 U	20 U	20 U	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	19 U	20 U	20 U	NA	NA	NA
Hexachlorobenzene	µg/kg	22	0.96 U	1 U	0.99 U	NA	NA	NA
Dibenzofuran	µg/kg	540	19 U	20 U	20 U	NA	NA	NA
Hexachlorobutadiene	µg/kg	11	0.96 U	1 U	0.99 U	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	19 U	20 U	20 U	NA	NA	NA
Pesticides								
p,p'-DDD	µg/kg	16	1.9 U	2 U	2 U	NA	NA	NA
p,p'-DDE	µg/kg	9	1.9 U	2 U	2 U	NA	NA	NA
p,p'-DDT	µg/kg	34	1.9 U	2 U	2 U	NA	NA	NA
Polychlorinated Biphenyls (PCBs)								
PCB-1016	µg/kg	NA	19 U	20 U	20 U	NA	NA	NA
PCB-1221	µg/kg	NA	19 U	20 U	20 U	NA	NA	NA
PCB-1232	µg/kg	NA	19 U	20 U	20 U	NA	NA	NA
PCB-1242	µg/kg	NA	19 U	20 U	20 U	NA	NA	NA
PCB-1248	µg/kg	NA	19 U	20 U	20 U	NA	NA	NA
PCB-1254	µg/kg	NA	19 U	20 U	20 U	NA	NA	NA
PCB-1260	µg/kg	NA	19 U	20 U	20 U	NA	NA	NA
PCBs (total)	µg/kg	300	19 U	20 U	20 U	NA	NA	NA

Notes:

SQO Sediment Quality Objective.
NA Not Applicable.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-14
Summary of RA 22 Cap Verification Sample Results

Parameter	Station		RA-22-021
	Sample ID		RA-22-021-060104-G
	Sample Date		1/4/2006
	Sample Depth		0-10 cm
	Units	SQO	
Conventionals			
Total Organic Carbon	mg/kg	NA	720 J
Total Solids	%	NA	97.9
Metals			
Arsenic	mg/kg	57	5 U
Copper	mg/kg	390	15.1
Lead	mg/kg	450	2 U
Zinc	mg/kg	410	34.5
Mercury	mg/kg	0.59	0.04 U
Semi-volatile Organic Compounds			
LPAHs			
2-Methylnaphthalene	µg/kg	670	19 U
Acenaphthene	µg/kg	500	19 U
Acenaphthylene	µg/kg	1,300	19 U
Anthracene	µg/kg	960	19 U
Fluorene	µg/kg	540	19 U
Naphthalene	µg/kg	2,100	19 U
Phenanthrene	µg/kg	1,500	19 U
Total LPAH	µg/kg	5,200	19 U
HPAHs			
Benzo(a)anthracene	µg/kg	1,600	19 U
Benzo(a)pyrene	µg/kg	1,600	19 U
Benzofluoranthenes (total)	µg/kg	3,600	19 U
Benzo(g,h,i)perylene	µg/kg	720	19 U
Chrysene	µg/kg	2,800	19 U
Dibenzo(a,h)anthracene	µg/kg	230	19 U
Fluoranthene	µg/kg	2,500	9.8 J
Indeno(1,2,3-cd)pyrene	µg/kg	690	19 U
Pyrene	µg/kg	3,300	19 U
Total HPAH	µg/kg	17,000	9.8 J

Parameter	Station		RA-22-021
	Sample ID		RA-22-021-060104-G
	Sample Date		1/4/2006
	Sample Depth		0-10 cm
	Units	SQO	
Other Semi-volatile Organic Compounds			
Dimethyl phthalate	µg/kg	160	19 U
Diethylphthalate	µg/kg	200	19 U
Di-n-butyl phthalate	µg/kg	1,400	19 U
Butyl benzyl phthalate	µg/kg	900	19 U
bis(2-ethylhexyl)phthalate	µg/kg	1,300	57 JB
Di-n-octyl phthalate	µg/kg	6,200	19 U
Phenol	µg/kg	420	19 U
2-Methylphenol	µg/kg	63	19 U
3- & 4-Methylphenol	µg/kg	670	19 U
2,4-Dimethylphenol	µg/kg	29	19 U
Pentachlorophenol	µg/kg	360	96 U
Benzyl alcohol	µg/kg	73	19 UJ
Benzoic acid	µg/kg	650	190 U
1,2-Dichlorobenzene	µg/kg	50	19 U
1,3-Dichlorobenzene	µg/kg	170	19 U
1,4-Dichlorobenzene	µg/kg	110	19 U
1,2,4-Trichlorobenzene	µg/kg	51	19 U
Hexachlorobenzene	µg/kg	22	0.96 U
Dibenzofuran	µg/kg	540	19 U
Hexachlorobutadiene	µg/kg	11	0.96 U
N-Nitrosodiphenylamine	µg/kg	28	19 U
Pesticides			
p,p'-DDD	µg/kg	16	1.9 U
p,p'-DDE	µg/kg	9	1.9 U
p,p'-DDT	µg/kg	34	1.9 U
Polychlorinated Biphenyls (PCBs)			
PCB-1016	µg/kg	NA	19 U
PCB-1221	µg/kg	NA	19 U
PCB-1232	µg/kg	NA	19 U
PCB-1242	µg/kg	NA	19 U
PCB-1248	µg/kg	NA	19 U
PCB-1254	µg/kg	NA	19 U
PCB-1260	µg/kg	NA	19 U
PCBs (total)	µg/kg	300	19 U

Notes:

SQO Sediment Quality Objective.

Not

LPAH Low molecular weight polycyclic aromatic hydrocarbons.

HPAH High molecular weight polycyclic aromatic hydrocarbons.

Qualifiers:

U The analyte was not detected at or above the identified numerical value

B The analyte was detected in the associated method blank.

J The analyte was analyzed for and positively identified, but the associate numerical value is an estimated quantity.

UJ The analyte was not detected at or above the estimated numerical valu

Table 2-15
Summary of Natural Recovery Area Sampling Events Used as Baseline

Area	Sampling Event Type	Results Table Name	Table No.	Event Date	Station	Sample	Report/Memorandum
Area North of 11th Street Bridge	RA 2 Dredge Boundary Verification	Summary of Baseline Natural Recovery Sample Results for the Area North of 11th Street Bridge	2-16	10/22/2004	RA-02-006	RA-02-006-041022-G	Construction Correspondence Memorandum (CR) -1557 (December 9, 2004)
						RA-02-004-041022-G (dup)	
					RA-02-007	RA-02-007-041022-G	
					RA-02-008	RA-02-008-041022-G	
					RA-02-009	RA-02-009-041022-G	
	RA 4 Dredge Boundary Verification			11/15/2004	RA-04-005	RA-04-005-041115-G	CR - 1591 (December 13, 2004)
					RA-04-006	RA-04-006-041115-G	
					RA-04-007	RA-04-007-041115-G	
					RA-04-008	RA-04-008-041115-G	
	RA 4 Dredge Boundary Verification, Offset Confirmation			12/29/2004	RA-04-009	RA-04-009-041229-G	CR - 1662 (January 20, 2005)
						RA-04-012-041229-G (dup)	
					RA-04-010	RA-04-010-041229-G	
					RA-04-011	RA-04-011-041229-G	
	Supplmental Baseline Natural Recovery Area Sampling			10/23/2006	NR-06	NR-06-Y0-D	Preliminary Findings Memorandum Supplemental Baseline Natural Recovery Monitoring (February 1, 2007)
					NR-07	NR-07-Y0-D	
					NR-11	NR-11-Y0-D	
Northern Portion of RA 5	Post-dredge, No Cap or Backfill	Summary of Baseline Natural Recovery Sample Results for the Northern Portion of RA 5	2-17	9/23/2005	RA-05-002	RA-05-002-050923-G	CR - 2094 (November 4, 2005)
	Dredge Boundary Verification			12/15/2005	RA-05-009	RA-05-009-051215-G	CR - 2244 (January 23, 2006)
						RA-05-010-051215-G (dup)	
Northern Portion of RA 6	Remedial Action Modification Evaluation in RA5, RA6, and RA7	Summary of Baseline Natural Recovery Sample Results for the Northern Portion of RA 6	2-18	6/29/2005	RA-06-001	RA-06-001-050629-G	CR - 1902 (August 11, 2005)
	Dredge Boundary Verification			12/15/2005	RA-06-014	RA-06-014-051215-G	CR - 2244 (January 23, 2006)
					RA-06-015	RA-06-015-051215-G	
RA 7	Remedial Action Modification Sampling in RA5, RA6, and RA7	Summary of Baseline Natural Recovery and Enhanced Natural Recovery Sample Results for RA 7	2-19	6/29/2005	RA-07-001	RA-07-001-050629-G	CR - 1902 (August 11, 2005)
	Supplmental Baseline Natural Recovery Area Sampling			10/23/2006	NR-16	NR-16-Y0-D	Preliminary Findings Memorandum Supplemental Baseline Natural Recovery Monitoring (February 1, 2007)
Area at the Mouth of the Wheeler-Osgood Waterway	Supplmental Baseline Natural Recovery Area Sampling	Summary of Baseline Natural Recovery Sample Results for the Area at the Mouth of the Wheeler-Osgood Waterway	2-20	10/23/2006	NR-17	NR-17-Y0-D	Preliminary Findings Memorandum Supplemental Baseline Natural Recovery Monitoring (February 1, 2007)
Shoreline of the Wheeler-Osgood Waterway	Supplmental Baseline Natural Recovery Area Sampling	Summary of Baseline Natural Recovery Sample Results for the Shoreline of the Wheeler-Osgood Waterway	2-21	10/25/2006	SR-10	SR-10-Y0-D	Preliminary Findings Memorandum Supplemental Baseline Natural Recovery Monitoring (February 1, 2007)
					SR-11	SR-11-Y0-D	
						SR-11-Y0-D4	
					SR-13	SR-13-Y0-D	
Head of the Wheeler-Osgood Waterway	Supplmental Baseline Natural Recovery Area Sampling	Summary of Baseline Natural Recovery Sample Results for the Head of the Wheeler-Osgood Waterway	2-22	10/23/2006	NR-19	NR-19-Y0-D	Preliminary Findings Memorandum Supplemental Baseline Natural Recovery Monitoring (February 1, 2007)
					NR-20	NR-20-Y0-D	
						NR-20-Y0-D1	
Harbor Area Adjacent to RA 15 and RA 16	Supplmental Baseline Natural Recovery Area Sampling	Summary of Baseline Natural Recovery Sample Results for the Harbor Area Adjacent to RA 15 and RA 16	2-23	10/24/2006	NR-25	NR-25-Y0-D	Preliminary Findings Memorandum Supplemental Baseline Natural Recovery Monitoring (February 1, 2007)
						NR-25-Y0-D1	

Notes: (dup) - Field duplicate sample

Table 2-16
Summary of Baseline Natural Recovery Sample Results for the Area North of 11th Street Bridge

Parameter	Station		RA-02-006				RA-02-007		RA-02-008		RA-02-009		RA-04-005		RA-04-006	
	Sample ID		RA-02-006-041022-G		RA-02-004-041022-G[1]		RA-02-007-041022-G		RA-02-008-041022-G		RA-02-009-041022-G		RA-04-005-041115-G		RA-04-006-041115-G	
	Sample Date		10/22/2004	Enrichment	10/22/2004	Enrichment	10/22/2004	Enrichment	10/22/2004	Enrichment	10/22/2004	Enrichment	11/15/2004	Enrichment	11/15/2004	Enrichment
	Sample Depth		0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio
	Units	SQO														
Conventionals																
Total Organic Carbon	mg/kg	NA	23,500	NA	22,400	NA	29,000	NA	23,400	NA	26,800	NA	42,900	NA	25,700	NA
Total Solids	%	NA	51.59	NA	52.41	NA	45.44	NA	50.96	NA	44.97	NA	42.02	NA	55.38	NA
Metals																
Antimony	mg/kg	150	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	mg/kg	57	9.77	0.17	9.26	0.16	12.4	0.22	9.59	0.17	10.8	0.19	12.6	0.22	18	0.32
Cadmium	mg/kg	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	mg/kg	390	77.1 J	0.20	71.3 J	0.18	90.4 J	0.23	70.9 J	0.18	91.8 J	0.24	113	0.29	83.8	0.21
Lead	mg/kg	450	59	0.13	56.7	0.13	75.2	0.17	59.8	0.13	63	0.14	98.2	0.22	81	0.18
Nickel	mg/kg	140	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	mg/kg	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	mg/kg	410	86	0.21	85.2	0.21	106	0.26	84.5	0.21	101	0.25	124 B	0.30	**2,870 B**	7.0
Mercury	mg/kg	0.59	0.161	0.27	0.169	0.29	0.207	0.35	0.224	0.38	0.234	0.40	0.194	0.33	0.187	0.32
Semi-volatile Organic Compounds																
LPAHs																
2-Methylnaphthalene	µg/kg	670	15.6	0.02	14.8	0.02	11.9	0.02	18.8	0.03	15.6	0.02	4.46 J	0.01	12.5	0.02
Acenaphthene	µg/kg	500	23.3	0.05	20.6	0.04	18.5	0.04	62.9	0.13	40.5	0.08	6.26 J	0.01	46	0.09
Acenaphthylene	µg/kg	1,300	81.2	0.06	59.5	0.05	56.6	0.04	134	0.10	130	0.10	20.6 J	0.02	71.3	0.05
Anthracene	µg/kg	960	249	0.26	122	0.13	79.5	0.08	218	0.23	212	0.22	48.4 J	0.05	161	0.17
Fluorene	µg/kg	540	57.6	0.11	27.5	0.05	24.9	0.05	76.5	0.14	50.9	0.09	17.8 J	0.03	74.8	0.14
Naphthalene	µg/kg	2,100	42.8	0.02	29.1	0.01	25.4	0.01	45.7	0.02	46.9	0.02	10.2 J	0.00	16.9	0.01
Phenanthrene	µg/kg	1,500	388	0.26	139	0.09	100	0.07	266	0.18	249	0.17	86.5 J	0.06	300	0.20
Total LPAH	µg/kg	5,200	858	0.16	413	0.08	317	0.06	822	0.16	745	0.14	194 J	0.04	683	0.13
HPAHs																
Benzo(a)anthracene	µg/kg	1,600	354	0.22	211	0.13	199	0.12	324	0.20	335	0.21	192 J	0.12	627	0.39
Benzo(a)pyrene	µg/kg	1,600	318	0.20	204	0.13	229	0.14	327	0.20	335	0.21	4.72 UJ	NA	3.6 U	NA
Benzofluoranthenes (total)	µg/kg	3,600	354	0.10	267	0.07	272	0.08	357	0.10	419	0.12	204 J	0.06	1,060	0.29
Benzo(g,h,i)perylene	µg/kg	720	154	0.21	106	0.15	126	0.18	173	0.24	155	0.22	96.2 J	0.13	226	0.31
Chrysene	µg/kg	2,800	359	0.13	220	0.08	223	0.08	338	0.12	380	0.14	160 J	0.06	636	0.23
Dibenzo(a,h)anthracene	µg/kg	230	20.8	0.09	38.1	0.17	36.1	0.16	68.8	0.30	59.9	0.26	4.72 UJ	NA	117	0.51
Fluoranthene	µg/kg	2,500	498	0.20	314	0.13	249	0.10	431	0.17	485	0.19	94.3 J	0.04	1,310	0.52
Indeno(1,2,3-cd)pyrene	µg/kg	690	129	0.19	86.6	0.13	105	0.15	129	0.19	133	0.19	102 J	0.15	510	0.74
Pyrene	µg/kg	3,300	752	0.23	406	0.12	357	0.11	798	0.24	826	0.25	161 J	0.05	1,030	0.31
Total HPAH	µg/kg	17,000	2,939	0.17	1,853	0.11	1,796	0.11	2,946	0.17	3,128	0.18	1,010 J	0.06	5,516	0.32
Other Semi-volatile Organic Compounds																
Dimethyl phthalate	µg/kg	160	19.4 U	NA	18.2 U	NA	21.6 U	NA	4.43 J	0.03	21.6 U	NA	23.6 UJ	NA	4.7 J	0.03
Diethylphthalate	µg/kg	200	19.4 U	NA	18.2 U	NA	21.6 U	NA	19 U	NA	21.6 U	NA	23.6 UJ	NA	18 U	NA
Di-n-butyl phthalate	µg/kg	1,400	24.7 UJB	NA	23 UB	NA	15.1 UJB	NA	16.8 UJB	NA	20 UJB	NA	13.3 UJB	NA	27.8 UB	NA
Butyl benzyl phthalate	µg/kg	900	79.7	0.09	36.4 U	NA	88.1	0.10	38 U	NA	43.2 U	NA	22.9 UJB	NA	36 U	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	114 B	0.09	113 B	0.09	122 B	0.09	92.7 B	0.07	120 B	0.09	47.2 UJ	NA	78.7 B	0.06
Di-n-octyl phthalate	µg/kg	6,200	38.8 U	NA	36.4 U	NA	43.2 U	NA	38 U	NA	43.2 U	NA	47.2 UJ	NA	36 U	NA
Phenol	µg/kg	420	54.1	0.13	12.9	0.03	43.3	0.10	13.3	0.03	11.9	0.03	4.59 J	0.01	21.3	0.05
2-Methylphenol	µg/kg	63	2.72 J	0.04	9.11 U	NA	10.8 U	NA	2.24 J	0.04	10.8 U	NA	11.8 UJ	NA	8.99 U	NA
3- & 4-Methylphenol	µg/kg	670	11.4	0.02	9.11	0.01	12	0.02	16.4	0.02	14	0.02	11.8 UJ	NA	9.26	0.01
2,4-Dimethylphenol	µg/kg	29	3.88 U	NA	3.64 U	NA	4.32 U	NA	2.44 J	0.08	4.32 U	NA	4.72 UJ	NA	3.6 U	NA
Pentachlorophenol	µg/kg	360	19.4 U	NA	18.2 U	NA	21.6 U	NA	19 U	NA	21.6 U	NA	23.6 UJ	NA	18 U	NA
Benzyl alcohol	µg/kg	73	4.13 J	0.06	4.85 J	0.07	6.09 J	0.08	9.51 U	NA	10.8 U	NA	11.8 UJ	NA	8.99 U	NA
Benzoic acid	µg/kg	650	116 U	NA	109 U	NA	130 U	NA	114 U	NA	130 U	NA	142 UJ	NA	108 U	NA
1,2-Dichlorobenzene	µg/kg	50	9.69 U	NA	9.11 U	NA	10.8 U	NA	9.51 U	NA	10.8 U	NA	11.8 UJ	NA	8.99 UJ	NA
1,3-Dichlorobenzene	µg/kg	170	9.69 U	NA	9.11 U	NA	10.8 U	NA	9.51 U	NA	10.8 U	NA	11.8 UJ	NA	8.99 UJ	NA
1,4-Dichlorobenzene	µg/kg	110	9.69 U	NA	9.11 U	NA	10.8 U	NA	9.51 U	NA	10.8 U	NA	11.8 UJ	NA	8.99 UJ	NA

Parameter	Station		RA-02-006				RA-02-007		RA-02-008		RA-02-009		RA-04-005		RA-04-006	
	Sample ID		RA-02-006-041022-G		RA-02-004-041022-G[1]		RA-02-007-041022-G		RA-02-008-041022-G		RA-02-009-041022-G		RA-04-005-041115-G		RA-04-006-041115-G	
	Sample Date		10/22/2004	Enrichment	10/22/2004	Enrichment	10/22/2004	Enrichment	10/22/2004	Enrichment	10/22/2004	Enrichment	11/15/2004	Enrichment	11/15/2004	Enrichment
	Sample Depth		0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio
	Units	SQO														
1,2,4-Trichlorobenzene	µg/kg	51	9.69 U	NA	9.11 U	NA	10.8 U	NA	9.51 U	NA	10.8 U	NA	11.8 UJ	NA	8.99 UJ	NA
Hexachlorobenzene	µg/kg	22	3.84 U	NA	3.78 U	NA	4.18 U	NA	3.85 U	NA	4.18 U	NA	3.71 U	NA	3.37 U	NA
Dibenzofuran	µg/kg	540	6.72 J	0.01	6.72 J	0.01	6.27 J	0.01	11.4	0.02	10.9	0.02	3.27 J	0.01	21.8	0.04
Hexachlorobutadiene	µg/kg	11	4.03	0.37	1.89 U	NA	5.36	0.49	5.13	0.47	2.09 U	NA	1.86 U	NA	1.68 U	NA
N-Nitrosodiphenylamine	µg/kg	28	3.88 U	NA	3.64 U	NA	4.32 U	NA	3.8 U	NA	4.32 U	NA	4.72 UJ	NA	3.6 U	NA
Pesticides																
p,p'-DDD	µg/kg	16	3.06 J	0.19	4.34	0.27	5.08	0.32	4.75	0.30	4.16 J	0.26	1.76 J	0.11	2.4 J	0.15
p,p'-DDE	µg/kg	9	2.85 J	0.32	3.49 J	0.39	4.93	0.55	3.51 J	0.39	3.51 J	0.39	3.71 U	NA	3.14 J	0.35
p,p'-DDT	µg/kg	34	7.68	0.23	8.98	0.26	11.6	0.34	8.75	0.26	9.07	0.27	4.27	0.13	5.49	0.16
Polychlorinated Biphenyls (PCBs)																
PCB-1016	µg/kg	NA	16.1 U	NA	15.6 U	NA	17.5 U	NA	16.3 U	NA	17.8 U	NA	18.6 U	NA	16.8 U	NA
PCB-1221	µg/kg	NA	16.1 U	NA	15.6 U	NA	17.5 U	NA	16.3 U	NA	17.8 U	NA	18.6 U	NA	16.8 U	NA
PCB-1232	µg/kg	NA	16.1 U	NA	15.6 U	NA	17.5 U	NA	16.3 U	NA	17.8 U	NA	18.6 U	NA	16.8 U	NA
PCB-1242	µg/kg	NA	16.1 U	NA	15.6 U	NA	17.5 U	NA	16.3 U	NA	17.8 U	NA	18.6 U	NA	16.8 U	NA
PCB-1248	µg/kg	NA	16.1 U	NA	15.6 U	NA	17.5 U	NA	16.3 U	NA	17.8 U	NA	18.6 U	NA	16.8 U	NA
PCB-1254	µg/kg	NA	16.1 U	NA	15.6 U	NA	17.5 U	NA	16.3 U	NA	17.8 U	NA	31.6	NA	41.4	NA
PCB-1260	µg/kg	NA	26.3	NA	22.4	NA	30.2	NA	21.5	NA	10.3 J	NA	40.4	NA	34.6	NA
PCBs (total)	µg/kg	300	26.3	0.09	22.4	0.07	30.2	0.10	21.5	0.07	10.3 J	0.03	72	0.24	76	0.25

Parameter	Station		RA-04-007		RA-04-008		RA-04-009				RA-04-010		RA-04-011		NR-06	
	Sample ID		RA-04-007-041115-G		RA-04-008-041115-G		RA-04-009-041229-G		RA-04-012-041229-G[2]		RA-04-010-041229-G		RA-04-011-041229-G		NR-06-Y0-D	
	Sample Date		11/15/2004	Enrichment	11/15/2004	Enrichment	12/29/2004	Enrichment	12/29/2004	Enrichment	12/29/2004	Enrichment	12/29/2004	Enrichment	10/23/2006	Enrichment
	Sample Depth		0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0 to 10 cm	Ratio
	Units	SQO														
Conventionals																
Total Organic Carbon	mg/kg	NA	43,600	NA	47,200	NA	NA	NA	NA	NA	NA	NA	NA	NA	21,900	NA
Total Solids	%	NA	43.29	NA	43.47	NA	53.16	NA	47.87	NA	62.1	NA	50.06	NA	47.7	NA
Metals																
Antimony	mg/kg	150	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6 U	NA
Arsenic	mg/kg	57	11.8	0.21	16	0.28	NA	NA	NA	NA	NA	NA	NA	NA	10.2	0.18
Cadmium	mg/kg	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.926	0.18
Copper	mg/kg	390	120	0.31	135	0.35	NA	NA	NA	NA	NA	NA	NA	NA	80.4 J	0.21
Lead	mg/kg	450	152	0.34	137	0.30	NA	NA	NA	NA	NA	NA	NA	NA	55.8	0.12
Nickel	mg/kg	140	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	17.6	0.13
Silver	mg/kg	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.22 U	NA
Zinc	mg/kg	410	166 B	0.40	163 B	0.40	130	0.32	130	0.32	53.9	0.13	106	0.26	102	0.25
Mercury	mg/kg	0.59	0.227	0.38	0.238	0.40	NA	NA	NA	NA	NA	NA	NA	NA	0.298	0.51
Semi-volatile Organic Compounds																
LPAHs																
2-Methylnaphthalene	µg/kg	670	6.56	0.01	8.7	0.01	NA	NA	NA	NA	NA	NA	NA	NA	160	0.24
Acenaphthene	µg/kg	500	11.5	0.02	14.3	0.03	NA	NA	NA	NA	NA	NA	NA	NA	100 U	NA
Acenaphthylene	µg/kg	1,300	42.9	0.03	62.7	0.05	NA	NA	NA	NA	NA	NA	NA	NA	100 U	NA
Anthracene	µg/kg	960	57.1	0.06	75.1	0.08	NA	NA	NA	NA	NA	NA	NA	NA	260	0.27
Fluorene	µg/kg	540	22.8	0.04	26.9	0.05	NA	NA	NA	NA	NA	NA	NA	NA	110	0.20
Naphthalene	µg/kg	2,100	10.9	0.01	12.9	0.01	NA	NA	NA	NA	NA	NA	NA	NA	290	0.14
Phenanthrene	µg/kg	1,500	90.5	0.06	143	0.10	NA	NA	NA	NA	NA	NA	NA	NA	510	0.34
Total LPAH	µg/kg	5,200	242	0.05	344	0.07	NA	NA	NA	NA	NA	NA	NA	NA	1,400	0.27
HPAHs																
Benzo(a)anthracene	µg/kg	1,600	138	0.09	296	0.19	NA	NA	NA	NA	NA	NA	NA	NA	500	0.31
Benzo(a)pyrene	µg/kg	1,600	385	0.24	426	0.27	NA	NA	NA	NA	NA	NA	NA	NA	520	0.33
Benzofluoranthenes (total)	µg/kg	3,600	286	0.08	396	0.11	NA	NA	NA	NA	NA	NA	NA	NA	1,100	0.31
Benzo(g,h,i)perylene	µg/kg	720	118	0.16	135	0.19	NA	NA	NA	NA	NA	NA	NA	NA	360	0.50
Chrysene	µg/kg	2,800	169	0.06	406	0.15	NA	NA	NA	NA	NA	NA	NA	NA	620	0.22
Dibenzo(a,h)anthracene	µg/kg	230	18.5	0.08	60.6	0.26	NA	NA	NA	NA	NA	NA	NA	NA	100 U	NA
Fluoranthene	µg/kg	2,500	234	0.09	290	0.12	NA	NA	NA	NA	NA	NA	NA	NA	810	0.32
Indeno(1,2,3-cd)pyrene	µg/kg	690	109	0.16	127	0.18	NA	NA	NA	NA	NA	NA	NA	NA	270	0.39
Pyrene	µg/kg	3,300	261	0.08	345	0.10	NA	NA	NA	NA	NA	NA	NA	NA	1,800	0.55
Total HPAH	µg/kg	17,000	1,719	0.10	2,482	0.15	NA	NA	NA	NA	NA	NA	NA	NA	6,100	0.36
Other Semi-volatile Organic Compounds																
Dimethyl phthalate	µg/kg	160	22.1 U	NA	22.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	10	0.06
Diethylphthalate	µg/kg	200	22.1 U	NA	22.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	100 U	NA
Di-n-butyl phthalate	µg/kg	1,400	22.9 UB	NA	30.8 UB	NA	NA	NA	NA	NA	NA	NA	NA	NA	100 U	NA
Butyl benzyl phthalate	µg/kg	900	44.2 U	NA	86.9 B	0.10	NA	NA	NA	NA	NA	NA	NA	NA	240	0.27
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	155 B	0.12	134 B	0.10	NA	NA	NA	NA	NA	NA	NA	NA	730	0.56
Di-n-octyl phthalate	µg/kg	6,200	31.8 J	0.01	44.2 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	100 U	NA
Phenol	µg/kg	420	11 U	NA	9.44 J	0.02	NA	NA	NA	NA	NA	NA	NA	NA	100 U	NA
2-Methylphenol	µg/kg	63	11 U	NA	11.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	4 UJ	NA
3- & 4-Methylphenol	µg/kg	670	7.13 J	0.01	7.87 J	0.01	NA	NA	NA	NA	NA	NA	NA	NA	100 U	NA
2,4-Dimethylphenol	µg/kg	29	4.42 U	NA	4.42 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	18 J	0.62
Pentachlorophenol	µg/kg	360	22.1 U	NA	22.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	4 UJ	NA
Benzyl alcohol	µg/kg	73	13.8	0.19	11.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	69 UJ	NA
Benzoic acid	µg/kg	650	132 U	NA	133 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	170 UJ	NA
1,2-Dichlorobenzene	µg/kg	50	11 UJ	NA	11.1 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	11 UJ	NA	11.1 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	4 U	NA
1,4-Dichlorobenzene	µg/kg	110	11 UJ	NA	11.1 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	11	0.10

Parameter	Station		RA-04-007		RA-04-008		RA-04-009				RA-04-010		RA-04-011		NR-06	
	Sample ID		RA-04-007-041115-G		RA-04-008-041115-G		RA-04-009-041229-G		RA-04-012-041229-G[2]		RA-04-010-041229-G		RA-04-011-041229-G		NR-06-Y0-D	
	Sample Date		11/15/2004	Enrichment	11/15/2004	Enrichment	12/29/2004	Enrichment	12/29/2004	Enrichment	12/29/2004	Enrichment	12/29/2004	Enrichment	10/23/2006	Enrichment
	Sample Depth		0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio	0 to 10 cm	Ratio
	Units	SQO														
1,2,4-Trichlorobenzene	µg/kg	51	11 UJ	NA	11.1 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	3.75 U	NA	3.62 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	4 U	NA
Dibenzofuran	µg/kg	540	11 U	NA	5.48 J	0.01	NA	NA	NA	NA	NA	NA	NA	NA	100 U	NA
Hexachlorobutadiene	µg/kg	11	1.87 U	NA	1.81 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	4.42 U	NA	4.42 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	17	0.61
Pesticides																
p,p'-DDD	µg/kg	16	1.68 J	0.11	2.11 J	0.13	NA	NA	NA	NA	NA	NA	NA	NA	4 U	NA
p,p'-DDE	µg/kg	9	3.75 U	NA	3.62 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	4 U	NA
p,p'-DDT	µg/kg	34	3.69 J	0.11	5.28	0.16	NA	NA	NA	NA	NA	NA	NA	NA	4 U	NA
Polychlorinated Biphenyls (PCBs)																
PCB-1016	µg/kg	NA	18.7 U	NA	18.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	20 U	NA
PCB-1221	µg/kg	NA	18.7 U	NA	18.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	20 U	NA
PCB-1232	µg/kg	NA	18.7 U	NA	18.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	20 U	NA
PCB-1242	µg/kg	NA	18.7 U	NA	18.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	20 U	NA
PCB-1248	µg/kg	NA	18.7 U	NA	18.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	20 U	NA
PCB-1254	µg/kg	NA	27.9	NA	34.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	150 J	NA
PCB-1260	µg/kg	NA	23	NA	31	NA	NA	NA	NA	NA	NA	NA	NA	NA	20 U	NA
PCBs (total)	µg/kg	300	50.9	0.17	65.4	0.22	NA	NA	NA	NA	NA	NA	NA	NA	150 J	0.50

Parameter	Station		NR-07		NR-11		Area North of 11th Street Bridge Statistics		
	Sample ID		NR-07-Y0-D		NR-11-Y0-D		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/23/2006	Enrichment Ratio	10/23/2006	Enrichment Ratio			
	Sample Depth		0 to 10 cm		0 to 10 cm				
	Units	SQO							
Conventionals									
Total Organic Carbon	mg/kg	NA	22,600	NA	25,800	NA	21,900	47,200	29,600
Total Solids	%	NA	46	NA	45.5	NA	42.0	62.1	49
Metals									
Antimony	mg/kg	150	6 U	NA	6 U	NA	NA	NA	NA
Arsenic	mg/kg	57	9.83	0.17	11.4	0.20	9.26	18	12
Cadmium	mg/kg	5	0.897	0.18	1.17	0.23	0.897	1.17	0.998
Copper	mg/kg	390	83 J	0.21	96.8 J	0.25	70.9	135	93
Lead	mg/kg	450	51.4	0.11	69.2	0.15	51.4	152	80
Nickel	mg/kg	140	15.7	0.11	18.7	0.13	15.7	18.7	17.3
Silver	mg/kg	6	0.2 U	NA	0.22 U	NA	NA	NA	NA
Zinc	mg/kg	410	109	0.27	130	0.32	53.9	2,870	284
Mercury	mg/kg	0.59	0.317	0.54	0.407	0.69	0.161	0.407	0.239
Semi-volatile Organic Compounds									
LPAHs									
2-Methylnaphthalene	µg/kg	670	150	0.22	150	0.22	4.46	160	47
Acenaphthene	µg/kg	500	100 U	NA	100 U	NA	6.26	62.9	27
Acenaphthylene	µg/kg	1,300	100 U	NA	100 U	NA	20.6	134	80
Anthracene	µg/kg	960	210	0.22	230	0.24	48.4	260	160
Fluorene	µg/kg	540	100 U	NA	110	0.20	17.8	110	58
Naphthalene	µg/kg	2,100	260	0.12	270	0.13	10.2	290	88
Phenanthrene	µg/kg	1,500	470	0.31	560	0.37	86.5	560	275
Total LPAH	µg/kg	5,200	1,200	0.23	1,400	0.27	194	1,400	718
HPAHs									
Benzo(a)anthracene	µg/kg	1,600	450	0.28	550	0.34	138	627	348
Benzo(a)pyrene	µg/kg	1,600	510	0.32	620	0.39	204	620	387
Benzofluoranthenes (total)	µg/kg	3,600	1,100	0.31	1,400	0.39	204	1,400	601
Benzo(g,h,i)perylene	µg/kg	720	330	0.46	400	0.56	96.2	400	198
Chrysene	µg/kg	2,800	620	0.22	700	0.25	160	700	403
Dibenzo(a,h)anthracene	µg/kg	230	100 U	NA	100 U	NA	18.5	117	52
Fluoranthene	µg/kg	2,500	770	0.31	900	0.36	94.3	1,310	532
Indeno(1,2,3-cd)pyrene	µg/kg	690	270	0.39	300	0.43	86.6	510	189
Pyrene	µg/kg	3,300	1,800	0.55	2,400	0.73	161	2,400	911
Total HPAH	µg/kg	17,000	5,800	0.34	7,300	0.43	1,010	7,300	3,549
Other Semi-volatile Organic Compounds									
Dimethyl phthalate	µg/kg	160	16	0.10	18	0.11	4.43	18	11
Diethylphthalate	µg/kg	200	100 U	NA	100 U	NA	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	100 U	NA	100 U	NA	NA	NA	NA
Butyl benzyl phthalate	µg/kg	900	290	0.32	480	0.53	79.7	480	211
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	1,000	0.77	**2,000**	1.54	78.7	2,000	424
Di-n-octyl phthalate	µg/kg	6,200	100 U	NA	100 U	NA	31.8	31.8	31.8
Phenol	µg/kg	420	100 U	NA	100 U	NA	4.59	54.1	21.4
2-Methylphenol	µg/kg	63	4 UJ	NA	4 UJ	NA	2.24	2.72	2.48
3- & 4-Methylphenol	µg/kg	670	100 U	NA	100 U	NA	7.13	16.4	10.9
2,4-Dimethylphenol	µg/kg	29	18 J	0.62	19 J	0.66	2.44	19	14.4
Pentachlorophenol	µg/kg	360	76	0.21	4 UJ	NA	76	76	76
Benzyl alcohol	µg/kg	73	**75 U**	NA	**81 UJ**	NA	4.13	13.8	7.2
Benzoic acid	µg/kg	650	170 UJ	NA	190 UJ	NA	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	4 U	NA	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	4 U	NA	4 U	NA	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	15	0.14	21	0.19	11	21	16

Parameter	Station		NR-07		NR-11		Area North of 11th Street Bridge Statistics		
	Sample ID		NR-07-Y0-D		NR-11-Y0-D		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/23/2006	Enrichment Ratio	10/23/2006	Enrichment Ratio			
	Sample Depth		0 to 10 cm		0 to 10 cm				
	Units	SQO							
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	NA	NA	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	NA	NA	NA
Dibenzofuran	µg/kg	540	100 U	NA	100 U	NA	3.27	21.8	9.07
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4.03	5.36	4.84
N-Nitrosodiphenylamine	µg/kg	28	13	0.46	12	0.43	12	17	14
Pesticides									
p,p'-DDD	µg/kg	16	4 U	NA	4 U	NA	1.68	5.08	3.26
p,p'-DDE	µg/kg	9	4 U	NA	4 U	NA	2.85	4.93	3.57
p,p'-DDT	µg/kg	34	4 U	NA	4 U	NA	3.69	11.6	7.2
Polychlorinated Biphenyls (PCBs)									
PCB-1016	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1221	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1232	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1242	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1248	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1254	µg/kg	NA	140 J	NA	200 J	NA	27.9	200	89.3
PCB-1260	µg/kg	NA	20 U	NA	20 U	NA	10.3	40.4	26.6
PCBs (total)	µg/kg	300	140 J	0.47	200 J	0.67	10.3	200	72

Notes:

SQO Sediment Quality Objective.

NA Not Applicable

LPAH Low molecular weight polycyclic aromatic hydrocarbons.

HPAH High molecular weight polycyclic aromatic hydrocarbons.

If sample concentration is highlighted in red, concentration exceeds the SQO.

1 Sample is a field duplicate of Sample RA-02-006-041022-G.

2 Sample is a field duplicate of Sample RA-04-009-041229-G.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.

B The analyte was detected in the associated method blank.

J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

UJ The analyte was not detected at or above the estimated numerical value.

Table 2-17
Summary of Baseline Natural Recovery Sample Results for the Northern Portion of RA 5

Parameter	Station		RA-05-002		RA-05-009				Northern Portion of RA 5 Statistics		
	Sample ID		RA-05-002-050923-G		RA-05-009-051215-G		RA-05-010-051215-G[1]		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		9/23/2005	Enrichment	12/15/2005	Enrichment	12/15/2005	Enrichment			
	Sample Depth		0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio			
	Units	SQO									
Conventionals											
Total Organic Carbon	mg/kg	NA	4,000	NA	2.96	NA	3.32	NA	2.96	4,000	1,300
Total Solids	%	NA	82.76	NA	49.4	NA	50	NA	49.4	83	61
Metals											
Arsenic	mg/kg	57	5.24	0.09	18	0.32	18	0.32	5.24	18	14
Copper	mg/kg	390	71.6	0.18	125	0.32	122	0.31	71.6	125	106
Lead	mg/kg	450	23.6	0.05	113	0.25	105	0.23	23.6	113	80.5
Zinc	mg/kg	410	82.9	0.20	150	0.37	150	0.37	82.9	150	128
Mercury	mg/kg	0.59	0.0711	0.12	0.41	0.69	0.45	0.76	0.0711	0.45	0.31
Semi-volatile Organic Compounds											
LPAHs											
2-Methylnaphthalene	µg/kg	670	8.53 J	0.01	64	0.10	52	0.08	8.53	64	42
Acenaphthene	µg/kg	500	14.4 J	0.03	64	0.13	47	0.09	14.4	64	42
Acenaphthylene	µg/kg	1,300	9.24 J	0.01	150	0.12	98	0.08	9.24	150	86
Anthracene	µg/kg	960	26.9 J	0.03	290	0.30	200	0.21	26.9	290	172
Fluorene	µg/kg	540	17.2 J	0.03	60	0.11	51	0.09	17.2	60	43
Naphthalene	µg/kg	2,100	23.7 J	0.01	130	0.06	100	0.05	23.7	130	84.6
Phenanthrene	µg/kg	1,500	61.3 J	0.04	520	0.35	320	0.21	61.3	520	300
Total LPAH	µg/kg	5,200	161 J	0.03	1,278	0.25	868	0.17	161	1,278	769
HPAHs											
Benzo(a)anthracene	µg/kg	1,600	34.6 J	0.02	720	0.45	420	0.26	34.6	720	392
Benzo(a)pyrene	µg/kg	1,600	28.9 J	0.02	880	0.55	610	0.38	28.9	880	506
Benzofluoranthenes (total)	µg/kg	3,600	43.3 J	0.01	2,400	0.67	1,550	0.43	43.3	2,400	1,331
Benzo(g,h,i)perylene	µg/kg	720	18.1 J	0.03	340	0.47	260	0.36	18.1	340	206
Chrysene	µg/kg	2,800	40.1 J	0.01	1,100	0.39	610	0.22	40.1	1,100	583
Dibenzo(a,h)anthracene	µg/kg	230	10.1 J	0.04	84	0.37	68	0.30	10.1	84	54
Fluoranthene	µg/kg	2,500	90 J	0.04	1,600	0.64	720	0.29	90	1,600	803
Indeno(1,2,3-cd)pyrene	µg/kg	690	15.4 J	0.02	320	0.46	240	0.35	15.4	320	192
Pyrene	µg/kg	3,300	110 J	0.03	1,600	0.48	1,000	0.30	110	1,600	903
Total HPAH	µg/kg	17,000	391 J	0.02	9,044	0.53	5,478	0.32	391	9,044	4,971
Other Semi-volatile Organic Compounds											
Dimethyl phthalate	µg/kg	160	12 UJ	NA	28	NA	23	0.14	23	28	26
Diethylphthalate	µg/kg	200	12 UJ	NA	20 U	NA	19 U	NA	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	30.7 JB	0.02	60 JB	0.04	160 JB	0.11	30.7	160	84
Butyl benzyl phthalate	µg/kg	900	17 J	0.02	390	0.43	350	0.39	17	390	252
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	31.7 JB	0.02	1,500 B	1.15	1,400 B	1.08	31.7	1,500	977
Di-n-octyl phthalate	µg/kg	6,200	23.9 UJ	NA	20 U	NA	19 U	NA	NA	NA	NA
Phenol	µg/kg	420	5.98 UJ	NA	26	0.06	21	0.05	21	26	24
2-Methylphenol	µg/kg	63	5.98 UJ	NA	20 U	NA	19 U	NA	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	4.58 UJ	NA	24	0.04	19 J	0.03	19	24	22
2,4-Dimethylphenol	µg/kg	29	2.39 UJ	NA	20 U	NA	19 U	NA	NA	NA	NA

Parameter	Station		RA-05-002		RA-05-009				Northern Portion of RA 5 Statistics		
	Sample ID		RA-05-002-050923-G		RA-05-009-051215-G		RA-05-010-051215-G[1]		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		9/23/2005	Enrichment	12/15/2005	Enrichment	12/15/2005	Enrichment			
	Sample Depth		0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio			
	Units	SQO									
Pentachlorophenol	µg/kg	360	18 J	0.05	99 U	NA	97 U	NA	18	18	18
Benzyl alcohol	µg/kg	73	5.98 UJ	NA	20 U	NA	19 U	NA	NA	NA	NA
Benzoic acid	µg/kg	650	71.7 UJ	NA	56 J	0.09	190 U	NA	56	56	56
1,2-Dichlorobenzene	µg/kg	50	5.98 UJ	NA	20 UJ	NA	19 UJ	NA	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	5.98 UJ	NA	20 U	NA	19 U	NA	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	5.98 UJ	NA	20 U	NA	19 U	NA	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	5.98 UJ	NA	20 U	NA	19 U	NA	NA	NA	NA
Hexachlorobenzene	µg/kg	22	2.36 U	NA	0.99 U	NA	0.98 U	NA	NA	NA	NA
Dibenzofuran	µg/kg	540	9.67 J	0.02	46	0.09	41	0.08	9.67	46	32
Hexachlorobutadiene	µg/kg	11	1.18 U	NA	0.99 U	NA	0.98 U	NA	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	2.39 UJ	NA	20 U	NA	19 U	NA	NA	NA	NA
Pesticides											
p,p'-DDD	µg/kg	16	1.12 J	0.07	6.4	0.40	6.3	0.39	1.12	6.4	4.6
p,p'-DDE	µg/kg	9	1.06 J	0.12	6.9 U	NA	6 U	NA	1.06	1.06	1.06
p,p'-DDT	µg/kg	34	1.77 J	0.05	12 U	NA	9.8 U	NA	1.77	1.77	1.77
Polychlorinated Biphenyls (PCBs)											
PCB-1016	µg/kg	NA	11.5 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1221	µg/kg	NA	11.5 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1232	µg/kg	NA	11.5 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1242	µg/kg	NA	11.5 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1248	µg/kg	NA	11.5 U	NA	36	NA	31	NA	31	36	34
PCB-1254	µg/kg	NA	34.1	NA	120	NA	110	NA	34.1	120	88
PCB-1260	µg/kg	NA	11.5 U	NA	91	NA	85	NA	85	91	88
PCBs (total)	µg/kg	300	34.1	0.11	247	0.82	226	0.75	34.1	247	169

Notes:

SQO Sediment Quality Objective.

NA Not Available.

LPAH Low molecular weight polycyclic aromatic hydrocarbons.

HPAH High molecular weight polycyclic aromatic hydrocarbons.

If sample concentration is highlighted in red, concentration exceeds the SQO.

1 Sample is a field duplicate of Sample RA-05-009-051215-G.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.

B The analyte was detected in the associated method blank.

J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

UJ The analyte was not detected at or above the estimated numerical value.

Table 2-18
Summary of Baseline Natural Recovery Sample Results for the Northern Portion of RA 6

Parameter	Station		RA-06-001		RA-06-014		RA-06-015		Northern Portion of RA 6 Statistics		
	Sample ID		RA-06-001-050629-G		RA-06-014-051215-G		RA-06-015-051215-G		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		6/29/2005	Enrichment	12/15/2005	Enrichment	12/15/2005	Enrichment			
	Sample Depth		0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio			
	Units	SQO									
Conventionals											
Total Organic Carbon	mg/kg	NA	31,600	NA	3.53	NA	3.12	NA	3.12	31,600	10,500
Total Solids	%	NA	56.32	NA	53.3	NA	55.9	NA	53.3	56.32	55.2
Metals											
Arsenic	mg/kg	57	4.28 J	0.08	13	0.23	11	0.19	4.28	13	9.4
Copper	mg/kg	390	68.9 J	0.18	79	0.20	73.2	0.19	68.9	79	74
Lead	mg/kg	450	72.5 J	0.16	71	0.16	64	0.14	64	72.5	69
Zinc	mg/kg	410	103 J	0.25	104	0.25	98	0.24	98	104	102
Mercury	mg/kg	0.59	0.241 J	0.41	0.34	0.58	0.32	0.54	0.241	0.34	0.30
Semi-volatile Organic Compounds											
LPAHs											
2-Methylnaphthalene	µg/kg	670	22.4	0.03	62	0.09	58	0.09	22.4	62	47.47
Acenaphthene	µg/kg	500	18.5	0.04	62	0.12	69	0.14	18.5	69	49.83
Acenaphthylene	µg/kg	1,300	49.6	0.04	100	0.08	92	0.07	49.6	100	80.5
Anthracene	µg/kg	960	84.4 J	0.09	210	0.22	200	0.21	84.4	210	165
Fluorene	µg/kg	540	23.3	0.04	63	0.12	66	0.12	23.3	66	50.77
Naphthalene	µg/kg	2,100	38.6	0.02	130	0.06	120	0.06	38.6	130	96.2
Phenanthrene	µg/kg	1,500	144 J	0.10	350	0.23	360	0.24	144	360	285
Total LPAH	µg/kg	5,200	381 J	0.07	977	0.19	965	0.19	381	977	774
HPAHs											
Benzo(a)anthracene	µg/kg	1,600	163 J	0.10	390	0.24	390	0.24	163	390	314
Benzo(a)pyrene	µg/kg	1,600	171 J	0.11	530	0.33	500	0.31	171	530	400
Benzofluoranthenes (total)	µg/kg	3,600	196	0.05	1,250	0.35	1,130	0.31	196	1,250	859
Benzo(g,h,i)perylene	µg/kg	720	107 J	0.15	240	0.33	220	0.31	107	240	189
Chrysene	µg/kg	2,800	191 J	0.07	530	0.19	480	0.17	191	530	400
Dibenzo(a,h)anthracene	µg/kg	230	58.7	0.26	52	0.23	50	0.22	50	58.7	54
Fluoranthene	µg/kg	2,500	283 J	0.11	710	0.28	670	0.27	283	710	554
Indeno(1,2,3-cd)pyrene	µg/kg	690	76.9 J	0.11	210	0.30	190	0.28	76.9	210	159
Pyrene	µg/kg	3,300	362 J	0.11	950	0.29	910	0.28	362	950	741
Total HPAH	µg/kg	17,000	1,609 J	0.09	4,862	0.29	4,540	0.27	1,609	4,862	3,670
Other Semi-volatile Organic Compounds											
Dimethyl phthalate	µg/kg	160	5.94 J	0.04	20 U	NA	20 U	NA	5.94	5.94	5.94
Diethylphthalate	µg/kg	200	17.5 U	NA	20 U	NA	20 U	NA	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	17.5 U	NA	71 B	NA	59 JB	0.04	59	71	65
Butyl benzyl phthalate	µg/kg	900	74.3	0.08	400	0.44	400	0.44	74.3	400	291
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	131 J	0.10	1,100 B	0.85	1,300 B	1.00	131	1,300	844
Di-n-octyl phthalate	µg/kg	6,200	34.9 U	NA	29	0.00	20 U	NA	29	29	29
Phenol	µg/kg	420	12.6	0.03	20 U	NA	20 U	NA	12.6	12.6	12.6
2-Methylphenol	µg/kg	63	8.73 U	NA	20 U	NA	20 U	NA	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	11.6	0.02	20	0.03	16 J	0.02	11.6	20	16
2,4-Dimethylphenol	µg/kg	29	3.49 U	NA	20 U	NA	20 U	NA	NA	NA	NA

Parameter	Station		RA-06-001		RA-06-014		RA-06-015		Northern Portion of RA 6 Statistics		
	Sample ID		RA-06-001-050629-G		RA-06-014-051215-G		RA-06-015-051215-G		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		6/29/2005	Enrichment	12/15/2005	Enrichment	12/15/2005	Enrichment			
	Sample Depth		0-10 cm	Ratio	0-10 cm	Ratio	0-10 cm	Ratio			
	Units	SQO									
Pentachlorophenol	µg/kg	360	17.5 U	NA	98 U	NA	97 U	NA	NA	NA	NA
Benzyl alcohol	µg/kg	73	8.73 U	NA	20 UJ	NA	20 U	NA	NA	NA	NA
Benzoic acid	µg/kg	650	105 UJ	NA	53 J	0.08	47 J	0.07	47	53	50
1,2-Dichlorobenzene	µg/kg	50	8.73 UJ	NA	20 UJ	NA	20 UJ	NA	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	8.73 UJ	NA	20 U	NA	20 U	NA	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	8.73 UJ	NA	20 U	NA	20 U	NA	NA	NA	NA
1,2,4-Trichlorobenzene	µg/kg	51	8.73 U	NA	20 U	NA	20 U	NA	NA	NA	NA
Hexachlorobenzene	µg/kg	22	3.86 U	NA	0.99 U	NA	0.99 U	NA	NA	NA	NA
Dibenzofuran	µg/kg	540	10.3	0.02	49	0.09	53	0.10	10.3	53	37.4
Hexachlorobutadiene	µg/kg	11	1.93 U	NA	0.99 U	NA	0.99 U	NA	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	3.49 U	NA	20 U	NA	20 U	NA	NA	NA	NA
Pesticides											
p,p'-DDD	µg/kg	16	3.93	0.25	5.1	0.32	4.6	0.29	3.93	5	4.5
p,p'-DDE	µg/kg	9	1.86 J	0.21	2 U	NA	2 U	NA	1.86	1.86	1.86
p,p'-DDT	µg/kg	34	7.47	0.22	7.8 U	NA	6.5 U	NA	7.47	7.47	7.47
Polychlorinated Biphenyls (PCBs)											
PCB-1016	µg/kg	NA	19.3 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1221	µg/kg	NA	19.3 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1232	µg/kg	NA	19.3 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1242	µg/kg	NA	19.3 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1248	µg/kg	NA	19.3 U	NA	24 J	NA	19 J	NA	19	24	22
PCB-1254	µg/kg	NA	19.3 U	NA	83	NA	68	NA	68	83	76
PCB-1260	µg/kg	NA	96.2	NA	78	NA	54	NA	54	96.2	66
PCBs (total)	µg/kg	300	96.2	0.32	185 J	0.62	141 J	0.47	96.2	185	141

Notes:

SQO Sediment Quality Objective.

NA Not Available.

LPAH Low molecular weight polycyclic aromatic hydrocarbons.

HPAH High molecular weight polycyclic aromatic hydrocarbons.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.

B The analyte was detected in the associated method blank.

J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

UJ The analyte was not detected at or above the estimated numerical value.

Table 2-19
Summary of Baseline Natural Recovery and Enhanced Natural Recovery Sample Results for RA 7

Parameter	Station		RA-07-001		NR-16		RA 7 Statistics		
	Sample ID		RA-07-001-050629-G		NR-16-Y0-D		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		6/29/2005	Enrichment	10/23/2006	Enrichment			
	Sample Depth		0-10 cm	Ratio	0-10 cm	Ratio			
	Units	SQO							
Conventionals									
Total Organic Carbon	mg/kg	NA	24,700	NA	21,600	NA	21,600	24,700	23,150
Total Solids	%	NA	50.35	NA	83.7	NA	50.35	83.7	67.0
Metals									
Antimony	mg/kg	150	NA	NA	0.76 U	NA	NA	NA	NA
Arsenic	mg/kg	57	5.8 J	0.10	3.33	0.06	3.33	5.8	4.6
Cadmium	mg/kg	5.1	NA	NA	0.238	0.05	0.238	0.238	0.238
Copper	mg/kg	390	81.7 J	0.21	20.9 J	0.05	21	82	51
Lead	mg/kg	450	76.9 J	0.17	7.95	0.02	7.95	76.9	42.4
Nickel	mg/kg	140	NA	NA	13.3	0.10	13.3	13.3	13.3
Silver	mg/kg	6.1	NA	NA	0.21 U	NA	NA	NA	NA
Zinc	mg/kg	410	136 J	0.33	35.3	0.09	35.3	136	86
Mercury	mg/kg	0.59	0.181 J	0.31	0.029 U	NA	0.181	0.181	0.181
Semi-volatile Organic Compounds									
LPAHs									
2-Methylnaphthalene	µg/kg	670	17	0.03	99 U	NA	17	17	17
Acenaphthene	µg/kg	500	33.4	0.07	99 U	NA	33.4	33.4	33.4
Acenaphthylene	µg/kg	1,300	91	0.07	99 U	NA	91	91	91
Anthracene	µg/kg	960	213 J	0.22	99 U	NA	213	213	213
Fluorene	µg/kg	540	37.5	0.07	99 U	NA	37.5	37.5	37.5
Naphthalene	µg/kg	2,100	28	0.01	99 U	NA	28	28	28
Phenanthrene	µg/kg	1,500	294 J	0.20	99 U	NA	294	294	294
Total LPAH	µg/kg	5,200	714 J	0.14	350 U	NA	714	714	714
HPAHs									
Benzo(a)anthracene	µg/kg	1,600	364 J	0.23	99 U	NA	364	364	364
Benzo(a)pyrene	µg/kg	1,600	365 J	0.23	99 U	NA	365	365	365
Benzofluoranthenes (total)	µg/kg	3,600	362	0.10	99	0.03	99	362	231
Benzo(g,h,i)perylene	µg/kg	720	165 J	0.23	99 U	NA	165	165	165
Chrysene	µg/kg	2,800	430 J	0.15	99 U	NA	430	430	430
Dibenzo(a,h)anthracene	µg/kg	230	60.4	0.26	99 U	NA	60.4	60.4	60.4
Fluoranthene	µg/kg	2,500	601 J	0.24	99 U	NA	601	601	601
Indeno(1,2,3-cd)pyrene	µg/kg	690	131	0.19	99 U	NA	131	131	131
Pyrene	µg/kg	3,300	851 J	0.26	99 U	NA	851	851	851
Total HPAH	µg/kg	17,000	3,329 J	0.20	450 U	NA	3,329	3,329	3,329
Other Semi-volatile Organic Compounds									
Dimethyl phthalate	µg/kg	160	6.22 J	0.04	1.2	0.01	1.2	6.22	3.7
Diethylphthalate	µg/kg	200	18.2 U	NA	99 U	NA	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	26.9 JB	0.02	99 U	NA	26.9	26.9	26.9
Butyl benzyl phthalate	µg/kg	900	102	0.11	99 U	NA	102	102	102

Parameter	Station		RA-07-001		NR-16		RA 7 Statistics		
	Sample ID		RA-07-001-050629-G		NR-16-Y0-D		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		6/29/2005	Enrichment	10/23/2006	Enrichment			
	Sample Depth		0-10 cm	Ratio	0-10 cm	Ratio			
	Units	SQO							
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	181 J	0.14	230	0.18	181	230	206
Di-n-octyl phthalate	µg/kg	6,200	36.4 U	NA	99 U	NA	NA	NA	NA
Phenol	µg/kg	420	113	0.27	99 U	NA	113	113	113
2-Methylphenol	µg/kg	63	9.11 U	NA	1 UJ	NA	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	8.45 J	0.01	99 U	NA	8.45	8.45	8.45
2,4-Dimethylphenol	µg/kg	29	3.64 U	NA	1 UJ	NA	NA	NA	NA
Pentachlorophenol	µg/kg	360	18.2 U	NA	1 U	NA	NA	NA	NA
Benzyl alcohol	µg/kg	73	9.11 U	NA	20 U	NA	NA	NA	NA
Benzoic acid	µg/kg	650	109 UJ	NA	48 UJ	NA	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	9.11 UJ	NA	1 U	NA	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	9.11 UJ	NA	1 U	NA	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	9.11 UJ	NA	1.2	0.01	1.2	1.2	1.2
1,2,4-Trichlorobenzene	µg/kg	51	9.11 U	NA	1 U	NA	NA	NA	NA
Hexachlorobenzene	µg/kg	22	4.1 U	NA	1 U	NA	NA	NA	NA
Dibenzofuran	µg/kg	540	17.2	0.03	99 U	NA	17.2	17.2	17.2
Hexachlorobutadiene	µg/kg	11	2.05 U	NA	1 U	NA	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	3.64 U	NA	2	0.07	2	2	2
Pesticides									
p,p'-DDD	µg/kg	16	1.82 J	0.11	1 U	NA	1.82	1.82	1.82
p,p'-DDE	µg/kg	9	2.1 J	0.23	1 U	NA	2.1	2.1	2.1
p,p'-DDT	µg/kg	34	3.52 J	0.10	1 U	NA	3.52	3.52	3.52
Polychlorinated Biphenyls (PCBs)									
PCB-1016	µg/kg	NA	20.5 U	NA	20 U	NA	NA	NA	NA
PCB-1221	µg/kg	NA	20.5 U	NA	20 U	NA	NA	NA	NA
PCB-1232	µg/kg	NA	20.5 U	NA	20 U	NA	NA	NA	NA
PCB-1242	µg/kg	NA	20.5 U	NA	20 U	NA	NA	NA	NA
PCB-1248	µg/kg	NA	20.5 U	NA	20 U	NA	NA	NA	NA
PCB-1254	µg/kg	NA	20.5 U	NA	20 U	NA	NA	NA	NA
PCB-1260	µg/kg	NA	47.1	NA	20 U	NA	47.1	47.1	47.1
PCBs (total)	µg/kg	300	47.1	0.16	20 U	NA	47.1	47.1	47.1

Notes:

SQO Sediment Quality Objective.
NA Not Available.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-20
Summary of Baseline Natural Recovery Sample Results for the Area at the Mouth of the Wheeler-Osgood Waterway

Parameter	Station		NR-17	
	Sample ID		NR-17-Y0-D	
	Sample Date		10/23/2006	Enrichment
	Sample Depth		0 to 10 cm	Ratio
	Units	SQO		
Conventionals				
Total Organic Carbon	mg/kg	NA	46,600	NA
Total Solids	%	NA	62.8	NA
Metals				
Antimony	mg/kg	150	0.8 U	NA
Arsenic	mg/kg	57	4.75	0.08
Cadmium	mg/kg	5.1	0.554	0.11
Copper	mg/kg	390	62 J	0.16
Lead	mg/kg	450	26.7	0.06
Nickel	mg/kg	140	9.41	0.07
Silver	mg/kg	6.1	0.22 U	NA
Zinc	mg/kg	410	65.6	0.16
Mercury	mg/kg	0.59	0.032 U	NA
Semi-volatile Organic Compounds				
LPAHs				
2-Methylnaphthalene	µg/kg	670	410	0.61
Acenaphthene	µg/kg	500	99 U	NA
Acenaphthylene	µg/kg	1,300	99 U	NA
Anthracene	µg/kg	960	520	0.54
Fluorene	µg/kg	540	300	0.56
Naphthalene	µg/kg	2,100	420	0.20
Phenanthrene	µg/kg	1,500	1,300	0.87
Total LPAH	µg/kg	5,200	3,000	0.58
HPAHs				
Benzo(a)anthracene	µg/kg	1,600	440	0.28
Benzo(a)pyrene	µg/kg	1,600	380	0.24
Benzofluoranthenes (total)	µg/kg	3,600	630	0.18
Benzo(g,h,i)perylene	µg/kg	720	200	0.28
Chrysene	µg/kg	2,800	580	0.21
Dibenzo(a,h)anthracene	µg/kg	230	99 U	NA
Fluoranthene	µg/kg	2,500	1,000	0.40
Indeno(1,2,3-cd)pyrene	µg/kg	690	160	0.23
Pyrene	µg/kg	3,300	**4,100**	1.24
Total HPAH	µg/kg	17,000	7,500	0.44
Other Semi-volatile Organic Compounds				
Dimethyl phthalate	µg/kg	160	4 U	NA
Diethylphthalate	µg/kg	200	99 U	NA
Di-n-butyl phthalate	µg/kg	1,400	99 U	NA
Butyl benzyl phthalate	µg/kg	900	99 U	NA
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	330	0.25
Di-n-octyl phthalate	µg/kg	6,200	99 U	NA

Parameter	Station		NR-17	
	Sample ID		NR-17-Y0-D	
	Sample Date		10/23/2006	Enrichment
	Sample Depth		0 to 10 cm	Ratio
	Units	SQO		
Phenol	µg/kg	420	99 U	NA
2-Methylphenol	µg/kg	63	4 UJ	NA
3- & 4-Methylphenol	µg/kg	670	99 U	NA
2,4-Dimethylphenol	µg/kg	29	21 J	0.72
Pentachlorophenol	µg/kg	360	4 U	NA
Benzyl alcohol	µg/kg	73	42 U	NA
Benzoic acid	µg/kg	650	190 UJ	NA
1,2-Dichlorobenzene	µg/kg	50	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	4 U	NA
1,4-Dichlorobenzene	µg/kg	110	6.3	0.06
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA
Dibenzofuran	µg/kg	540	130	0.24
Hexachlorobutadiene	µg/kg	11	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	18	0.64
Pesticides				
4,4'-DDD	µg/kg	16	4 U	NA
4,4'-DDE	µg/kg	9	4 U	NA
4,4'-DDT	µg/kg	34	4 U	NA
Polychlorinated Biphenyls (PCBs)				
PCB-1016	µg/kg	NA	20 U	NA
PCB-1221	µg/kg	NA	20 U	NA
PCB-1232	µg/kg	NA	20 U	NA
PCB-1242	µg/kg	NA	20 U	NA
PCB-1248	µg/kg	NA	20 U	NA
PCB-1254	µg/kg	NA	20 U	NA
PCB-1260	µg/kg	NA	20 U	NA
PCBs (total)	µg/kg	300	20 U	NA

Notes:

SQO Sediment Quality Objective.

NA Not Available.

LPAH Low molecular weight polycyclic aromatic hydrocarbons.

HPAH High molecular weight polycyclic aromatic hydrocarbons.

If sample concentration is highlighted in red, concentration exceeds the SQO.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.

B The analyte was detected in the associated method blank.

J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.

UJ The analyte was not detected at or above the estimated numerical value.

Table 2-21
Summary of Baseline Natural Recovery Sample Results for the Shoreline of the Wheeler-Osgood Waterway

Parameter	Station		SR-10		SR-11				SR-13		Shoreline of the Wheeler-Osgood Waterway Statistics		
	Sample ID		SR-10-Y0-D		SR-11-Y0-D		SR-11-Y0-D4[1]		SR-13-Y0-D		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/25/2006	Enrichment	10/25/2006	Enrichment	10/25/2006	Enrichment	10/25/2006	Enrichment			
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio			
	Units	SQO											
Conventionals													
Total Organic Carbon	mg/kg	NA	10,600	NA	3,590	NA	3,820	NA	6,040	NA	3,590	10,600	6,013
Total Solids	%	NA	79.2	NA	76.4	NA	76.3	NA	78.7	NA	76.3	79.2	77.7
Metals													
Antimony	mg/kg	150	6 U	NA	6 U	NA	0.79 U	NA	0.79 U	NA	NA	NA	NA
Arsenic	mg/kg	57	5.81	0.10	4.23	0.07	4.29	0.08	3.93	0.07	3.93	5.81	5
Cadmium	mg/kg	5.1	0.249	0.05	0.251	0.05	0.251	0.05	0.285	0.06	0.249	0.285	0.26
Copper	mg/kg	390	31 J	0.08	25.4 J	0.07	18.3 J	0.05	27.8 J	0.07	18.3	31	26
Lead	mg/kg	450	52	0.12	18.5	0.04	13.4	0.03	14.9	0.03	13.4	52	25
Nickel	mg/kg	140	13.3	0.10	10.8	0.08	9.91	0.07	16.4	0.12	9.91	16.4	12.6
Silver	mg/kg	6.1	0.21 U	NA	0.21 U	NA	0.22 U	NA	0.22 U	NA	NA	NA	NA
Zinc	mg/kg	410	77.6	0.19	56	0.14	52	0.13	58.1	0.14	52	77.6	61
Mercury	mg/kg	0.59	0.056	0.09	0.016 U	NA	0.014 U	NA	0.052	0.09	0.052	0.056	0.054
Semi-volatile Organic Compounds													
LPAHs													
2-Methylnaphthalene	µg/kg	670	99 U	NA	84 U	NA	100 U	NA	96 U	NA	NA	NA	NA
Acenaphthene	µg/kg	500	99 U	NA	84 U	NA	100 U	NA	96 U	NA	NA	NA	NA
Acenaphthylene	µg/kg	1,300	99 U	NA	84 U	NA	100 U	NA	96 U	NA	NA	NA	NA
Anthracene	µg/kg	960	140	0.15	84 U	NA	100 U	NA	96 U	NA	140	140	140
Fluorene	µg/kg	540	99 U	NA	84 U	NA	100 U	NA	96 U	NA	NA	NA	NA
Naphthalene	µg/kg	2,100	130	0.06	84 U	NA	100 U	NA	96 U	NA	130	130	130
Phenanthrene	µg/kg	1,500	480	0.32	84 U	NA	100 U	NA	96 U	NA	480	480	480
Total LPAH	µg/kg	5,200	950	0.18	290 U	NA	350 U	NA	340 U	NA	950	950	950
HPAHs													
Benzo(a)anthracene	µg/kg	1,600	390	0.24	84 U	NA	100 U	NA	96 U	NA	390	390	390
Benzo(a)pyrene	µg/kg	1,600	340	0.21	84 U	NA	100 U	NA	96 U	NA	340	340	340
Benzofluoranthenes (total)	µg/kg	3,600	650	0.18	100	0.03	140	0.04	180	0.05	100	650	268
Benzo(g,h,i)perylene	µg/kg	720	170	0.24	84 U	NA	100 U	NA	96 U	NA	170	170	170
Chrysene	µg/kg	2,800	520	0.19	84 U	NA	100 U	NA	130	0.05	130	520	325
Dibenzo(a,h)anthracene	µg/kg	230	99 U	NA	84 U	NA	100 U	NA	96 U	NA	NA	NA	NA
Fluoranthene	µg/kg	2,500	740	0.30	84 U	NA	100 U	NA	150	0.06	150	740	445
Indeno(1,2,3-cd)pyrene	µg/kg	690	140	0.20	84 U	NA	100 U	NA	96 U	NA	140	140	140
Pyrene	µg/kg	3,300	1,500	0.45	130	0.04	140	0.04	200	0.06	130	1,500	493
Total HPAH	µg/kg	17,000	4,400	0.26	524	0.03	630	0.04	900	0.05	524	4,400	1,614
Other Semi-volatile Organic Compounds													
Dimethyl phthalate	µg/kg	160	4 U	NA	1.5	0.01	1	0.01	10	0.06	1	10	4
Diethylphthalate	µg/kg	200	99 U	NA	84 U	NA	100 U	NA	96 U	NA	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	99 U	NA	84 U	NA	100 U	NA	96 U	NA	NA	NA	NA
Butyl benzyl phthalate	µg/kg	900	99 U	NA	84 U	NA	100 U	NA	170	0.19	170	170	170
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	190	0.15	84 U	NA	100 U	NA	380	0.29	190	380	285
Di-n-octyl phthalate	µg/kg	6,200	99 U	NA	84 U	NA	100 U	NA	96 U	NA	NA	NA	NA
Phenol	µg/kg	420	99 U	NA	84 U	NA	100 UJ	NA	100 U	NA	NA	NA	NA
2-Methylphenol	µg/kg	63	4 UJ	NA	1 UJ	NA	1 UJ	NA	4 UJ	NA	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	99 U	NA	84 U	NA	100 UJ	NA	96 U	NA	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	4 UJ	NA	1 UJ	NA	1 UJ	NA	4 UJ	NA	NA	NA	NA
Pentachlorophenol	µg/kg	360	4 U	NA	1 UJ	NA	1 UJ	NA	4 U	NA	NA	NA	NA
Benzyl alcohol	µg/kg	73	55 U	NA	27 UJ	NA	33 UJ	NA	51 U	NA	NA	NA	NA

Parameter	Station		SR-10		SR-11				SR-13		Shoreline of the Wheeler-Osgood Waterway Statistics		
	Sample ID		SR-10-Y0-D		SR-11-Y0-D		SR-11-Y0-D4[1]		SR-13-Y0-D		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/25/2006	Enrichment	10/25/2006	Enrichment	10/25/2006	Enrichment	10/25/2006	Enrichment			
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio			
	Units	SQO											
Benzoic acid	µg/kg	650	170 UJ	NA	51 UJ	NA	51 UJ	NA	150 UJ	NA	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	1 U	NA	1 U	NA	4 U	NA	NA	NA	NA
1,3-Dichlorobenzene	µg/kg	170	4 U	NA	1 U	NA	1 U	NA	4 U	NA	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	4 U	NA	1.3	0.01	1.1	0.01	4 U	NA	1.1	1.3	1.2
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	1 U	NA	1 U	NA	4 U	NA	NA	NA	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	1 U	NA	1 U	NA	4 U	NA	NA	NA	NA
Dibenzofuran	µg/kg	540	99 U	NA	84 U	NA	100 U	NA	96 U	NA	NA	NA	NA
Hexachlorobutadiene	µg/kg	11	4 U	NA	1 U	NA	1 U	NA	4 U	NA	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	14	0.50	3.1	0.11	3.3	0.12	6.8	0.24	3.1	14	6.8
Pesticides													
4,4'-DDD	µg/kg	16	4 U	NA	1 U	NA	1 U	NA	4 U	NA	NA	NA	NA
4,4'-DDE	µg/kg	9	4 U	NA	1 U	NA	1 U	NA	4 U	NA	NA	NA	NA
4,4'-DDT	µg/kg	34	4 U	NA	1 U	NA	1 U	NA	4 U	NA	NA	NA	NA
Polychlorinated Biphenyls (PCBs)													
PCB-1016	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1221	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1232	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1242	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1248	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1254	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1260	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCBs (total)	µg/kg	300	20 U	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA

Notes:

SQO Sediment Quality Objective.
NA Not Available.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.
1 Sample is a field duplicate of Sample SR-11-Y0-D.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-22
Summary of Baseline Natural Recovery Sample Results for the Head of the Wheeler-Osgood Waterway

Parameter	Station		NR-19		NR-20				Head of the Wheeler-Osgood Waterway Statistics		
	Sample ID		NR-19-Y0-D		NR-20-Y0-D		NR-20-Y0-D1[1]		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/23/2006	Enrichment	10/23/2006	Enrichment	10/23/2006	Enrichment			
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio			
	Units	SQO									
Conventionals											
Total Organic Carbon	mg/kg	NA	27,700	NA	36,900	NA	35,600	NA	27,700	36,900	33,400
Total Solids	%	NA	63.2	NA	56.5	NA	57.7	NA	56.5	63.2	59.1
Metals											
Antimony	mg/kg	150	6 U	NA	6 U	NA	6 U	NA	NA	NA	NA
Arsenic	mg/kg	57	6.23	0.11	9.62	0.17	10.6	0.19	6.23	10.6	8.8
Cadmium	mg/kg	5.1	0.529	0.10	0.952	0.19	0.994	0.19	0.529	0.994	0.825
Copper	mg/kg	390	49.6 J	0.13	87 J	0.22	88.8 J	0.23	49.6	88.8	75.1
Lead	mg/kg	450	41.5	0.09	67.4	0.15	75.7	0.17	41.5	75.7	61.5
Nickel	mg/kg	140	12.6	0.09	15.6	0.11	17.3	0.12	12.6	17.3	15.2
Silver	mg/kg	6.1	0.21 U	NA	0.22 U	NA	0.22 U	NA	NA	NA	NA
Zinc	mg/kg	410	84	0.20	167	0.41	178	0.43	84	178	143
Mercury	mg/kg	0.59	0.099	0.17	0.175	0.30	0.173	0.29	0.099	0.175	0.149
Semi-volatile Organic Compounds											
LPAHs											
2-Methylnaphthalene	µg/kg	670	400	0.60	500	0.75	360	0.54	360	500	420
Acenaphthene	µg/kg	500	140	0.28	**820**	1.64	100 U	NA	140	820	480
Acenaphthylene	µg/kg	1,300	260	0.20	100 U	NA	100 U	NA	260	260	260
Anthracene	µg/kg	960	420	0.44	**1,700**	1.77	250	0.26	250	1,700	790
Fluorene	µg/kg	540	100 U	NA	**1,100**	2.04	140	0.26	140	1,100	620
Naphthalene	µg/kg	2,100	510	0.24	360	0.17	330	0.16	330	510	400
Phenanthrene	µg/kg	1,500	950	0.63	**7,800**	5.20	640	0.43	640	7,800	3,130
Total LPAH	µg/kg	5,200	2,700	0.52	**12,000**	2.31	1,800	0.35	1,800	12,000	5,500
HPAHs											
Benzo(a)anthracene	µg/kg	1,600	**1900**	1.19	**2700**	1.69	780	0.49	780	2,700	1,793
Benzo(a)pyrene	µg/kg	1,600	920	0.58	1,500	0.94	540	0.34	540	1,500	987
Benzofluoranthenes (total)	µg/kg	3,600	1,600	0.44	3,400	0.94	1,300	0.36	1,300	3,400	2,100
Benzo(g,h,i)perylene	µg/kg	720	430	0.60	**870**	1.21	340	0.47	340	870	547
Chrysene	µg/kg	2,800	2,300	0.82	2,700	0.96	1,100	0.39	1,100	2,700	2,033
Dibenzo(a,h)anthracene	µg/kg	230	130	0.57	200	0.87	100	0.43	100	200	143
Fluoranthene	µg/kg	2,500	2,000	0.80	**3,900**	1.56	850	0.34	850	3,900	2,250
Indeno(1,2,3-cd)pyrene	µg/kg	690	360	0.52	670	0.97	260	0.38	260	670	430
Pyrene	µg/kg	3,300	**6,800**	2.06	**7,600**	2.30	2,000	0.61	2,000	7,600	5,467
Total HPAH	µg/kg	17,000	16,000	0.94	**24,000**	1.41	7,400	0.44	7,400	24,000	15,800
Other Semi-volatile Organic Compounds											
Dimethyl phthalate	µg/kg	160	9.6	0.06	27	0.17	47	0.29	9.6	47	28
Diethylphthalate	µg/kg	200	100 U	NA	100 U	NA	100 U	NA	NA	NA	NA
Di-n-butyl phthalate	µg/kg	1,400	100 U	NA	100 U	NA	100	0.07	100	100	100
Butyl benzyl phthalate	µg/kg	900	230	0.26	520	0.58	480	0.53	230	520	410

Parameter	Station		NR-19		NR-20				Head of the Wheeler-Osgood Waterway Statistics		
	Sample ID		NR-19-Y0-D		NR-20-Y0-D		NR-20-Y0-D1[1]		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/23/2006	Enrichment	10/23/2006	Enrichment	10/23/2006	Enrichment			
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio			
	Units	SQO									
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	720	0.55	**1,600**	1.23	**1,600**	1.23	720	1,600	1,307
Di-n-octyl phthalate	µg/kg	6,200	100 U	NA	100 U	NA	100 U	NA	NA	NA	NA
Phenol	µg/kg	420	100 UJ	NA	100 UJ	NA	100 J	0.24	100	100	100
2-Methylphenol	µg/kg	63	4 UJ	NA	4 UJ	NA	4 UJ	NA	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	100 UJ	NA	100 UJ	NA	100 U	NA	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	4 UJ	NA	4 UJ	NA	4 UJ	NA	NA	NA	NA
Pentachlorophenol	µg/kg	360	77 J	0.21	4 UJ	NA	4 UJ	NA	77	77	77
Benzyl alcohol	µg/kg	73	62 UJ	NA	**79 UJ**	NA	71 UJ	NA	NA	NA	NA
Benzoic acid	µg/kg	650	170 UJ	NA	170 UJ	NA	190 UJ	NA	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	6	0.12	**91**	1.82	**85**	1.70	6	91	61
1,3-Dichlorobenzene	µg/kg	170	4 U	NA	6	0.04	4.8	0.03	4.8	6	5.4
1,4-Dichlorobenzene	µg/kg	110	8.8	0.08	63	0.57	44	0.40	8.8	63	39
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	6.8	0.13	4.8	0.09	4.8	6.8	5.8
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	NA	NA	NA
Dibenzofuran	µg/kg	540	120	0.22	270	0.50	100 U	NA	120	270	195
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	**30**	1.07	4 U	NA	4 U	NA	30	30	30
Pesticides											
4,4'-DDD	µg/kg	16	4 U	NA	4 U	NA	4 U	NA	NA	NA	NA
4,4'-DDE	µg/kg	9	4 U	NA	4 U	NA	4 U	NA	NA	NA	NA
4,4'-DDT	µg/kg	34	4 U	NA	4 U	NA	4 U	NA	NA	NA	NA
Polychlorinated Biphenyls (PCBs)											
PCB-1016	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1221	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1232	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1242	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1248	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1254	µg/kg	NA	110 J	NA	350 J	NA	490 J	NA	110	490	317
PCB-1260	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	NA	NA	NA
PCBs (total)	µg/kg	300	110 J	0.37	**350** J	1.17	**490** J	1.63	110	490	317

Notes:

SQO Sediment Quality Objective.
NA Not Available.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.
If sample concentration is highlighted in red, concentration exceeds the SQO.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.

Table 2-23
Summary of Baseline Natural Recovery Sample Results for the Harbor Area Adjacent to RA 15 and RA 16

Parameter	Station		NR-25				Harbor Area Adjacent to RA 15 and RA 16 Statistics		
	Sample ID		NR-25-Y0-D		NR-25-Y0-D1[1]		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/24/2006	Enrichment	10/24/2006	Enrichment			
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio			
	Units	SQO							
Conventionals									
Total Organic Carbon	mg/kg	NA	90,300	NA	95,100	NA	90,300	95,100	92,700
Total Solids	%	NA	35.8	NA	36.5	NA	35.8	36.5	36.2
Metals									
Antimony	mg/kg	150	7.45	0.05	6 U	NA	7.45	7.45	7.45
Arsenic	mg/kg	57	31.4	0.55	22.8	0.40	22.8	31.4	27.1
Cadmium	mg/kg	5.1	2.36	0.46	1.96	0.38	1.96	2.36	2.16
Copper	mg/kg	390	173 J	0.44	136 J	0.35	136	173	155
Lead	mg/kg	450	130	0.29	108	0.24	108	130	119
Nickel	mg/kg	140	19.9	0.14	19.3	0.14	19.3	19.9	19.6
Silver	mg/kg	6.1	0.22 U	NA	0.22 U	NA	NA	NA	NA
Zinc	mg/kg	410	254	0.62	206	0.50	206	254	230
Mercury	mg/kg	0.59	**0.602**	1.02	**0.771**	1.31	0.602	0.771	0.687
Semi-volatile Organic Compounds									
LPAHs									
2-Methylnaphthalene	µg/kg	670	320	0.48	310	0.46	310	320	315
Acenaphthene	µg/kg	500	280	0.56	250	0.50	250	280	265
Acenaphthylene	µg/kg	1,300	170	0.13	130	0.10	130	170	150
Anthracene	µg/kg	960	720	0.75	640	0.67	640	720	680
Fluorene	µg/kg	540	350	0.65	320	0.59	320	350	335
Naphthalene	µg/kg	2,100	790	0.38	740	0.35	740	790	765
Phenanthrene	µg/kg	1,500	**1,800**	1.20	1,500	1.00	1,500	1,800	1,650
Total LPAH	µg/kg	5,200	4,500	0.87	3,900	0.75	3,900	4,500	4,200
HPAHs									
Benzo(a)anthracene	µg/kg	1,600	**1700**	1.06	**1700**	1.06	1,700	1,700	1,700
Benzo(a)pyrene	µg/kg	1,600	1,400	0.88	1,300	0.81	1,300	1,400	1,350
Benzofluoranthenes (total)	µg/kg	3,600	3,200	0.89	3,400	0.94	3,200	3,400	3,300
Benzo(g,h,i)perylene	µg/kg	720	**820**	1.14	640	0.89	640	820	730
Chrysene	µg/kg	2,800	2,400	0.86	2,100	0.75	2,100	2,400	2,250
Dibenzo(a,h)anthracene	µg/kg	230	180	0.78	140	0.61	140	180	160
Fluoranthene	µg/kg	2,500	2,500	1.00	**2,900**	1.16	2,500	2,900	2,700
Indeno(1,2,3-cd)pyrene	µg/kg	690	650	0.94	520	0.75	520	650	585
Pyrene	µg/kg	3,300	**6,900**	2.09	**7,100**	2.15	6,900	7,100	7,000
Total HPAH	µg/kg	17,000	**20,000**	1.18	**20,000**	1.18	20,000	20,000	20,000
Other Semi-volatile Organic Compounds									
Dimethyl phthalate	µg/kg	160	87	0.54	46	0.29	46	87	67
Diethylphthalate	µg/kg	200	100 U	NA	170	0.85	170	170	170
Di-n-butyl phthalate	µg/kg	1,400	100 U	NA	100 U	NA	NA	NA	NA
Butyl benzyl phthalate	µg/kg	900	**1,400**	1.56	**1,400**	1.56	1,400	1,400	1,400

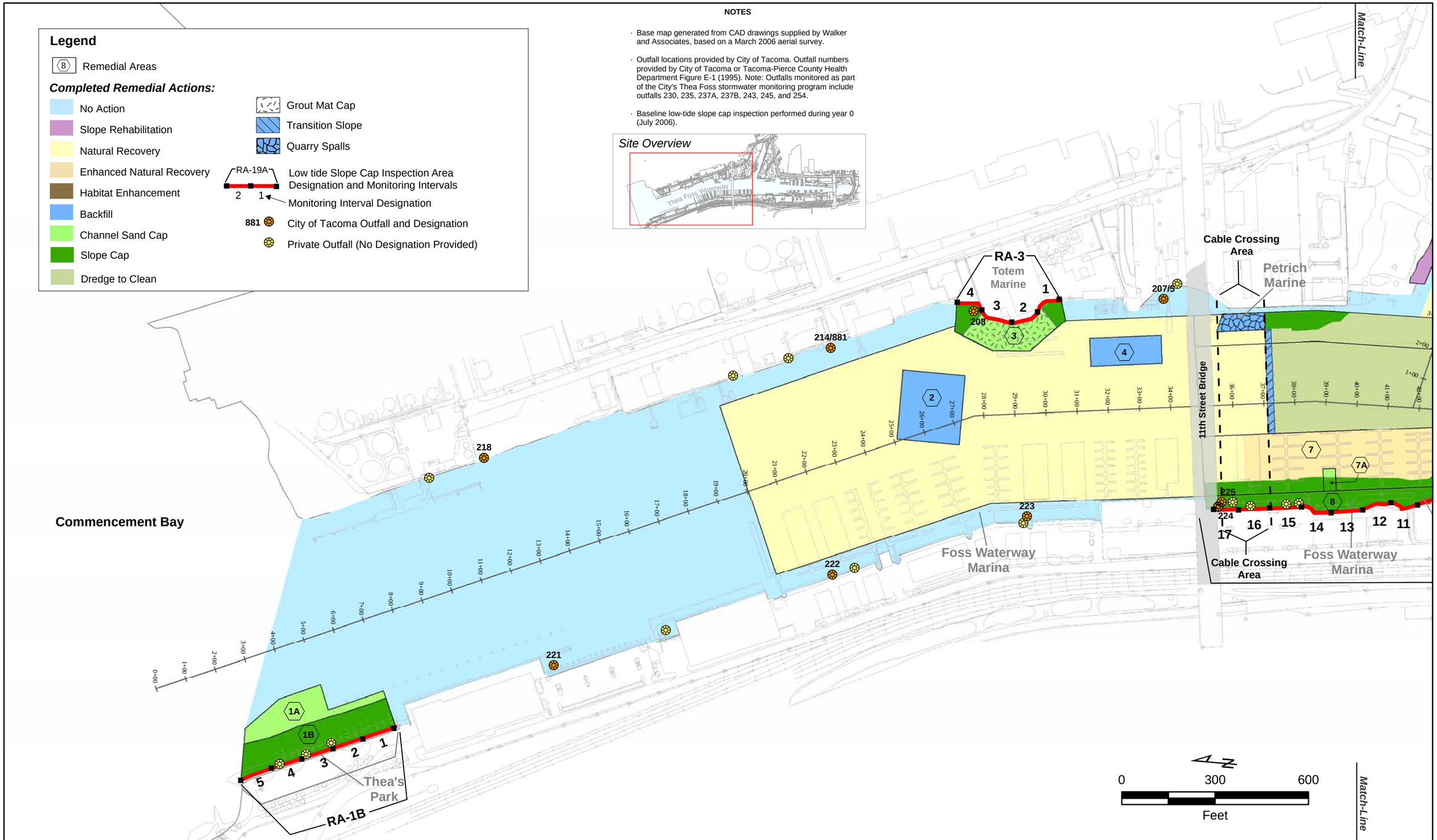
Parameter	Station		NR-25				Harbor Area Adjacent to RA 15 and RA 16 Statistics		
	Sample ID		NR-25-Y0-D		NR-25-Y0-D1[1]		Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration
	Sample Date		10/24/2006	Enrichment	10/24/2006	Enrichment			
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio			
	Units	SQO							
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	**3,600**	2.77	**2,700**	2.08	2,700	3,600	3,150
Di-n-octyl phthalate	µg/kg	6,200	100 U	NA	100 U	NA	NA	NA	NA
Phenol	µg/kg	420	100 U	NA	100 U	NA	NA	NA	NA
2-Methylphenol	µg/kg	63	4 UJ	NA	4 UJ	NA	NA	NA	NA
3- & 4-Methylphenol	µg/kg	670	100 U	NA	100 U	NA	NA	NA	NA
2,4-Dimethylphenol	µg/kg	29	4 UJ	NA	4 UJ	NA	NA	NA	NA
Pentachlorophenol	µg/kg	360	4 U	NA	4 U	NA	NA	NA	NA
Benzyl alcohol	µg/kg	73	4 U	NA	4 U	NA	NA	NA	NA
Benzoic acid	µg/kg	650	80 UJ	NA	80 UJ	NA	NA	NA	NA
1,2-Dichlorobenzene	µg/kg	50	7.6	0.15	6.4	0.13	6.4	7.6	7.0
1,3-Dichlorobenzene	µg/kg	170	4 U	NA	4 U	NA	NA	NA	NA
1,4-Dichlorobenzene	µg/kg	110	28	0.25	28	0.25	28	28	28
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	NA	NA	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	NA	NA	NA
Dibenzofuran	µg/kg	540	240	0.44	240	0.44	240	240	240
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	NA	NA	NA
N-Nitrosodiphenylamine	µg/kg	28	4 U	NA	4 U	NA	NA	NA	NA
Pesticides									
4,4'-DDD	µg/kg	16	4 U	NA	4 U	NA	NA	NA	NA
4,4'-DDE	µg/kg	9	4 U	NA	4 U	NA	NA	NA	NA
4,4'-DDT	µg/kg	34	4 U	NA	4 U	NA	NA	NA	NA
Polychlorinated Biphenyls (PCBs)									
PCB-1016	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1221	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1232	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1242	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1248	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCB-1254	µg/kg	NA	270 J	NA	290 J	NA	270	290	280
PCB-1260	µg/kg	NA	20 U	NA	20 U	NA	NA	NA	NA
PCBs (total)	µg/kg	300	270 J	0.90	290 J	0.97	270	290	280

Notes:

SQO Sediment Quality Objective.
NA Not Available.
LPAH Low molecular weight polycyclic aromatic hydrocarbons.
HPAH High molecular weight polycyclic aromatic hydrocarbons.
If sample concentration is highlighted in red, concentration exceeds the SQO.

Qualifiers:

U The analyte was not detected at or above the identified numerical value.
B The analyte was detected in the associated method blank.
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
UJ The analyte was not detected at or above the estimated numerical value.



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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 2-1 (Page 1 of 2)
Low Tide Slope Cap Inspection Monitoring Intervals

DATE: 2/20/2007 10:40:50 AM
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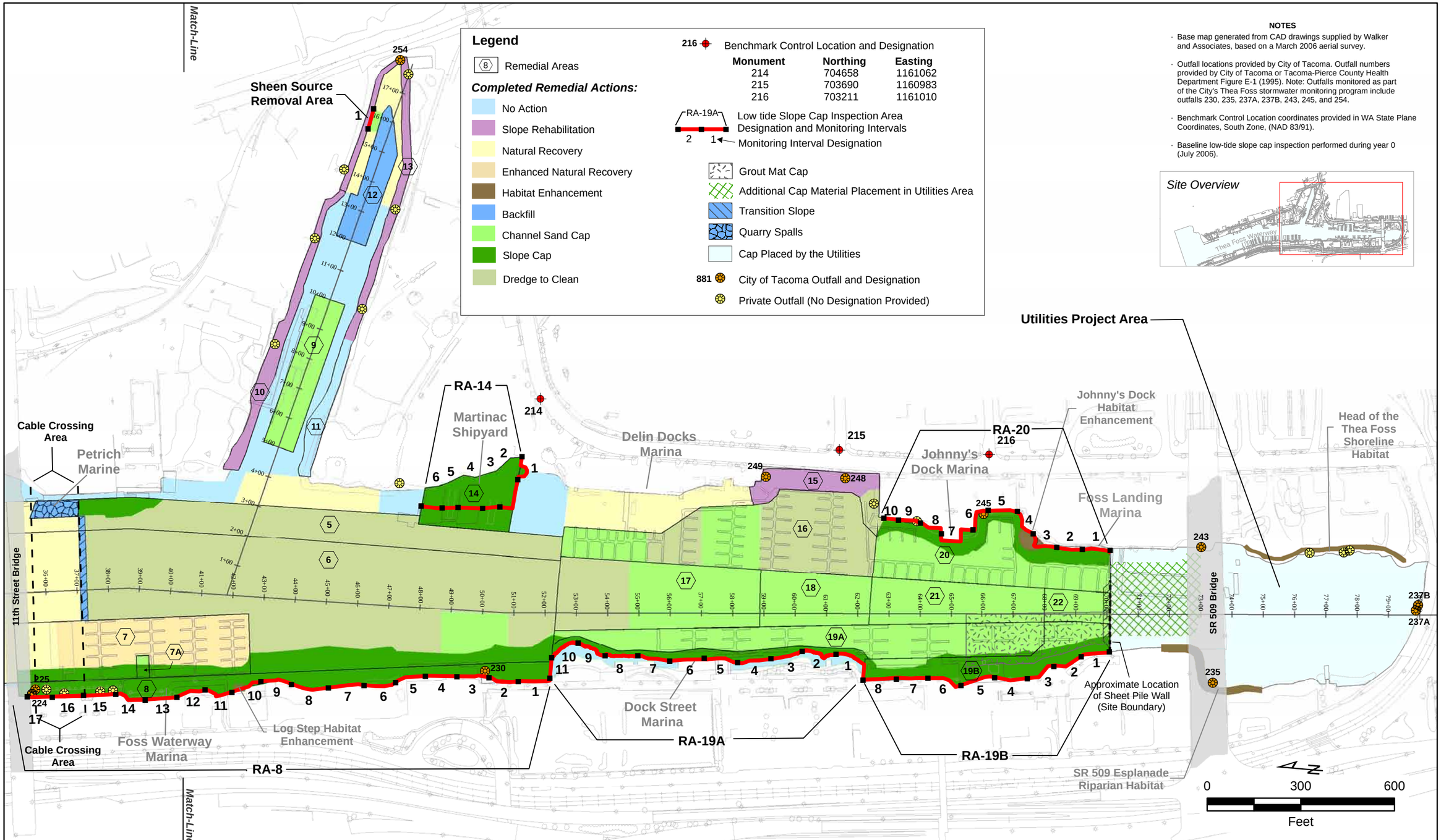

NOTES

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995). Note: Outfalls monitored as part of the City's Thea Foss stormwater monitoring program include outfalls 230, 235, 237A, 237B, 243, 245, and 254.
- Benchmark Control Location coordinates provided in WA State Plane Coordinates, South Zone, (NAD 83/91).
- Baseline low-tide slope cap inspection performed during year 0 (July 2006).

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Figure 2-1 (Page 2 of 2)
Low Tide Slope Cap Inspection Monitoring Intervals

DATE: 2/20/2007 10:35:38 AM
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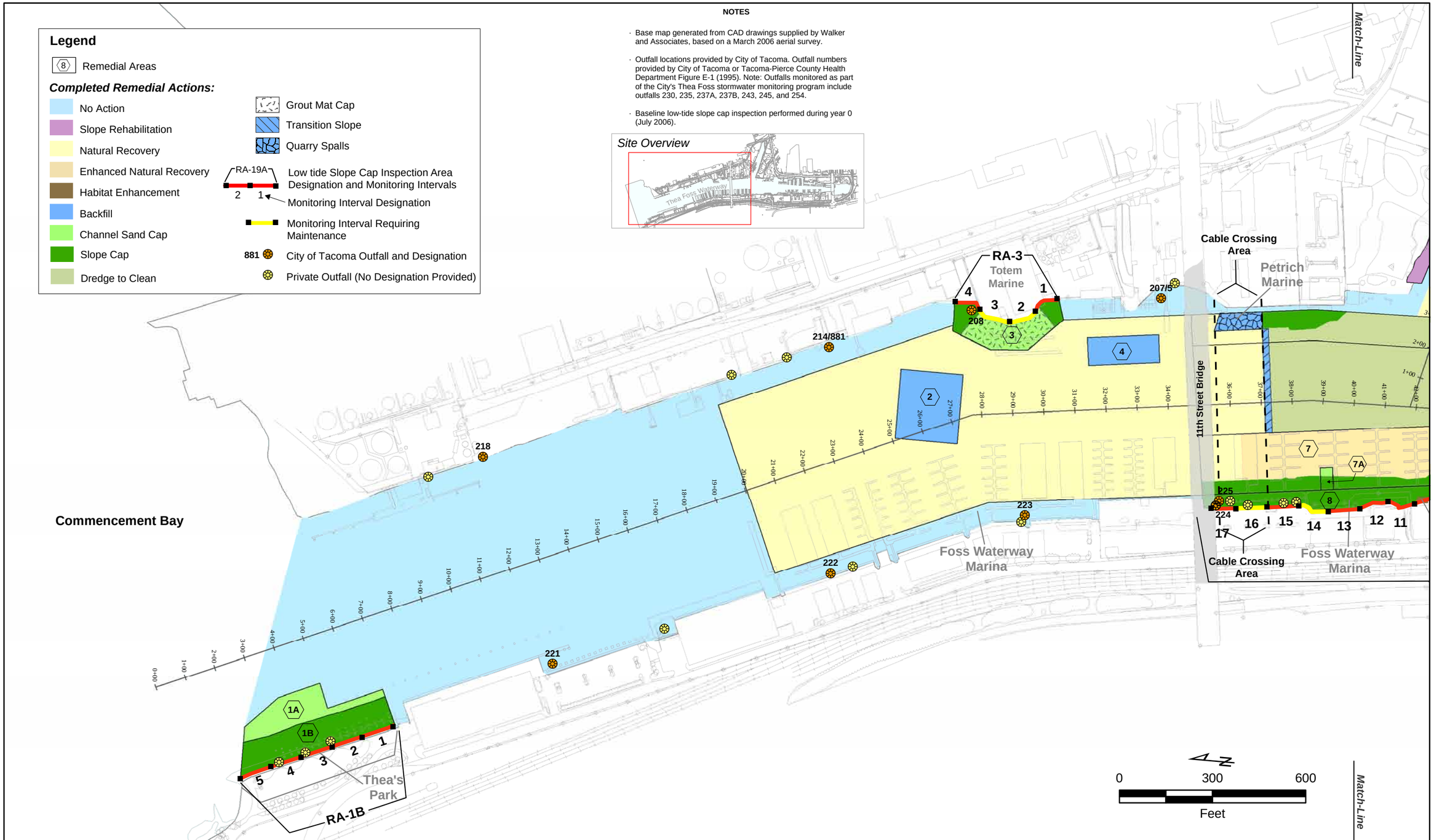

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Figure 2-2 (Page 1 of 2)
Slope Areas Requiring Maintenance

DATE: 2/20/2007 10:44:15 AM
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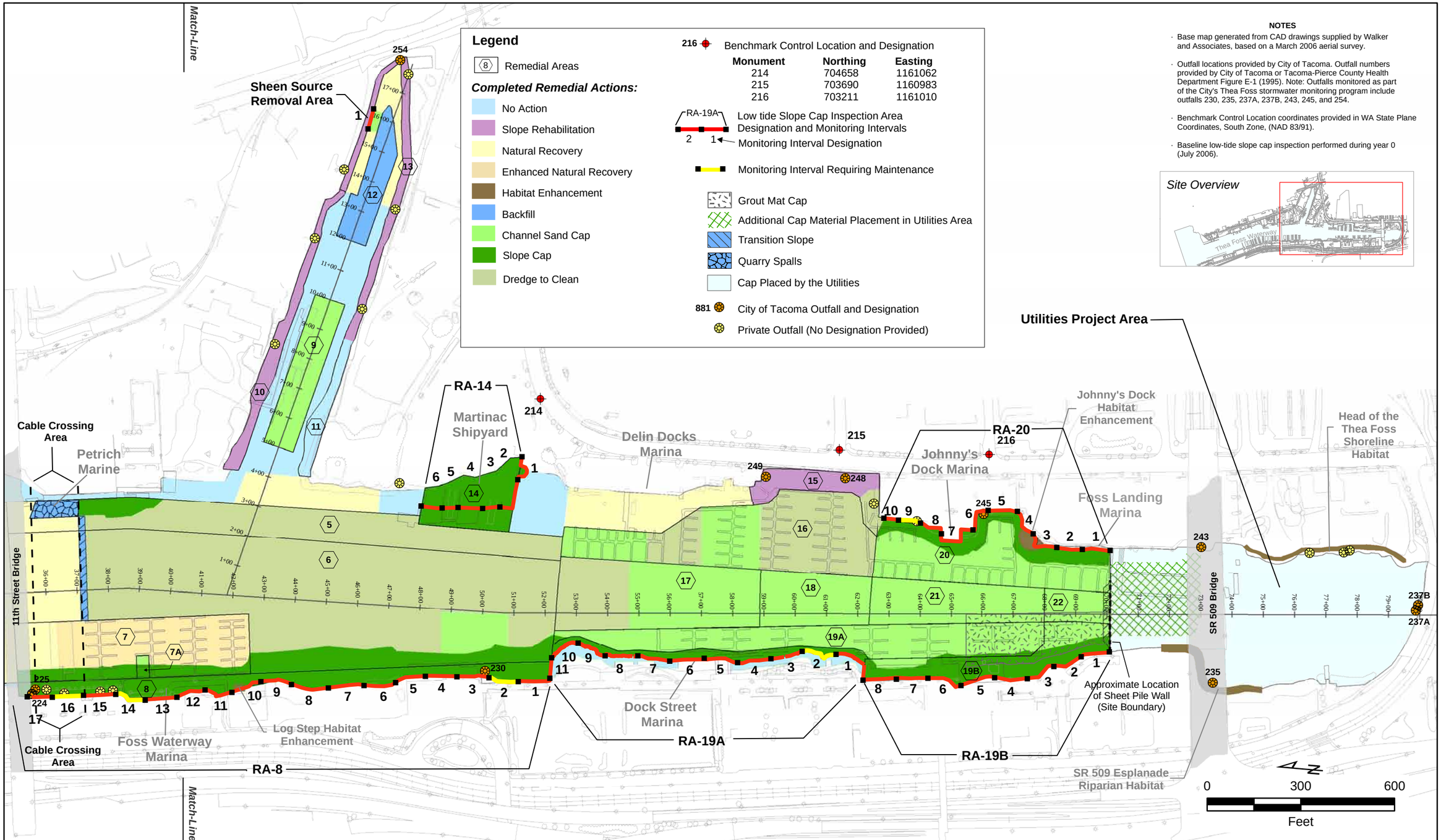

NOTES

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Figure 2-2 (Page 2 of 2)
Slope Areas Requiring Maintenance

DATE: 2/20/2007 10:47:24 AM
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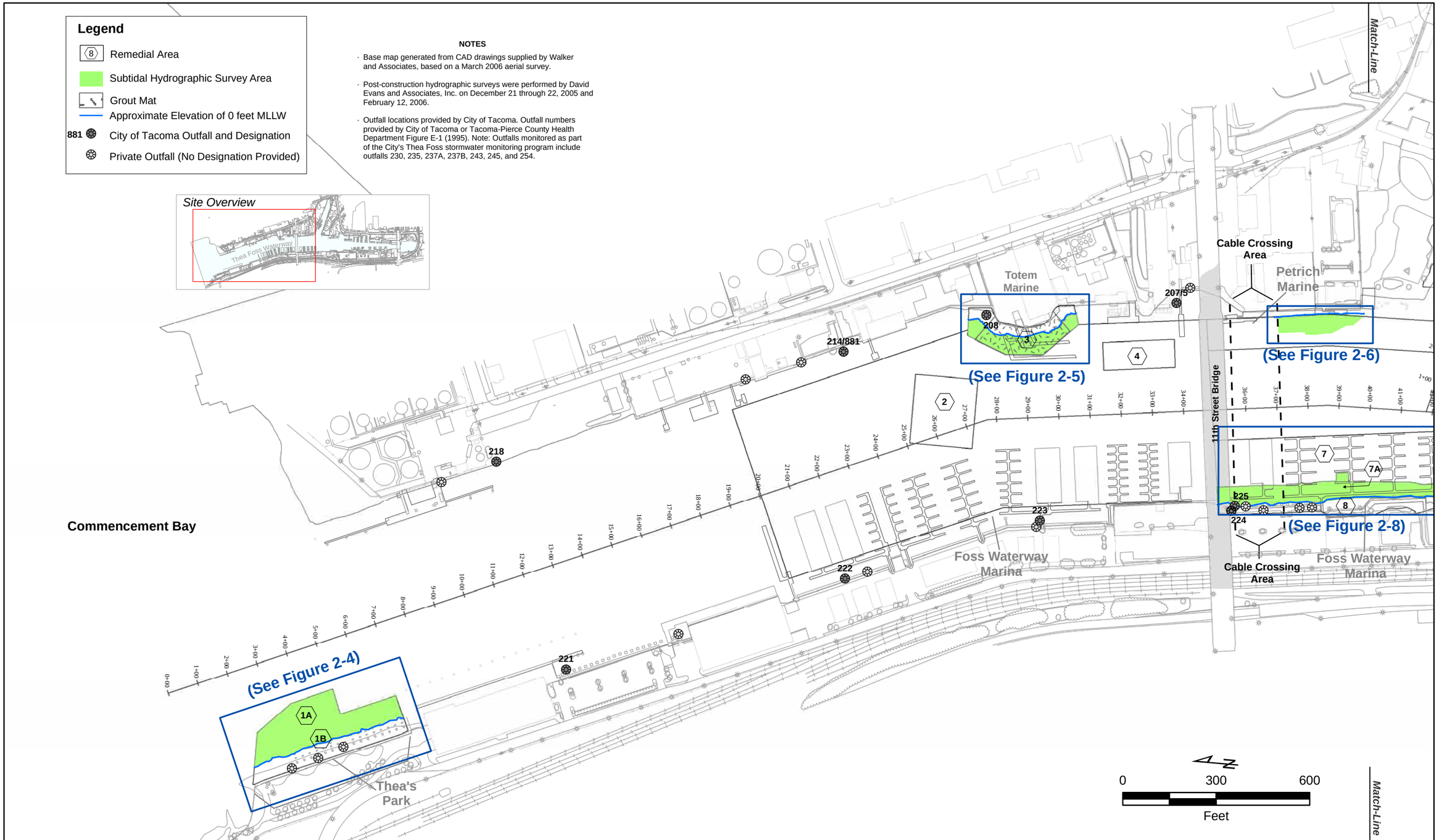

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Figure 2-3 (Page 1 of 2)
Subtidal Hydrographic Survey Areas

DATE: 9/25/2006 11:34:20 AM
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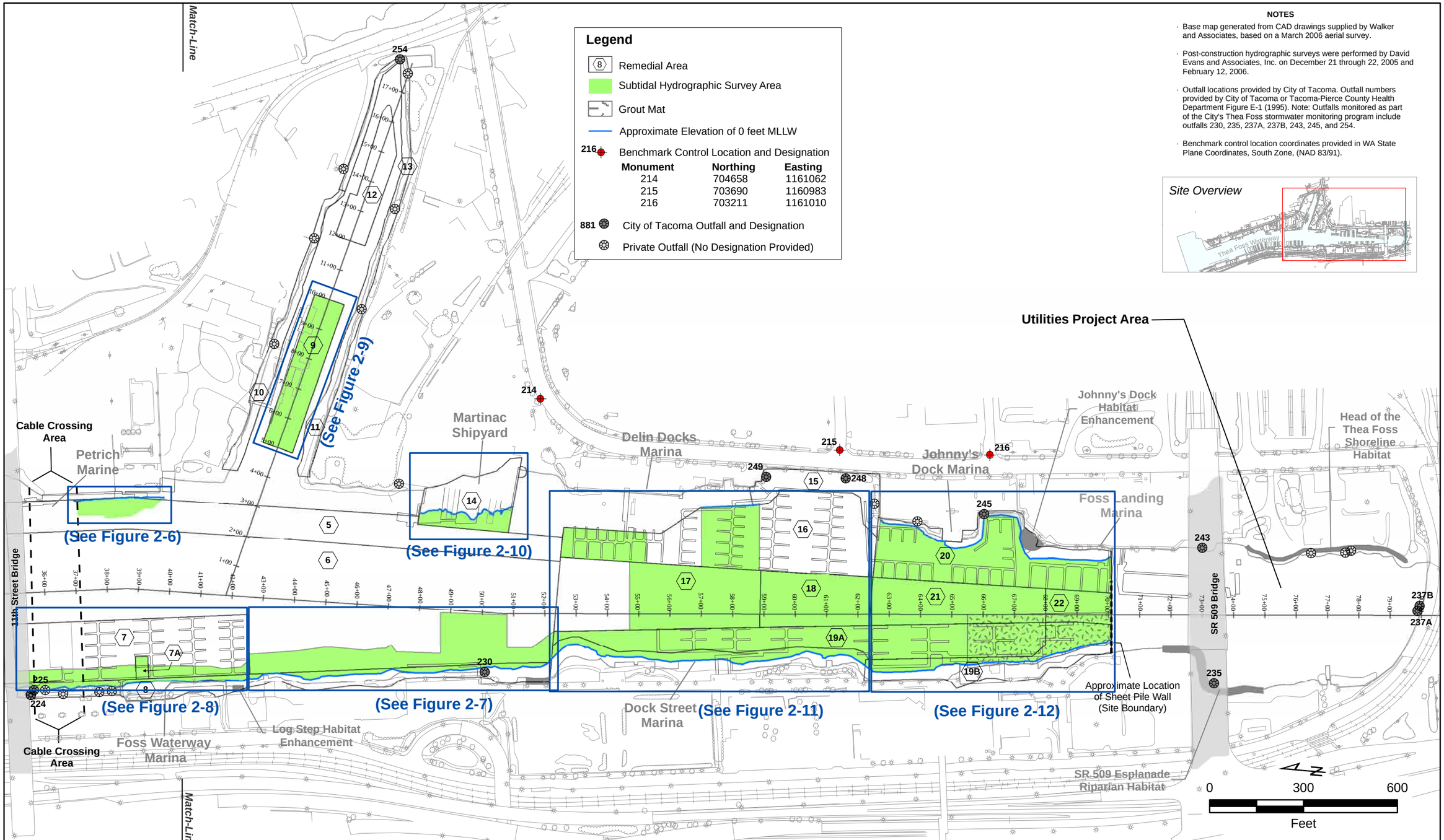

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Year 0 Baseline OMMP Report

Figure 2-3 (Page 2 of 2)
Subtidal Hydrographic Survey Areas

DATE: 2/20/2007 10:54:58 AM
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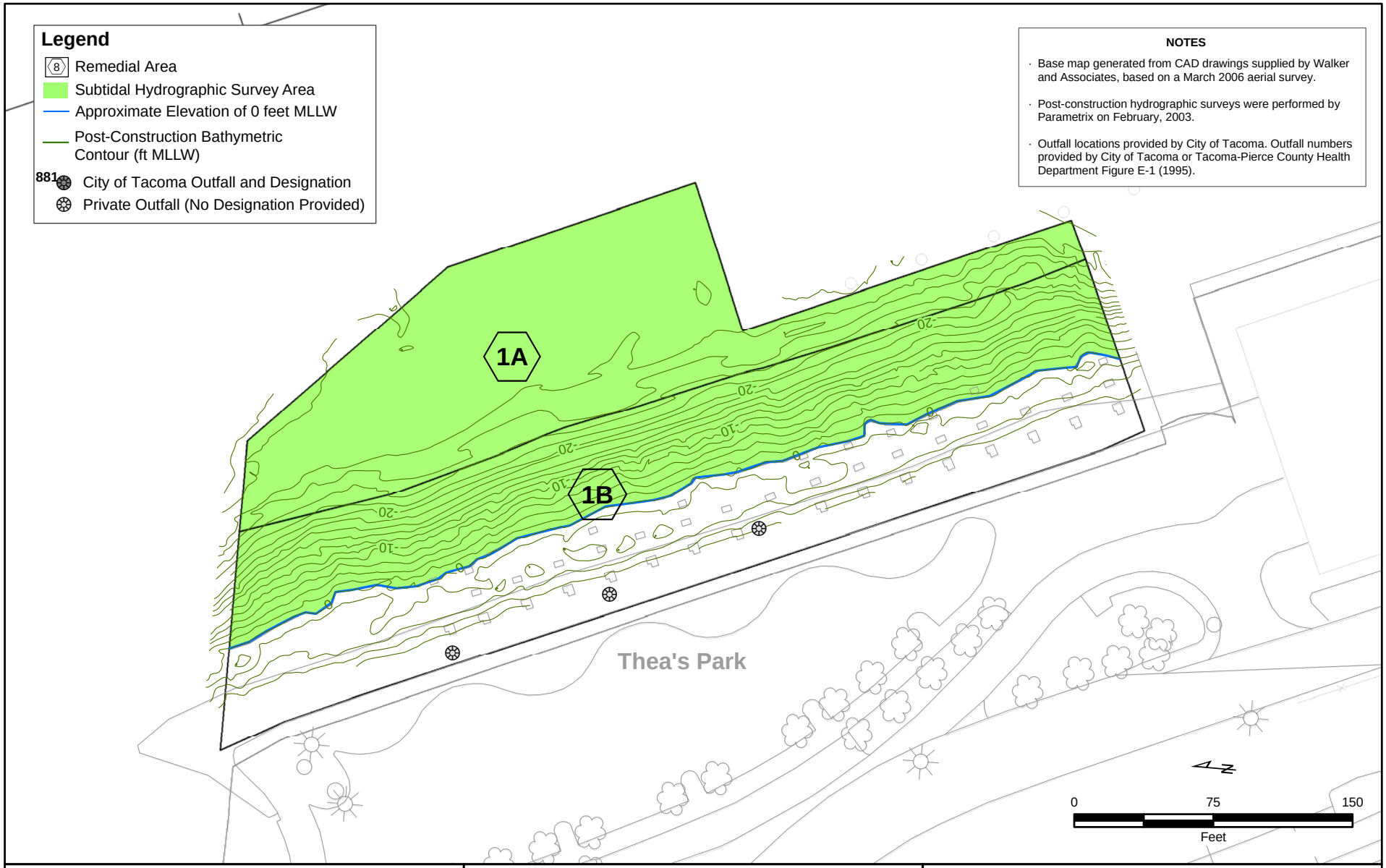

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Year 0 Baseline OMMP Report

Figure 2-4
RA 1 Baseline Subtidal Hydrographic Survey Results

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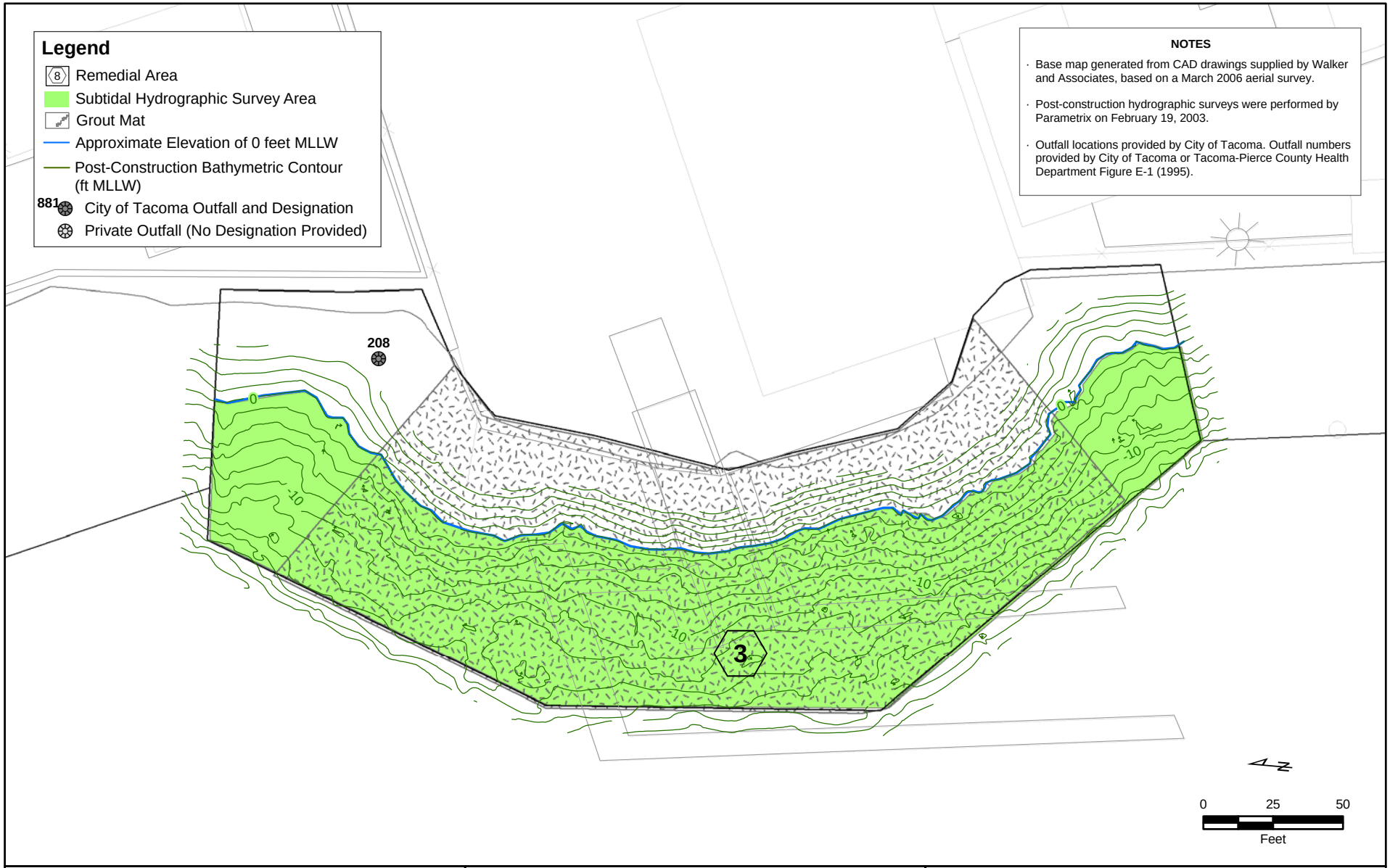

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Figure 2-5
RA 3 Baseline Subtidal Hydrographic Survey Results

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Figure 2-6
RA 5 Baseline Subtidal Hydrographic Survey Results

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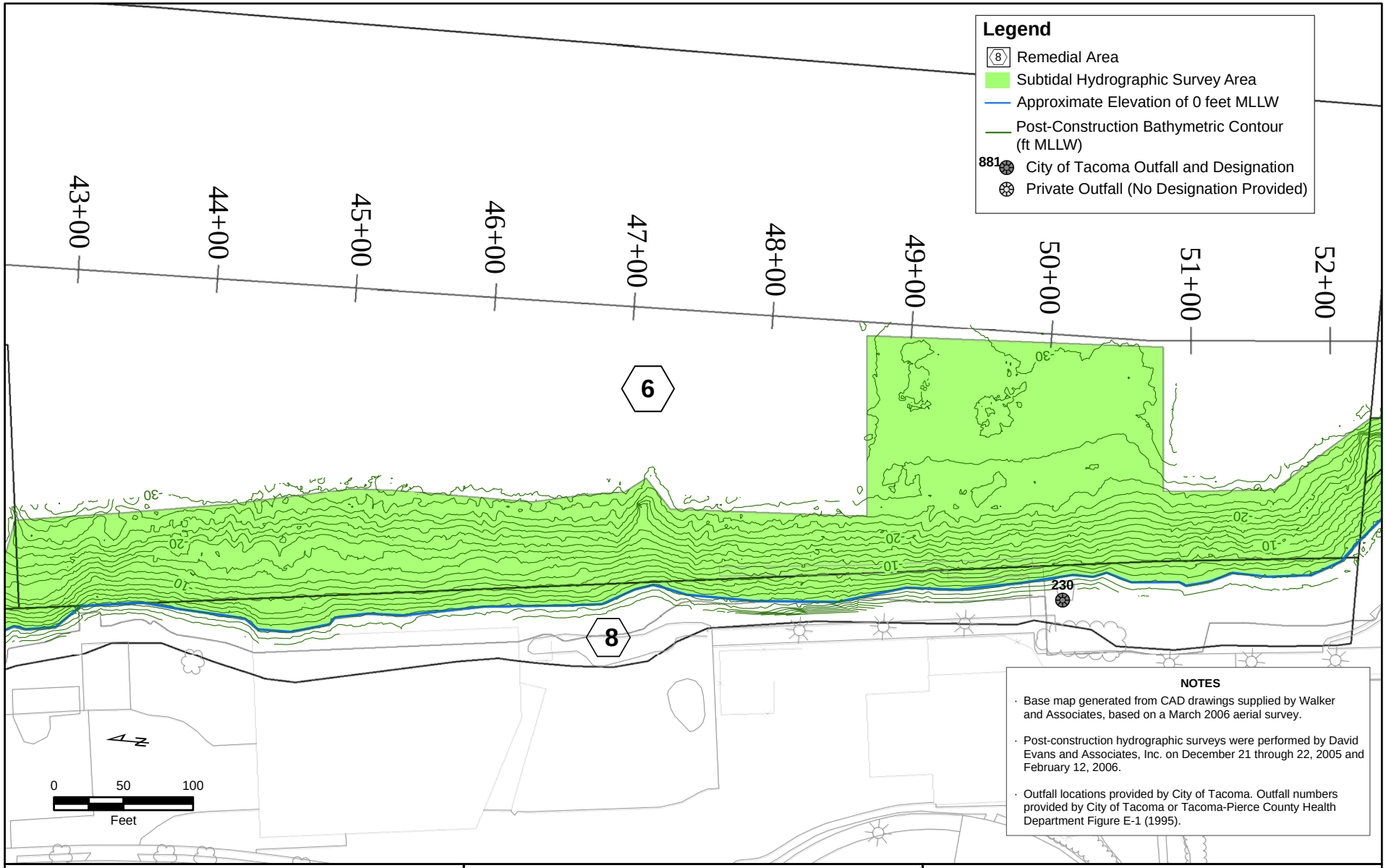

NOTES

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic surveys were performed by David Evans and Associates, Inc. on December 21 through 22, 2005 and February 12, 2006.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).

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Figure 2-7
RA 6 and Southern Portion of RA 8 Baseline Subtidal Hydrographic Survey Results

DATE: 2/20/2007 1:11:57 PM
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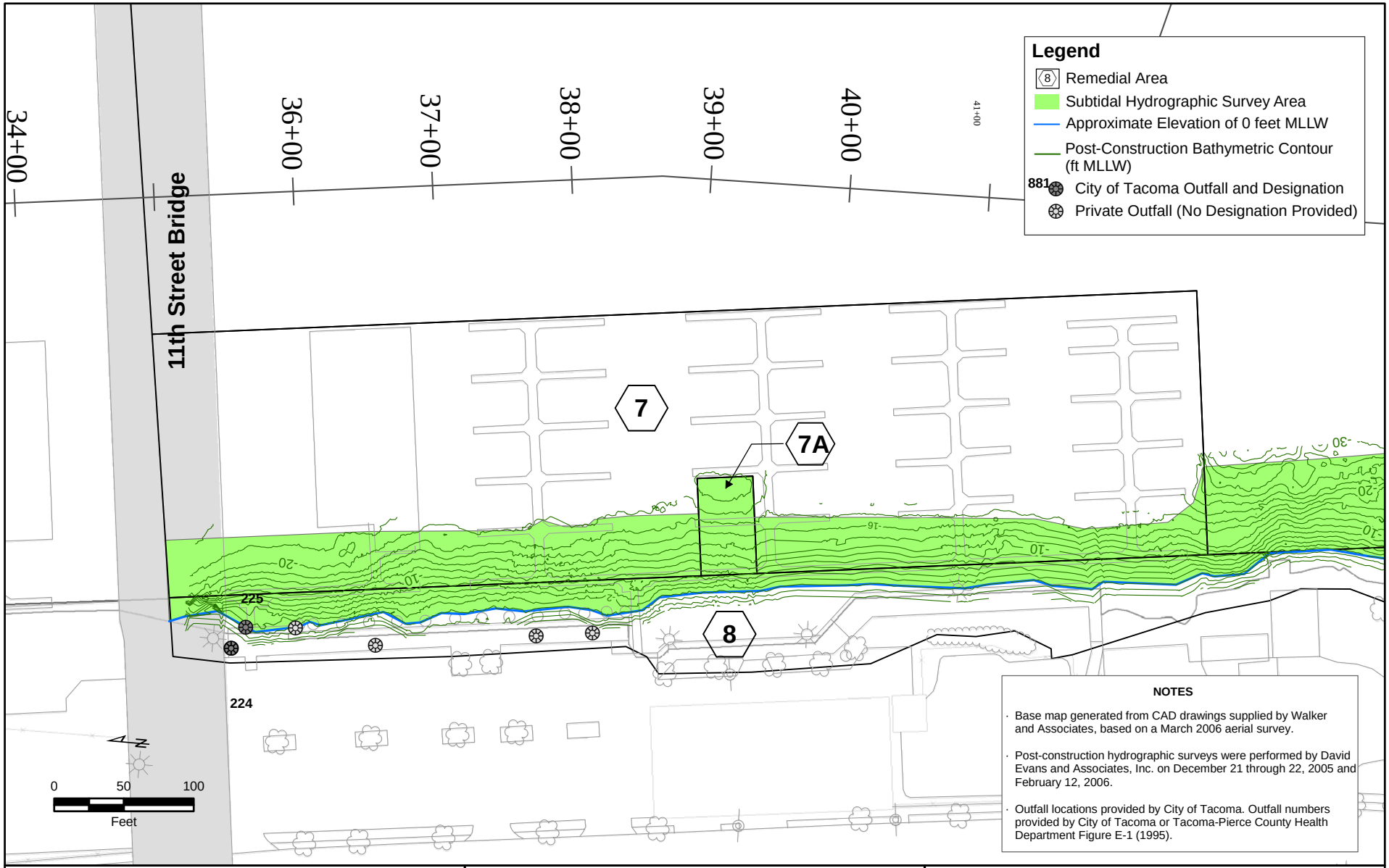

NOTES

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Figure 2-8
RA 7A and Northern Portion of RA8 Baseline Subtidal Hydrographic Survey Results

DATE: 2/20/2007 1:14:18 PM
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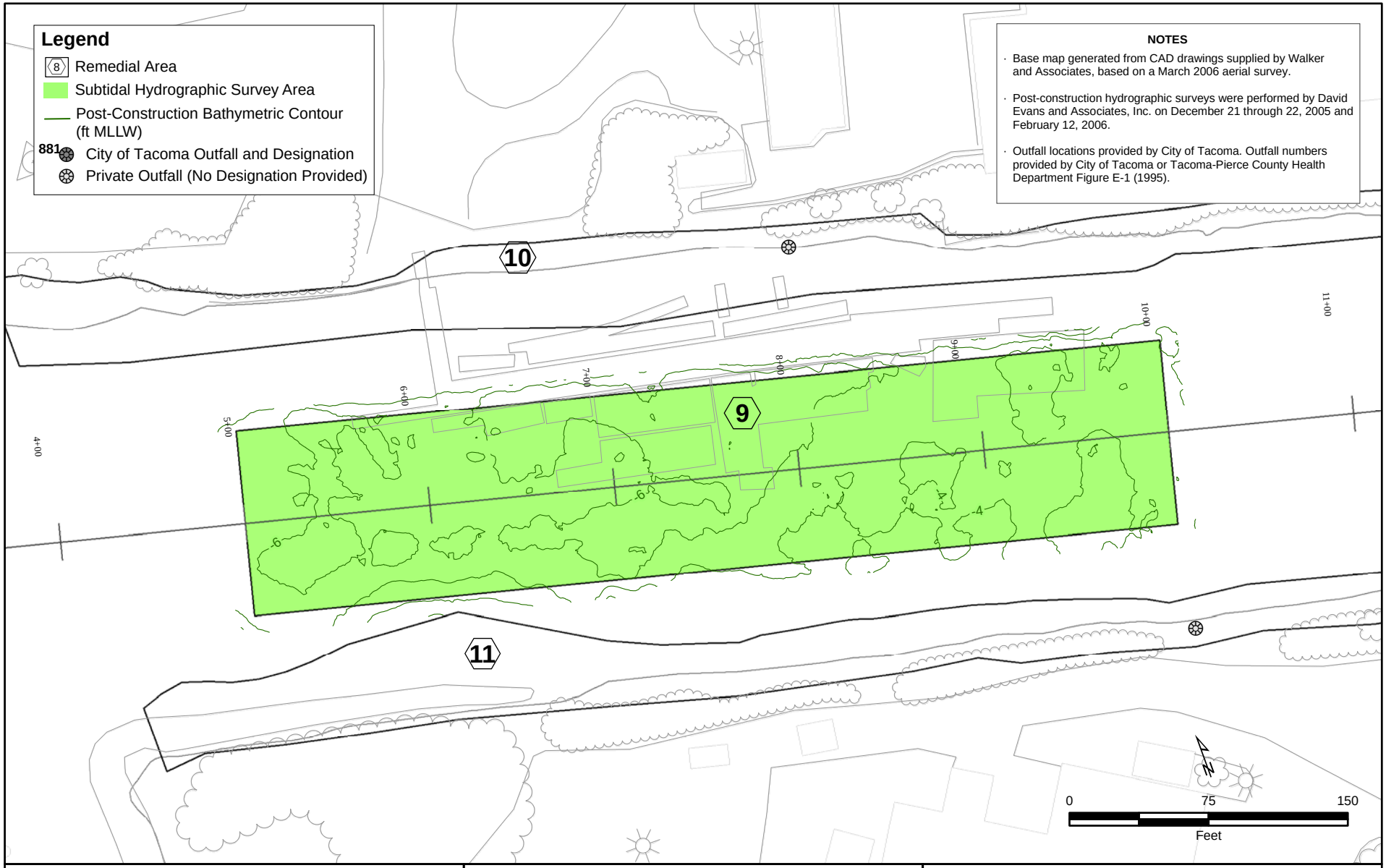

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Figure 2-9
RA 9 Baseline Subtidal Hydrographic Survey Results

DATE: 2/20/2007 1:16:40 PM
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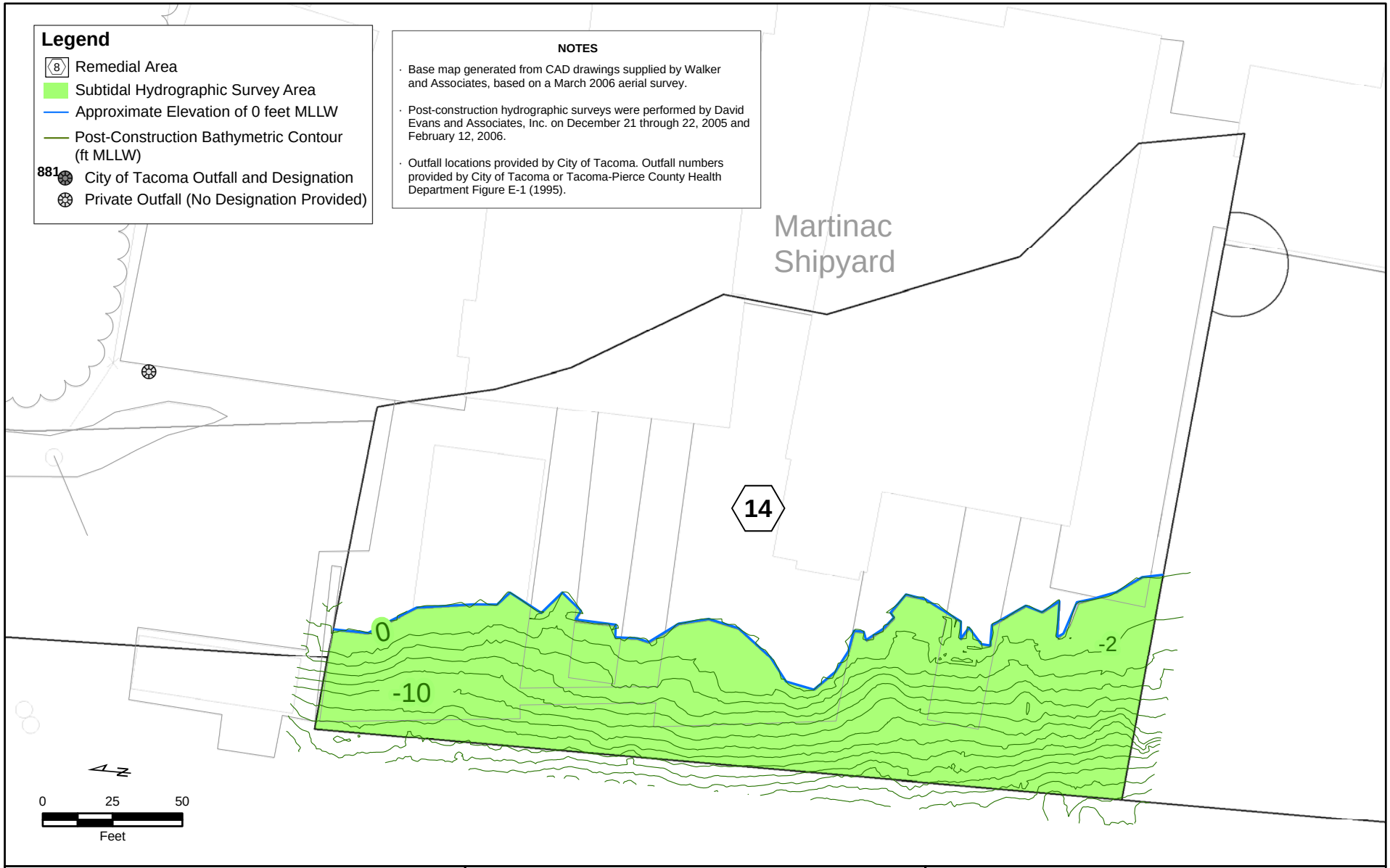

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Figure 2-10
RA 14 Baseline Subtidal Hydrographic Survey Results

DATE: 2/20/2007 1:27:48 PM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\Baseline Report Figures\Figure 2-10 RA 14 Baseline Subtidal Hydrographic Survey Results 022007.mxd

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Year 0 Baseline OMMP Report

Figure 2-11
RA 16, RA 17, RA 18, and the Northern Portion of RA 19A Baseline Subtidal Hydrographic Survey Results

DATE: 2/20/2007 1:29:22 PM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\Baseline Report Figures\Figure 2-11 RA 16, 17, 18, 19A Baseline Subtidal Hydrographic Survey Results 022007.mxd

NOTES

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
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Figure 2-12
Southern Portion of RA 19A, RA 19B, RA 20, RA 21, and RA 22 Baseline Subtidal Hydrographic Survey Results

DATE: 2/20/2007 1:31:51 PM
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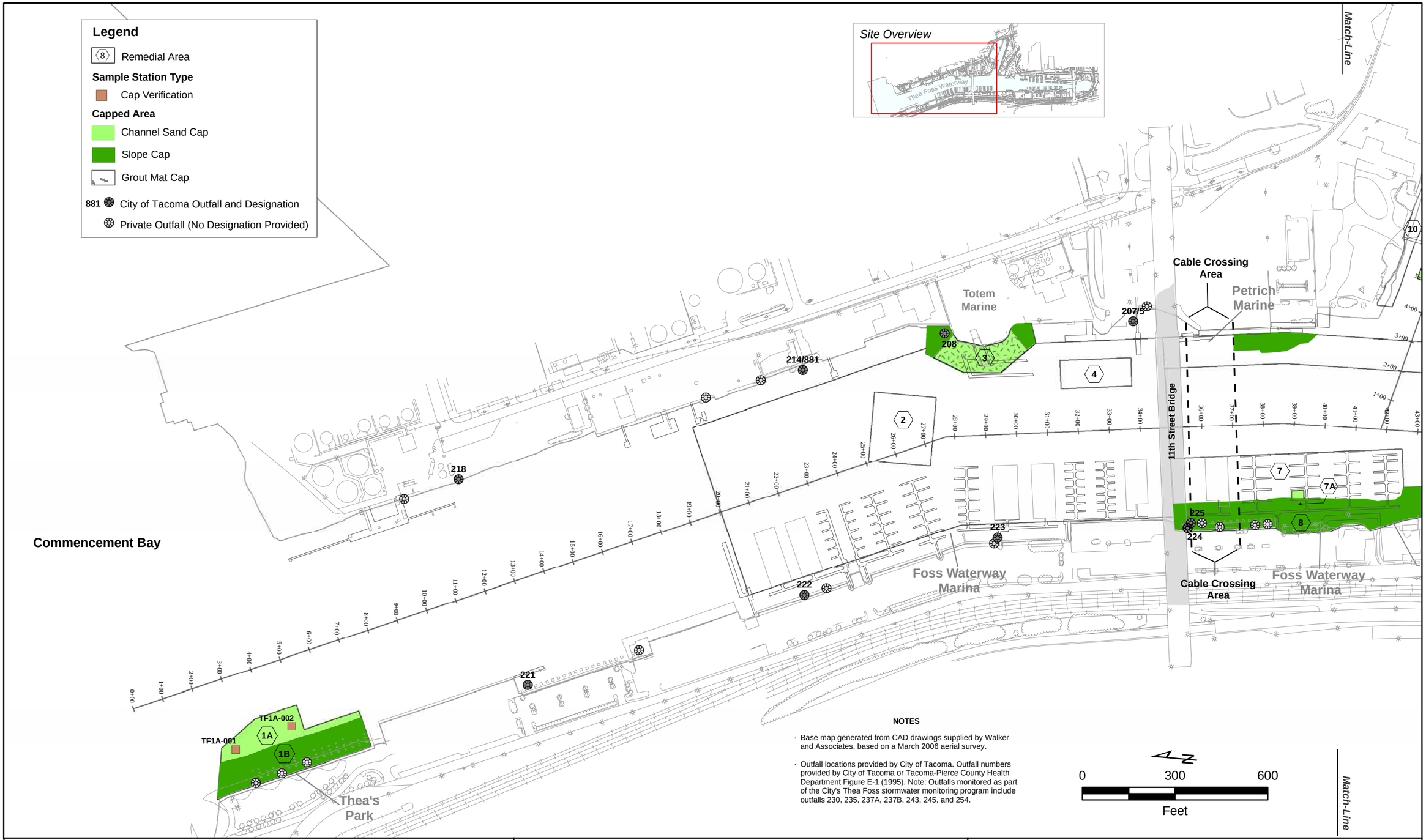

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Year 0 Baseline OMMP Report

Figure 2-13 (Page 1 of 2)
Baseline Cap Area Sampling Locations

DATE: 1/23/2007 7:46:15 AM
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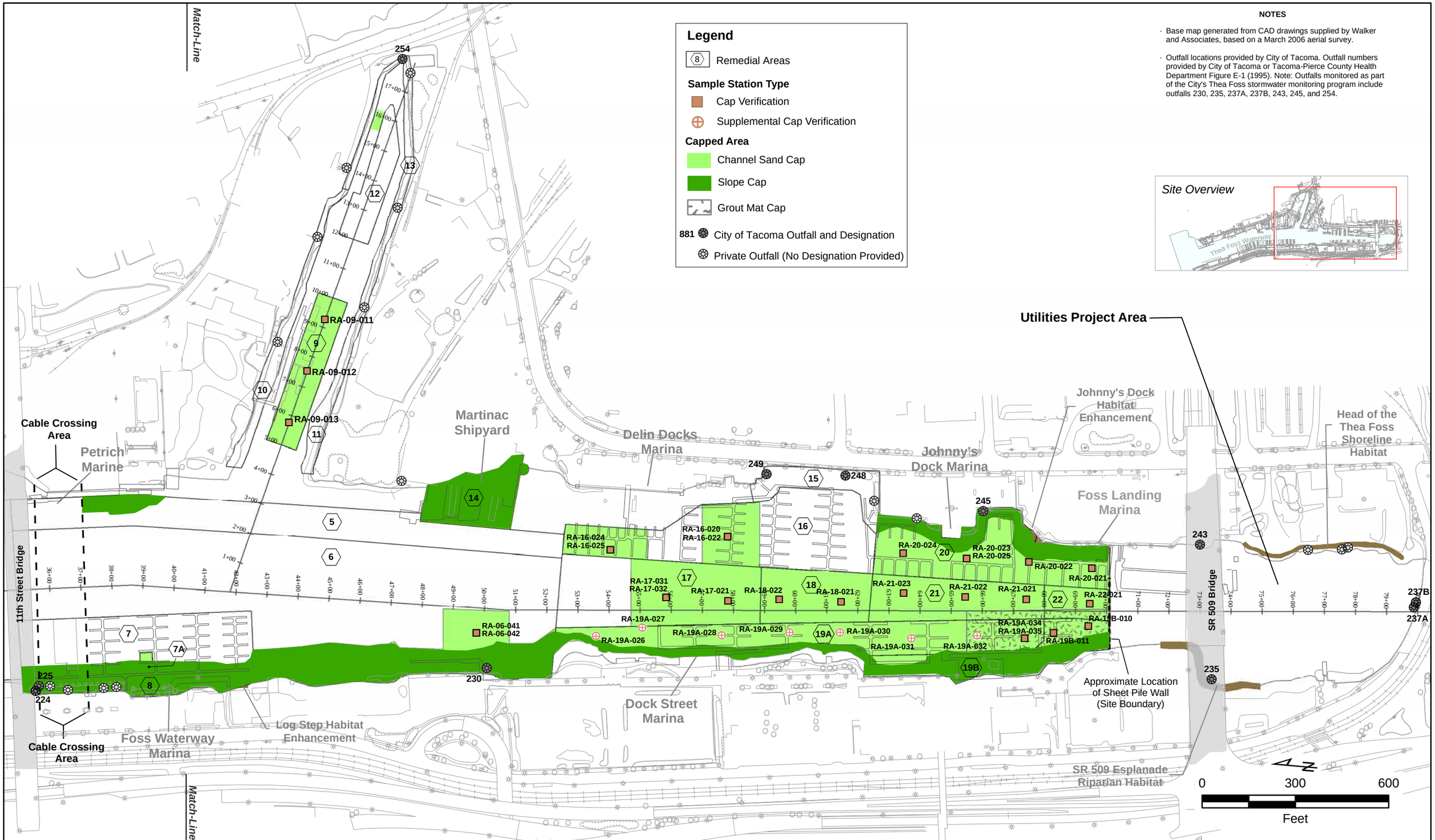

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Year 0 Baseline OMMP Report

Figure 2-13 (Page 2 of 2)
Baseline Cap Area Sampling Locations

DATE: 1/31/2007 10:40:14 AM
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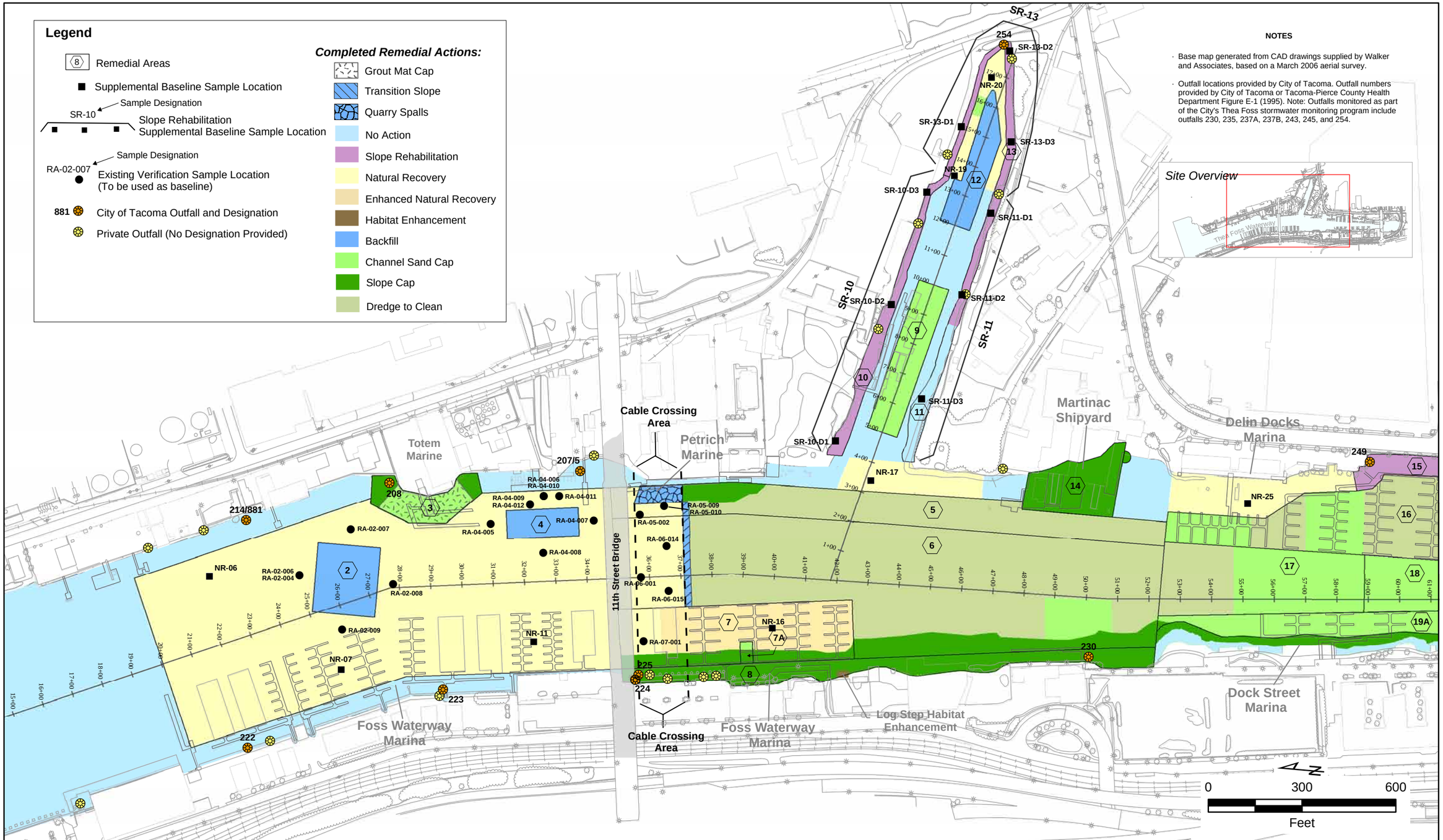

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Figure 2-14
Baseline Natural Recovery Sample Locations

DATE: 2/20/2007 1:57:10 PM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\Baseline Report Figures\Figure 2-14 Baseline Natural Recovery Locations 022007.mxd

3.0 EARLY WARNING MONITORING FOR RECONTAMINATION

Early warning monitoring for recontamination, referred to as early warning monitoring, will be performed to evaluate the potential for recontamination in the Thea Foss and Wheeler-Osgood Waterways. As described in Section 3.0 of the Operations, Maintenance, and Monitoring Plan (OMMP) (City of Tacoma 2006), early warning monitoring includes collection and analysis of recently deposited sediments represented by the 0 to 2 cm interval of the sediment column. Early warning sampling and analysis data will be used to evaluate the potential for recontamination and identify potential sources of recontamination (if suspected) before the remediated sediments become out of compliance with the remedial action and long-term monitoring objectives. Early warning monitoring will be performed throughout the Thea Foss and Wheeler-Osgood Waterways including dredged to clean, capped, and natural recovery areas.

Early warning monitoring is specifically designed to achieve the following objectives:

- Monitor the chemical quality of recently deposited sediments in remediation areas of the Thea Foss and Wheeler-Osgood Waterways with attention to potential sources of recontamination (i.e., marinas, outfalls, industrial facilities, etc.); and
- Identify potential sources of recontamination if exceedances of chemical Sediment Quality Objectives (SQO) and early warning threshold concentrations have occurred or are predicted to occur.

Early warning monitoring was not required as part of Baseline (Year 0) OMMP activities. Early warning monitoring will first be performed in Year 2. The schedule for OMMP activities to be performed as part of the Thea Foss and Wheeler-Osgood Waterways Remediation Project (Foss Project) is presented in Table 1-1. The scope of early warning monitoring to be conducted in Year 2 is described in the OMMP.

4.0 BENTHIC RECOLONIZATION MONITORING

Monitoring will be performed in the Thea Foss and Wheeler-Osgood Waterways to track the progress of benthic recolonization. Benthic habitat was altered by historical contamination and sediment dredging and capping actions completed in the waterways. Given the habitat improvements resulting from the completed remedial actions, the waterway is expected to be recolonized by benthic infauna and epifauna common to Commencement Bay. As described in Section 4.0 of the Operations, Maintenance, and Monitoring Plan (OMMP) (City of Tacoma 2006), benthic recolonization monitoring utilizes Sediment Profile Imagery (SPI) technology. SPI will allow for data to be collected on sediment composition, benthic habitat classification, infaunal successional stages, redox potential discontinuity, and organism-sediment index. Data from each specific location within a remediation area will be evaluated relative to previous years of monitoring at the specific location to assess the rate and success of benthic recolonization.

The objective of the benthic recolonization monitoring is to document and evaluate the success of benthic recolonization in the Thea Foss and Wheeler-Osgood Waterways. Benthic recolonization will be evaluated throughout the waterways including dredged to clean, capped, and natural recovery areas as described in the OMMP. Additionally, four benthic monitoring locations outside of the remediated areas near the mouth of the waterway are included to provide background information in non-remediated areas.

Benthic recolonization monitoring was not required as part of Baseline (Year 0) OMMP activities. Benthic recolonization monitoring will first be performed in Year 2. The schedule for OMMP activities to be performed as part of the Thea Foss and Wheeler-Osgood Waterways Remediation Project (Foss Project) is presented in Table 1-1. The scope of benthic recolonization monitoring to be conducted in Year 2 is described in the OMMP.

5.0 CONFINED DISPOSAL FACILITY MONITORING

5.1 Introduction

Confined Disposal Facility (CDF) monitoring is designed to protect water quality in adjacent surface water bodies from the migration of contaminants from dredged material confined within the St. Paul CDF. The St. Paul CDF was constructed to dispose of and confine contaminated dredged sediment from the Thea Foss and Wheeler-Osgood Waterways (Figure 5-1). The primary, potential mechanism for contaminant transport is groundwater flow through the CDF and into the adjacent water bodies. Monitoring activities consist of the collection and analysis of hydrogeologic and groundwater data to evaluate groundwater flow and quality in and around the CDF to ensure compliance with performance criteria.

As described in Section 5.0 of the Operations, Maintenance, and Monitoring Plan (OMMP) (City of Tacoma 2006), CDF monitoring includes the following activities:

- Installation and development of 15 monitoring wells in and adjacent to the CDF;
- Performance of slug tests and a 72-hour tidal study to evaluate post-construction groundwater gradients and flow conditions at the CDF;
- Documentation of the hydrogeologic conditions at the CDF in the Post-Construction Hydrogeologic Conditions Report;
- Selection of monitoring wells to be used for baseline groundwater quality monitoring;
- Performance of quarterly groundwater and surface water monitoring for two years to identify baseline conditions;
- Documentation of the baseline conditions in a report to be submitted to EPA;
- Identification of the performance monitoring program for the CDF;
- Monitoring of groundwater quality over time in accordance with the performance monitoring program; and
- Performance of visual observations of the berms and CDF cap.

CDF monitoring activities that have been performed since the completion of CDF construction in March 2006 include the following:

- Installation and development of 15 monitoring wells in and adjacent to the CDF (i.e., MW-01 through MW-15) was performed from August 28, 2006 through September 18, 2006 (Figure 5-1);
- Slug testing of the new wells was performed on September 27-28, 2006;
- Performance of a 72-hour tidal study was performed on October 3-6, 2006;
- Documentation of field activities, observations, and hydrogeologic conditions in the Post-Construction Hydrogeologic Conditions Report (City of Tacoma 2006) (provided in Attachment D-1 of Appendix D);
- Preparation of a memorandum identifying the proposed wells to be used to monitor baseline groundwater quality conditions at the St. Paul CDF. This memorandum is provided in Attachment D-2 of Appendix D;

- Submittal of the Post-Construction Hydrogeologic Conditions Report and memorandum identifying the wells to be monitored to establish baseline conditions to EPA for review on November 22, 2006; and
- Preparation of response to EPA comments on the Post-Construction Hydrogeologic Conditions Report and memorandum identifying the wells to be monitored to establish baseline conditions at the CDF. EPA provided comments in an email from Piper Peterson Lee, EPA to Mary Henley, City of Tacoma, dated December 20, 2006. This response to comments was submitted to EPA on January 16, 2007. The response to EPA comments is provided in Attachment D-3 of Appendix D.

All investigation activities, preparation of the Post-Construction Hydrogeologic Conditions Report, and identification of wells to be monitored to establish baseline conditions have been performed in accordance with requirements specified in the OMMP. The results of CDF monitoring activities performed to date are summarized in the following sections.

5.2 Post-Construction Hydrogeologic Conditions

5.2.1 Monitoring Well Network

Fifteen monitoring wells (MW-01 through MW-15) were installed in and adjacent to the St. Paul CDF (Figure 5-1). The monitoring wells were installed in accordance with the Confined Disposal Facility Monitoring Operations Manual developed as part of the OMMP (Appendix D of the OMMP) and the Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC).

Eight of the monitoring wells were completed at shallow depths (MW-01 through MW-04, MW-06, MW-09, MW-10, and MW-13). The shallow wells are located and screened to evaluate hydrogeologic conditions in near-surface soil, fill, and material used to construct the containment and offset berms, and to allow characterization and monitoring of the quality of groundwater that is most likely to be impacted by the saltwater washout effect (i.e., where the lowest saline groundwater and stormwater infiltration come in contact with and flow over the surface of contaminated sediment placed in the CDF).

Three of the monitoring wells were completed at intermediate depths (MW-07, MW-11, and MW-14) and are located and screened to evaluate hydrogeologic conditions and allow characterization and monitoring of the quality of groundwater occurring within a depth that is between the shallow and deep monitoring well depths.

Four of the wells were completed as deep wells (MW-05, MW-08, MW-12, and MW-15). The deep wells were designed to evaluate hydrogeologic conditions and allow characterization and monitoring of groundwater quality at the elevation of the bottom of the CDF.

5.2.2 Hydraulic Conductivity

Following well development activities, slug tests were conducted on all the monitoring wells in general accordance with ASTM D 4044-96 to estimate the hydraulic conductivity in and adjacent to the CDF. The methods of Bouwer and Rice (Bouwer and Rice 1976 and 1989) and Butler and Garnett (Butler and Garnett 2000) were used to evaluate the slug test data collected from the site and estimate hydraulic conductivities.

Hydraulic conductivity varies across the site. The estimated hydraulic conductivity values for the soil and fill within and adjacent to the CDF ranged from 1.2 x 10^{-4} centimeters per second (cm/sec) or 0.35 feet per day (ft/day) in MW-05 to 4.6 x 10^{-1} cm/sec or 1,320 ft/day in MW-01, located in the containment berm. This variability is the result of differences in soil characteristics encountered in a given location and horizon.

The hydraulic conductivity values measured at the CDF are highest in the containment and offset berms, as expected. The two wells located within the berms (MW-01 and MW-09) show similar hydraulic conductivity values of 4.64 x 10^{-1} cm/sec or 1,320 ft/day and 3.57 x 10^{-1} cm/sec or 1,010 ft/day, respectively. MW-01 and MW-09 are screened over highly-permeable coarse gravel and sand fill placed during construction of the berms.

The wells located adjacent to the Middle Waterway (MW-02, MW-06 through MW-08 and MW-10 through MW-12) show similar hydraulic conductivity values ranging from 2.02 x 10^{-2} cm/sec or 57.2 ft/day at MW-07 to 1.1 x 10^{-1} cm/sec or 310 ft/day at MW-06. Hydraulic conductivities estimated for MW-06 through MW-08 and MW-10 through MW-12 are within the mid-range of conductivities observed at the site and reflect the hydraulic properties of the silty fine sand to coarse sand comprising the historical fill and deltaic and shallow marine deposits in which these wells are screened.

The two wells installed within the dredged material disposed of in the CDF (MW-04 and MW-05) exhibit the lowest estimated hydraulic conductivity values at the site (4.08 x 10^{-4} cm/sec or 1.16 ft/day and 1.24 x 10^{-4} cm/sec or 0.35 ft/day, respectively). The low conductivity values reflect the low permeability of the predominantly fine sandy silt dredged material fill disposed of in the CDF.

5.2.3 Groundwater Response to Tidal Fluctuations

A 72-hour tidal study was completed to assess tidal effects on groundwater levels in and around the CDF. Water levels were recorded at 15-minute intervals at each well location, at a tide gauge established in the Middle Waterway, and in a still well established in the surface water swale located on the eastern boundary of the CDF (Figure 5-1). Data for the elevation of groundwater in each well was compared to the surface water elevations in the Middle Waterway to evaluate the affect of tidal fluctuations on groundwater in and adjacent to the CDF.

The data for shallow wells installed in the containment and offset berms and shallow and intermediate wells west of the CDF indicate a relatively rapid to moderately rapid response in groundwater elevation in response to tidal fluctuations with calculated lag times ranging from 15 to 45 minutes. Additionally, the change in groundwater elevations ranged from approximately four to seven feet.

Although the shallow wells installed in the berms and shallow and intermediate wells installed west of the CDF had significant responses to changes in tidal fluctuations, MW-04 and MW-05 installed within the CDF had a limited response to tidal fluctuations. The calculated lag time for MW-04 and MW-05 were 165 and 135 minutes, respectively (i.e., 2 hours and 45 minutes and 2 hours and 15 minutes, respectively). Groundwater elevation changes in shallow monitoring well MW-04 and deep monitoring well MW-05 were three inches and approximately six inches, respectively. The relatively small response to tidal fluctuations in MW-04 and MW-05 are indicative of the fine sandy, silt that was disposed of in the CDF.

The data for MW-03, MW-13, and MW-14 installed east of the CDF also indicated minimal response to tidal fluctuations. However, deep monitoring well MW-15 located east of the CDF exhibited a greater response to tidal fluctuations than the shallow and intermediate wells. The greater response to tidal fluctuations exhibited by MW-15 indicates that the presence of the silty dredged material fill in the CDF is likely inhibiting the response in MW-03, MW-13, and MW-14.

The information from groundwater responses to tidal fluctuations corroborates the results of hydraulic conductivities and further indicates that the silt and fine sand comprising the dredged fill material placed in the CDF limits the hydraulic connection between groundwater within the CDF and groundwater and surface water surrounding the CDF and the potential transport of contaminants out of the dredged fill material.

5.2.4 Mean Groundwater Elevation, Gradients, and Flow Direction

Groundwater elevation data collected during the tidal study was used to determine the mean groundwater elevation at each monitoring well location to identify groundwater gradients across the CDF. Mean groundwater elevations were calculated for the wells in and adjacent to the CDF using the method described by Serfes (Serfes 1991). The groundwater gradients identified from the tidal study are used to infer overall groundwater flow directions at the CDF and areas of potential groundwater discharge to surface water.

Mean groundwater elevations for shallow and intermediate depth monitoring wells show that groundwater flow is west toward the outer St. Paul and Middle Waterways. The groundwater gradients for the shallow and intermediate depths were similar in magnitude and greater than the gradient for deep groundwater which is essentially flat.

Although net groundwater flow is westerly, the groundwater elevation data from the tidal study shows that the horizontal hydraulic gradients change in response to tidal fluctuation in the St. Paul and Middle Waterways and Commencement Bay. The groundwater flow direction was observed to reverse direction during flood tide. However, the reversal of the groundwater gradient is transient and the overall net groundwater gradient is to the west.

The vertical groundwater gradients at monitoring wells located downgradient of the CDF and adjacent to the Middle Waterway indicate that the vertical gradient is upward from the deep well depth toward the intermediate depth and downward from the shallow depth toward the intermediate depth. The upward vertical gradient from the deep well depth toward the intermediate well depth adjacent to the Middle Waterway indicates that groundwater is not likely to transport contaminants into deeper deltaic marine sediment downgradient of the CDF. Additionally, because both sets of gradients (i.e., shallow / intermediate and intermediate / deep) are toward the intermediate depth horizon, intermediate depth groundwater has the potential to transport contamination from the dredged material recently placed in the CDF.

5.2.5 Conceptual Model for CDF Post-Construction Hydrogeological Conditions

The hydraulic conductivities of the soil and fill at the CDF, groundwater response to tidal fluctuations, direction of groundwater flow, and hydraulic gradients influence potential contaminant transport and discharge to surface water. Details of the post-construction investigation and evaluation of hydrogeologic conditions at the St. Paul CDF can be found in the

Post-Construction Hydrogeologic Conditions Report. The following summarizes the conclusions resulting from this work:

- Information for hydraulic conductivities and tidal fluctuations indicates that the silt and fine sand comprising the dredged fill material placed in the CDF has lower hydraulic conductivities than the materials surrounding the CDF which will reduce the hydraulic connection between groundwater within the CDF and groundwater and surface water surrounding the CDF and the potential transport of contaminants out of the dredged fill material;
- The groundwater flow direction at the shallow and intermediate well depths is to the west and indicates that groundwater at these depths likely discharges to the outer St. Paul and Middle Waterways;
- The average horizontal groundwater gradient for the shallow groundwater interval was slightly greater than that of the intermediate depth groundwater interval whereas the groundwater gradient for the deep monitoring well interval is relatively flat; and
- The vertical groundwater gradients at monitoring wells located west of the CDF (i.e., horizontally downgradient from the CDF) and adjacent to the Middle Waterway indicate that groundwater flows upward from the deep well depth toward the intermediate depth and downward from the shallow depth toward the intermediate depth.

5.2.6 Potential for Contaminant Transport from Recently Placed Dredge Material

Based on the findings of the hydrogeologic investigation of the CDF and adjacent areas, and the conceptual model for post-construction hydrogeologic conditions, the following conditions identify potential contaminant transport mechanisms:

- Shallow groundwater, downgradient of the dredged sediment recently placed in the CDF is most likely to be impacted by saltwater washout effects and to transport contaminants from the CDF. Modeling performed as part of the design identified that contaminant release is most likely to occur where less saline groundwater and stormwater infiltration come in contact with confined, contaminated dredged materials and then flows away from (i.e., downgradient from) the CDF. Hydrogeologic investigations indicate that shallow groundwater generally flows to the west toward the outer St. Paul and Middle Waterways; and
- Intermediate depth groundwater, downgradient of the CDF, also has the potential to transport contamination from the confined, contaminated dredged materials. Evaluation of vertical groundwater gradients shows that shallow and deep groundwater flowing through the CDF converge at the intermediate depth horizon. Therefore, groundwater from all depths that has been in contact with the contaminated dredged material has the potential to flow from the CDF within the intermediate depth horizon. Hydrogeologic investigations indicate that intermediate depth groundwater flows to the west toward the Middle Waterway.

The wells to be monitored to establish baseline water quality were selected based on the results of the hydrogeologic investigation of the CDF and findings for potential chemical transport.

5.3 Identification of Wells to be Monitored to Establish Baseline Water Quality

The proposed wells and rationale for well selection were presented in the memorandum titled Identification of Wells to be Monitored to Establish Baseline at the CDF (Attachment D-2 of Appendix D). Comments on the memorandum were received from EPA and were incorporated into the selection of wells identified for baseline monitoring. The wells selected for baseline monitoring are summarized below:

- Shallow depth monitoring wells MW-01, MW-02, MW-06, and MW-10, which are located downgradient of dredged sediment placed in the CDF (Figure 5-2), were selected to characterize baseline for groundwater that may be affected as a result of salt washout by shallow groundwater that encounters the dredged material confined within the CDF and is then discharged downgradient;
- Intermediate depth monitoring wells MW-07 and MW-11, also located downgradient of dredged sediment placed in the CDF, were selected to characterize baseline for groundwater that may be affected as a result of shallow, intermediate, and deep groundwater that encounters the dredged material within the CDF and converges at the intermediate depth as it discharges downgradient;
- MW-04 and MW-05, installed within the CDF, were selected to identify contaminant levels in groundwater within the dredged material confined in the CDF; and
- Deep monitoring wells MW-08 and MW-12, also located downgradient of dredged sediment placed in the CDF, were selected at the request of EPA to establish baseline groundwater quality present at the depth of the bottom of the CDF.

5.4 Schedule of CDF Monitoring

The monitoring plan has been approved by EPA, and the first quarter of water quality monitoring to establish baseline conditions is scheduled for March 2007 pending installation of pumps. Groundwater sampling and analysis will be performed on selected wells in accordance with procedures specified in the OMMP. The scope of CDF monitoring to be conducted during the two year baseline monitoring period is described in the OMMP. The schedule for all OMMP activities is presented in Table 1-1.

FIGURES

5-1 – Site Map and Monitoring Locations

5-2 – Baseline Groundwater Monitoring Locations

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Figure 5-1
Site Map and Monitoring Locations

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Figure 5-2
Baseline Groundwater Monitoring Locations

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6.0 HABITAT MITIGATION AREA MONITORING

6.1 Introduction

This section presents a summary of the Baseline (Year 0) habitat mitigation area monitoring performed at the Thea Foss Waterway and Wheeler-Osgood Waterways Remediation Project (Foss Project) habitat mitigation and enhancement area sites. This habitat mitigation area monitoring was performed in accordance with the Operations, Maintenance, and Monitoring Plan (OMMP) (City of Tacoma 2006). The OMMP requires that various components of habitat mitigation monitoring occur throughout the first ten years following completion of the remedial action. After 10 years of monitoring, the City and EPA will evaluate the need for and scope of additional monitoring. A summary of the habitat area monitoring activities performed during this baseline monitoring year is provided in Table 6-1.

As described in Section 6.0 of the OMMP, the habitat mitigation areas for the project are identified as the North Beach Habitat, Middle Waterway Tideflat Habitat, Puyallup River Side Channel, and the Hylebos Creek Mitigation Site. Constructed acreages of these mitigation areas are provided in Table 6-2. The Thea Foss Habitat Enhancement Areas are identified as the Johnny's Dock Habitat Enhancement, Head of Thea Foss Shoreline Habitat, SR 509 Esplanade Riparian Habitat, and the Log Step Habitat Enhancement.

Following completion of the habitat mitigation area monitoring field activities described below, the City prepared the Year 0 Baseline Monitoring Habitat Mitigation Area Monitoring Preliminary Findings Memorandum (City of Tacoma, 2006) that summarized the work performed and the findings. This memorandum was submitted for agency review on November 30, 2006. A copy of this Preliminary Findings Memorandum is included in Attachment E-1 of Appendix E.

6.1.1 Habitat Mitigation Area Monitoring Objectives

The OMMP specifies that habitat mitigation monitoring be performed to achieve the following objectives:

- To evaluate the effectiveness of the development of biological features and physical features at the mitigation and enhancement sites to confirm that they are on a trajectory to provide habitat function necessary to meet the objectives for each site; and
- To confirm that the habitat sites have attained and continue to meet the objectives for each site over time.

As required by the OMMP, habitat monitoring activities are generally performed when tidal elevations are below 0.0 feet Mean Lower Low Water (MLLW) except at the Hylebos Creek Mitigation Site where the primary monitoring activities are performed when tidal elevations are below 8.78 feet MLLW.

6.1.2 Scope of Habitat Mitigation Area Monitoring

Baseline mitigation area performance monitoring consists of three components: baseline habitat mitigation area monitoring, habitat mitigation area maintenance, and contingency planning and response actions.

Baseline habitat mitigation area monitoring included the following activities:

- Qualitative ground surveys;
- Photo documentation;
- Elevation monitoring;
- Brackish marsh salinity monitoring; and
- Water surface elevation monitoring.

These activities are described in more detail in Section 6.2.1 below.

Site stewardship and routine maintenance, performed on an ongoing basis throughout the year, are key components of the habitat maintenance and monitoring program. The City had, under contract, a site steward who routinely checked up on the sites for the purpose of identifying any areas of concern to the City. At this time, the site steward has determined that he will retire and will no longer be routinely available for this work. The City will evaluate the need for a replacement vs. performing this task with City staff during the coming year.

In addition, the City maintains a contract with the Washington Conservation Corps (WCC) for performance of routine maintenance activities at the various mitigation and enhancement sites. The crew picks up garbage, repairs goose exclusion grids, tightens Large Woody Debris (LWD) cables, pulls weeds, and replants on an as needed basis. A summary of their work during the baseline monitoring year is provided in Section 6.3.

Adaptive management and contingency planning procedures were established in Sections 6.4 and 6.5 of the OMMP. As issues are identified over time, these procedures will be implemented to determine the best course of action. To date, only one issue, erosion at the North Beach Habitat area, has been identified that requires follow-up action. The current status of this issue is described in Section 6.4.

6.2 Baseline Habitat Mitigation Area Monitoring

6.2.1 Summary of Baseline Habitat Mitigation Area Monitoring

Baseline habitat mitigation area monitoring activities are set forth in the OMMP. The primary function of the baseline monitoring event is to provide confirmation that the habitat mitigation and enhancement sites were constructed and planted in accordance with the approved plans. This was done through the performance of qualitative inspections of each of the sites. In addition, elevation stakes were established at the mitigation sites as part of the baseline work to provide a mechanism for monitoring sediment accretion/erosion at the sites. These elevation stakes will be used during subsequent monitoring years to track changes in elevation over time. Photo points were established at both the mitigation and enhancement sites. Photographs were taken at these points to provide baseline documentation. Photographs taken during this baseline year will be used for comparative purposes with photographs taken during subsequent monitoring years.

Additional mitigation monitoring work performed during this baseline monitoring year included salinity monitoring at the brackish marsh at the Middle Waterway Tideflat Habitat and water surface elevation monitoring at the Hylebos Creek Mitigation Site.

6.2.2 Summary of Field Activities

Year 0 baseline habitat monitoring activities were initiated in April 2006 with the placement of the water surface elevation monitoring probe at the Hylebos Creek Mitigation Site. The water surface elevation monitoring at Hylebos Creek was completed on November 2, 2006.

Brackish marsh salinity monitoring at the Middle Waterway Tideflat Habitat was performed between May 2006 and December 2006

Qualitative ground surveys, photo documentation, and elevation monitoring were performed primarily on July 10-11, 2006, with minor follow-up on July 12-13, 2006. Copies of the completed inspection forms and photographs are included in the Preliminary Findings Memorandum in Appendix E. The following is a summary of activities performed at each site:

North Beach Habitat – The qualitative ground survey of the site was completed on July 11, 2006. Six permanent photo points were established at the locations shown on Figure 6-1. A total of 17 photographs were taken at these points at tidal elevations ranging from approximately -1.66 feet MLLW to 1.91 feet MLLW. Rebar were placed at the photo point locations and the points surveyed to allow for reproducibility in subsequent monitoring years. Photographs for photo point 5 were retaken on October 17, 2006, as the original photographs were lost due to technical difficulties.

Five elevation stakes were placed at the locations shown on Figure 6-1. Photographs showing the elevation stakes in place were taken and the stakes were surveyed to allow for replacement if needed. Top of stake and ground surface elevations were also measured. Survey information for photo point locations and elevation stakes are included in Table 6-3.

Middle Waterway Tideflat Habitat – The qualitative ground survey of the site was completed on July 11, 2006. Four permanent photo points were established at the locations shown on Figure 6-2. A total of eleven photographs were taken at these points at tidal elevations ranging from approximately -3.25 feet MLLW to -2.77 feet MLLW. Rebar were placed at the photo point locations and the points surveyed to allow for reproducibility in subsequent monitoring years.

Six elevation stakes were placed at the locations shown on Figure 6-2. Photographs showing the elevation stakes in place were taken and the stakes were surveyed to allow for replacement if needed. Top of stake and ground surface elevations were also measured. Survey information for photo point locations and elevation stakes are included in Table 6-3.

As specified in the OMMP, initial salinity measurements were taken at the site prior to brackish marsh planting to ensure that the conditions were suitable. Three rounds of samples were taken in May 2006 as the irrigation system was being adjusted and prior to planting. Plantings were then completed in July 2006, followed by monthly sampling for three months between July 2006 and September 2006. Because of inconclusive results for the third of these sampling events, a fourth sampling event was performed in December 2006.

Puyallup River Side Channel – The qualitative ground survey of the site was completed on July 10, 2006. Six permanent photo points were established at the locations shown on Figure 6-3. A total of ten photographs were taken at these points at tidal elevations ranging from

approximately -3.10 feet MLLW to -0.83 feet MLLW. Rebar were placed at the photo point locations and the points surveyed to allow for reproducibility in subsequent monitoring years.

Six elevation stakes were placed at the locations shown on Figure 6-3. Photographs showing the elevation stakes in place were taken and the stakes were surveyed to allow for replacement if needed. Top of stake and ground surface elevations were also measured. Survey information for photo point locations and elevation stakes are included in Table 6-3.

Hylebos Creek Mitigation Site – The qualitative ground survey of the site was completed on July 11, 2006. Seven permanent photo points were established at the locations shown on Figure 6-4. A total of 21 photographs were taken at these points at tidal elevations ranging from approximately 0.58 feet MLLW to 3.3 feet MLLW. In addition, a second set of photographs were taken at six of the seven photo point locations at tidal elevations ranging from approximately 12.69 feet MLLW to 12.74 feet MLLW to show site conditions during periods of inundation. Rebar were placed at the photo point locations and the points surveyed to allow for reproducibility in subsequent monitoring years.

Six elevation stakes were placed at the locations shown on Figure 6-4. Photographs showing the elevation stakes in place were taken and the stakes were surveyed to allow for replacement if needed. Top of stake and ground surface elevations were also measured. Survey information for photo point locations and elevation stakes are included in Table 6-3.

Water surface elevation monitoring was performed between April 18, 2006 and November 2, 2006. The monitoring was completed using a hydrostatic pressure water level sensor attached to a data logger. The logger recorded water depth during periods of inundation in 10-minute intervals. The elevation of the data probe was surveyed to NGVD29 datum.

Johnny's Dock Habitat Enhancement – The qualitative ground survey of the site was completed on July 10, 2006. Two permanent photo points were established at the locations shown on Figure 6-5. A total of four photographs were taken at these points at tidal elevations ranging from approximately -2.82 feet MLLW to -2.75 feet MLLW. Rebar were placed at the photo point locations and the points surveyed to allow for reproducibility in subsequent monitoring years. Survey information for photo point locations is included in Table 6-3.

Head of Thea Foss Shoreline Habitat – The qualitative ground survey of the site was completed on July 10, 2006. Two permanent photo points were established at the locations shown on Figure 6-6. Two photographs were taken at these points at tidal elevations ranging from approximately -2.96 feet MLLW to -2.89 feet MLLW. Rebar were placed at the photo point locations and the points surveyed to allow for reproducibility in subsequent monitoring years. Survey information for photo point locations is included in Table 6-3.

SR 509 Esplanade Riparian Habitat – The qualitative ground survey of the site was completed on July 10, 2006. Three permanent photo points were established at the locations shown on Figure 6-7. A total of four photographs were taken at these points at tidal elevations ranging from approximately -2.68 feet MLLW to -2.28 feet MLLW. Rebar were placed at the photo point locations and the points surveyed to allow for reproducibility in subsequent monitoring years. Survey information for photo point locations is included in Table 6-3.

Log Step Habitat Enhancement – The qualitative ground survey of the site was completed on July 10, 2006. One permanent photo point was established at the location shown on Figure 6-8.

One photograph was taken at this point at a tidal elevation of -1.24 feet MLLW. Rebar was placed at the photo point location and the point surveyed to allow for reproducibility in subsequent monitoring years. Survey information for photo point locations is included in Table 6-3.

6.2.3 Summary of Findings from Baseline Habitat Mitigation Area Monitoring

The primary purpose of the Year 0 monitoring was to document that habitat mitigation and enhancement sites were constructed and planted in accordance with the approved plans and that sites are in a healthy condition required for plant establishment. In addition, this monitoring event provides documentation of the baseline conditions at the sites. Results of monitoring at each of the sites is described in detail in the Year 0 Baseline Monitoring Habitat Mitigation Area Monitoring Preliminary Findings Memorandum, and are summarized in the sections below.

North Beach Habitat – The qualitative ground survey confirmed that the site had been constructed and planted in general accordance with the approved plans. Some of the willows were planted farther back from the top of bank than intended in the plan, and are currently in close proximity to the access road. Therefore, additional willows will be planted to ensure that adequate coverage is achieved. Additional distichilis will also be planted in the nodes since there was only an estimated 50% survival rate for these plantings.

Minor repairs to the goose exclusion grids are needed along with some minor weeding of the area.

Middle Waterway Tideflat Habitat – The qualitative ground survey confirmed that the site had been constructed and planted in general accordance with the approved plans. The plants in the brackish marsh nodes appear to be establishing well. Salinity monitoring indicated that the sprinkler system is functioning as designed. Continued adjustment and maintenance of the system, along with monitoring of plant health will be performed to achieve the site performance standards.

Some erosion from seeps and springs in the marsh area was identified, but is minor and consistent with the amount that would be expected in this setting. In addition, pickleweed is beginning to spread into the southern portion of the site from seed sources in the head of the Middle Waterway.

Minor repairs to the goose exclusion grids are needed, along with some limited weeding. There is some bark and other wood debris accumulating within the goose exclusion grids which should be removed as needed to prevent impact to the plants.

Puyallup River Side Channel – The qualitative ground survey confirmed that the site had been constructed and planted in general accordance with the approved plans. Only one small area of erosion was identified on the outside of the old levee, but no action is necessary at this time.

Overall, this site appeared to be in excellent condition. Plants are establishing well, and only minor weeding and trash removal are needed at this time. A small temporary shelter, believed to be a fishing camp, has been established on the north half of the old levee. The City has been in contact with Puyallup Tribe representatives on this issue.

Hylebos Creek Mitigation Site – The qualitative ground survey confirmed that the site had been constructed and planted in general accordance with the approved plans. Planted species are generally doing well, although there is some drought stress on the upland forest due to the unusually dry summer. Some bulrush were found to be volunteering in the downstream lobe. Overall, this site appeared to be in excellent condition. Only minor weeding and the repair of one of the LWD anchors is needed at this time.

As a result of final discussions with the agencies regarding the acceptance of this site, the City is in the process of placing additional LWD as well as smaller branches at the site and in Hylebos Creek. Figure 6-4 has been updated to include this information. In addition, additional red alders will be planted in Spring 2007 in compliance with agency request.

Johnny's Dock Habitat Enhancement – The qualitative ground survey confirmed that the site had been constructed and planted in general accordance with the approved plans. Overall, the site appeared to be in excellent condition. The distichilis and pickleweed appear to be establishing well, however, the tufted hairgrass has not. A survey was performed to confirm the elevation of the top of the planting area. The survey indicated that the top of the goose exclusion fence was between approximate elevations 13.7 feet MLLW and 14.6 feet MLLW. This was higher than the planned planting zone of 12 feet MLLW to 13 feet MLLW, and therefore, the hairgrass was likely planted at an elevation somewhat higher than is optimum for its growth. Therefore, these plants have been replaced at a somewhat lower elevation.

Head of Thea Foss Shoreline Habitat – The qualitative ground survey confirmed that the site had been constructed and planted in general accordance with the approved plans. The fleshy jaumea is not doing well at the site and the City plans to change species and replace the jaumea with more distichilis and deschampsia per discussions with the agencies as outlined in Section 6.4.2. In addition, some of the willows will be replaced in the higher elevations where survivability was estimated at 50%. Some gumweed is volunteering at the site.

Minor repairs to the goose exclusion grids are needed, along with some weeding.

SR 509 Esplanade Riparian Habitat – The qualitative ground survey confirmed that the site had been constructed and planted in general accordance with the approved plans. The site appeared to be in excellent condition, with only reduced survivability on the Pacific madrone. The sprinkler system in the area under the bridge was in good repair and is adequately watering this area. For ease of maintenance of this area, the sprinkler system was extended, after initial construction was completed, to the north and south ends of the planting area.

Minor weeding and replanting of some of the Pacific madrone are the only required follow-up activities at this site.

Log Step Habitat Enhancement – The qualitative ground survey confirmed that the site had been constructed and planted in general accordance with the approved plans. Overall, the site appeared to be in excellent condition with close to 100% survival of the american dunegrass. The tufted hairgrass had a fairly low survival rate, and will be replaced in Spring 2007.

Minor weeding and replanting of the tufted hairgrass are the only required follow-up activities at this site.

As outlined above, very few follow-up actions were identified during this monitoring event and these are summarized in Table 6-4. The status of each of these follow-up actions is described in Section 6.3.

6.2.4 Schedule of Habitat Mitigation Area Monitoring Activities

The next round of habitat mitigation area monitoring activities is scheduled for Year 1, in 2007. Year 1 monitoring activities are summarized in Table 6-5 and include qualitative site surveys and photo documentation at both the mitigation sites and the enhancement sites. In addition, quantitative vegetation monitoring, elevation monitoring, and juvenile salmonid monitoring will be performed at the mitigation sites. The juvenile salmonid monitoring will be conducted during the first and last weeks of May 2007. The remainder of these activities will be conducted in July 2007 during appropriate tidal cycles.

In addition, invertebrate monitoring will be performed at the Puyallup River Side Channel and the Hylebos Creek Mitigation Site in conjunction with the qualitative ground surveys. Finally, the last planned salinity sampling event will be scheduled in March 2007 or April 2007 at an appropriate tidal cycle.

6.3 Habitat Mitigation Area Maintenance

6.3.1 Maintenance Approach

The approach established at this time by the City for maintenance of the mitigation sites includes a combination of site stewardship (a private contractor) and maintenance by the Washington Conservation Crew (WCC). Both the site steward and WCC have visited the sites periodically during the year doing both routine inspections and maintenance, as well as specifically following up on issues identified during the qualitative site surveys.

6.3.2 Completed Maintenance Activities

Since the performance of the qualitative site inspections in July 2006, the WCC has followed up on the majority of the maintenance issues identified. Specifically, they have performed the following activities:

- Repaired goose exclusion grids at the Head of Thea Foss Shoreline Habitat;
- Picked up trash as needed from all sites;
- Tightened the anchors on the LWD at the Log Step Habitat Enhancement area; and
- Weeded at the Head of Thea Foss Shoreline Habitat, Puyallup River Side Channel, Log Step Habitat Enhancement, SR 509 Esplanade Riparian Habitat, and Middle Waterway Tideflat Habitat.

Items remaining at this time include:

- Repair goose exclusion grids as needed at the North Beach Habitat and Middle Waterway Tideflat Habitat;
- Minor weeding at the North Beach Habitat and the Hylebos Creek Mitigation Site;

- Removal of any remaining wood debris within goose exclusion at the Middle Waterway Tideflat Habitat; and
- Complete placement and tightening of LWD at the Hylebos Creek Mitigation Site.

6.3.3 Replanting Performed as Part of Maintenance Activities

The primary purpose of this baseline monitoring event was to confirm that the sites had been constructed and planted in accordance with the approved plans and specifications. Under the approved OMMP, replanting will generally be performed as a contingency action if, upon completion of quantitative evaluation, it is determined that plant coverage is less than the performance standards. The first quantitative vegetation survey is not scheduled until Year 1 monitoring in 2007. However, during the qualitative surveys, the City identified some areas where certain plants had not become established after planting. The reason for this varied, from certain species being planted somewhat higher than optimum at the Johnny's Dock Habitat Enhancement and the Head of Thea Foss Shoreline Habitat, to willows being planted too far back from the top of slope at the North Beach Habitat, to potential drought stress during establishment. In some cases, the cause could not be identified.

Because of these issues, and while not specifically required at this time, the City has elected to do some replanting and additional plantings as part of maintenance activities to ensure the establishment of these habitat areas. The following replanting/additional plantings have been completed at this time:

- Harvested willow stakes from Swan Creek and planted them at the Head of Thea Foss Shoreline Habitat;
- Planted 70 tufted hairgrass at the Johnny's Dock Habitat Enhancement;
- Planted 32 tufted hairgrass at the Log Step Habitat Enhancement;
- Planted 86 oceanspray at the Puyallup River Side Channel;
- Planted 10 Pacific madrone, 28 oceanspray, 20 rhododendron, and 10 huckleberry at the SR 509 Esplanade Riparian Habitat;
- Planted 238 tufted hairgrass at the Head of Thea Foss Shoreline Habitat; and
- Planted 86 oceanspray in the riparian area at the Middle Waterway Tideflat Habitat;

Other replanting activities planned for Spring 2007 include the following:

- Plant additional pickleweed at the Johnny's Dock Habitat Enhancement;
- Plant additional tufted hairgrass at the Log Step Habitat Enhancement;
- Plant additional riparian plants at the Puyallup River Side Channel, including snowberry, big leaf maple, red alder, cottonwood, and red flowering currant;
- Plant approximately 280 red alder at the Hylebos Creek Mitigation Site;
- Plant additional riparian plants, including shore pine, red flowering currant, and salal at the SR 509 Esplanade Riparian Habitat;
- Plant distichilis (saltgrass) and tufted hairgrass at the Head of Thea Foss Shoreline Habitat, likely, to replace the fleshy jaumea, per EPA approval (see Section 6.4.2);

- Harvest additional willows, likely from Swan Creek, and plant at the Head of Thea Foss Shoreline Habitat;
- In accordance with the approved design, construct four new planting nodes at the Middle Waterway Tideflat Habitat to accelerate colonization. Plantings will include pickleweed, distichilis, and tufted hairgrass. Nodes will be constructed and planted pending agency approval of the locations proposed in an email dated January 23, 2007; and
- Plant additional oceanspray, willows, and distichilis at the North Beach Habitat.

6.4 Contingency Planning and Response Actions

The approach to adaptive management and contingency planning are set forth in Sections 6.4 and 6.5 of the OMMP, respectively. To date, only two issues have been identified relative to habitat mitigation monitoring that have required potential review of adaptive management and/or contingency planning. These issues are described below.

6.4.1 St. Paul Beach Habitat / North Beach Habitat

After completion of the qualitative site survey in July, some increasing erosion of an area of the St. Paul Beach portion of the North Beach Habitat was identified. The City verbally informed EPA that we were tracking this issue in August 2006, and followed up with an email on October 5, 2006. In that email, the City proposed the placement of some LWD at the northwest corner of the Middle/St. Paul Waterway peninsula to protect the bank.

After further email correspondence, it was determined that the best course of action was to conduct a meeting at the site to further evaluate the conditions. The site meeting was held on December 7, 2006. A Coastal Geologist from the Department of Ecology attended the meeting to provide additional expertise. The consensus at the meeting was that the movement of material at the site was not unusual, and that it had likely not reached a state of equilibrium. The outcomes from the meeting were to:

- Take quarterly photographs of the site at the established photo points and other relevant locations to track continued movement of the beach at the site. This will be done in conjunction with the quarterly monitoring of the CDF beginning in March 2007;
- Develop a modified plan for placement of LWD at the northwest corner of the peninsula; and
- Evaluate the potential for placement of additional beach nourishment material in the future. The first step of this is to perform a gradation of the surface materials currently present at the beach and provide that gradation to the Army Corps of Engineers. The purpose of providing the gradation is to evaluate whether materials are available in Commencement Bay that could be used for nourishment of the St. Paul Beach at a future date. A sample of material has been taken and the grain size analysis is being performed.

In summary, in terms of the Contingency Planning Procedures set forth in Section 6.5 of the OMMP, the following tasks in the Contingency Screening Process have been performed:

- **Task 1 – Screening Levels**: The City identified that erosion was taking place at the site.

- **Task 2 – Notice and Verification**: The City notified EPA verbally in August 2006, and via email on October 5, 2006.
- **Task 3 – Meeting and Consultation**: A meeting was held on December 7, 2006, to review the site conditions.
- **Task 4 – Response to Contingency Screening**: In accordance with the meeting outcome, the City will continue to monitor the site and is also gathering information that may be needed for determination of future response actions. In addition, the City is preparing a proposal for placement of additional LWD as a contingency action, and will place the LWD pending agency approval.

6.4.2 Replacement of Plants at the Head of Thea Foss Shoreline Habitat

During the qualitative site inspection it was found that there was a low survival rate for the fleshy jaumea and the tufted hairgrass. As described in Section 6.3.3, approximately 50% of the number of tufted hairgrass originally planted has been replaced at this time with additional tufted hairgrass to be planted in Spring 2007. When completed, 400 of the original 500 tufted hairgrass plants will have been replaced.

In attempting to order additional fleshy jaumea for replacement at the site, it was found that the species was unavailable at this time from the nurseries. As a result, the City sent an email request to EPA on January 3, 2007, to modify the planting plan to include 200 additional tufted hairgrass in lieu of the fleshy jaumea.

Through subsequent email correspondence and review of the construction and planting plans, it was identified that the elevation of the log step was probably too high to support the growth of the jaumea. Therefore, on January 10, 2007, U.S. Fish and Wildlife Services recommended the planting of a combination of tufted hairgrass, distichlis, and possibly some jaumea and additional species. Therefore, the City has proposed to plant approximately 200 additional tufted hairgrass and 300 additional distichilis at the site to replace the 300 fleshy jaumea. These plantings will be completed per agency approval received on February 15, 2007.

6.5 Additional Work at the Hylebos Creek Mitigation Site

As part of the final approval of the construction of the Hylebos Creek Mitigation Site, a number of meetings and discussions have been held. As a result, and in the interest of working toward final acceptance of the site by EPA, several work elements have been agreed upon:

- Additional LWD has been placed at the site, and several pieces of LWD are being placed in Hylebos Creek. In addition, some small branches will be placed around the LWD;
- Approximately 280 additional red alders will be planted in the forested wetland area in Spring 2007;
- Invertebrate monitoring has been added in Monitoring Years 1 and 3 to confirm the presence of juvenile salmon prey;
- Water Surface Elevation Monitoring was performed between April 2006 and November 2006, and additional Water Surface Elevation Monitoring will be performed in Monitoring Years 3, 5, 7, and 10; and

- Annual centerline transect surveys of the two channels will be performed to monitor elevation changes over time.

The City believes that the additional water surface elevation monitoring and annual centerline transect survey information will allow for reasonable evaluation of this site relative to the established performance standards in the future.

TABLES

6-1 - Baseline Monitoring Activities

6-2 - Mitigation Area Acreage

6-3 - Survey Information for Photo Points and Elevation Stakes

6-4 - Summary of Preliminary Findings from Baseline Habitat Mitigation Area Monitoring

6-5 - Year 1 Monitoring Activities

FIGURES

6-1 - North Beach Habitat

6-2 - Middle Waterway Tideflat Habitat

6-3 - Puyallup River Side Channel

6-4 - Hylebos Creek Mitigation Site

6-5 - Johnny's Dock Habitat Enhancement

6-6 - Head of Thea Foss Shoreline Habitat

6-7 - SR 509 Esplanade Riparian Habitat

6-8 - Log Step Habitat Enhancement

Table 6-1
Baseline Monitoring Activities

	North Beach Habitat	Middle Waterway Tideflat Habitat	Puyallup River Side Channel	Hylebos Creek Mitigation Site	Thea Foss Enhancement Areas
Qualitative Ground Survey	x	x	x	x	x
Photo Documentation	x	x	x	x	x
Quantitative Vegetation Monitoring					
Invertebrate Monitoring					
Elevation Monitoring	x	x	x	x	
Surface Water Elevation Sampling				x	
Brackish Marsh Salinity Monitoring		x			
Juvenile Salmonid Monitoring					

Table 6-2
Mitigation Area Acreage

Site	Subtidal, acres (Below -10 feet MLLW)	Littoral, acres (Between OHW and -10 feet MLLW)	Total Aquatic Habitat, acres	Riparian, acres
Puyallup River Side Channel		5.39	5.39	0.44
North Beach	0.10	7.26	7.36	0.30
Middle Waterway Tideflat Habitat		8.84	8.84	0.55
Hylebos Creek Mitigation Site		0.58	0.58	0.30

[1] At the Hylebos Creek Mitigation Site, the riparian area subject to performance monitoring is identified as forested wetland (see Figure 6-4).

Table 6-3
Survey Information for Photo Points and Elevation Stakes

Site	Photo Point Identification	Elevation Stake Identification	Coordinates	Elevation Top of Stake	
				Top of Stake	Depth from Top of Stake to Sediment Surface
North Beach	P-1		710023.3 / 1161327		
	P-2		709994.3 / 1161228		
	P-3		709909.6 / 1160964		
	P-4		709869.5 / 1160958		
	P-5		709671.7 / 1160934		
	P-6		710551.3 / 1160645		
		E-1	710056.7 / 1161259	-0.689	1.07
		E-2	710001.4 / 1161054	8.207	1.09
		E-3	709900.2 / 1160916	5.383	0.68
		E-4	709818.6 / 1160941	5.984	1.02
		E-5	709742.3 / 1160912	3.442	1.05
Middle Waterway Tideflat Habitat	P-1		708961.1 / 1161384		
	P-2		708534.1 / 1161575		
	P-3		708040.6 / 1161800		
	P-4		707863.4 / 1161619		
		E-1	708976.1 / 1161325	6.801	1.05
		E-2	708792.6 / 1161327	0.398	1.05
		E-3	708545.3 / 1161470	-1.133	1.05
		E-4	708494.6 / 1161558	5.429	1.02
		E-5	708269 / 1161523	0.003	1.05
		E-6	707981.6 / 1161745	5.548	1.05

Site	Photo Point Identification	Elevation Stake Identification	Coordinates	Elevation Top of Stake	
				Top of Stake	Depth from Top of Stake to Sediment Surface
Puyallup River Side Channel	P-1		706460.3 / 1164098		
	P-2		706548.9 / 1164081		
	P-3		706064.8 / 1163970		
	P-4		705490.6 / 1164036		
	P-5		705143.7 / 1164421		
	P-6		705321.7 / 1164354		
		E-1	706461.3 / 1164073	6.273	1.06
		E-2	706278.4 / 1164065	3.089	1.03
		E-3	706109.5 / 1164066	1.68	1.05
		E-4	705269.5 / 1164313	0.563	1.06
		E-5	705220.3 / 1164352	2.443	1.05
		E-6	705180.7 / 1164385	4.414	1.08
Hylebos Creek Mitigation Site	P-1		706015.6 / 1181008		
	P-2		705967.8 / 1181125		
	P-3		705840.7 / 1181168		
	P-4		705733.2 / 1181050		
	P-5		705943.3 / 1181089		
	P-6		705787.3 / 1181053		
	P-7		705708.4 / 1181016		
		E-1	705743.9 / 1181053	2.483	1.07
		E-2	705904.4 / 1181079	2.474	1.05
		E-3	705819.2 / 1181135	6.49	1.07
		E-4	705869.6 / 1181162	3.829	1.07
		E-5	705955.1 / 1181110	2.97	1.07
		E-6	705999 / 1181026	2.763	1.03

Site	Photo Point Identification	Elevation Stake Identification	Coordinates	Elevation Top of Stake	
				Top of Stake	Depth from Top of Stake to Sediment Surface
Johnny's Dock Habitat Enhancement	P-1		703065.1 / 1160772		
	P-2		703022.6 / 1160731		
Head of Thea Foss Shoreline Habitat	P-1		702352.7 / 1160773		
	P-2		701860.2 / 1160780		
SR 509 Esplanade Riparian Habitat	P-1		702697.8 / 1160410		
	P-2		702498.2 / 1160286		
	P-3		702257.3 / 1160311		
Log Step Habitat Enhancement	P-1		705509.6 / 1160052		

Note: Horizontal Datum 83-91
Vertical Datum NGVD 29

Table 6-4

Summary of Preliminary Findings from Baseline Habitat Mitigation Area Monitoring

Site	Corrective Action Tasks
North Beach Habitat	- minor repairs to the goose exclusion grid - minor weeding - replanting
Middle Waterway Tideflat Habitat	- minor repairs to the goose exclusion grids - removal of wood debris within goose exclusion
Puyallup River Side Channel	- minor weeding - trash removal
Hylebos Creek Mitigation Site	- minor weeding - repair of anchor on LWD - place additional LWD, small branches, and plant additional red alder per final site approval agreement
Log Step Habitat Enhancement	- minor weeding - tighten anchors on logs
SR 509 Esplanade Riparian Habitat	- minor weeding
Head of Thea Foss Shoreline Habitat	- minor repairs to the goose exclusion grid - minor weeding - replanting
Johnny's Dock Habitat Enhancement	- survey to confirm elevation at top of planting - replanting of Tufted Hairgrass

Table 6-5
Year 1 Monitoring Activities

	North Beach Habitat	Middle Waterway Tideflat Habitat	Puyallup River Side Channel	Hylebos Creek Mitigation Site	Thea Foss Enhancement Areas
Qualitative Ground Survey	x	x	x	x	x
Photo Documentation	x	x	x	x	x
Quantitative Vegetation Monitoring	x	x	x	x	
Invertebrate Monitoring			x	x	
Elevation Monitoring	x	x	x	x	
Water Surface Elevation Sampling					
Brackish Marsh Salinity Monitoring		x			
Juvenile Salmonid Monitoring	x	x	x	x	

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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 6-1
North Beach Habitat

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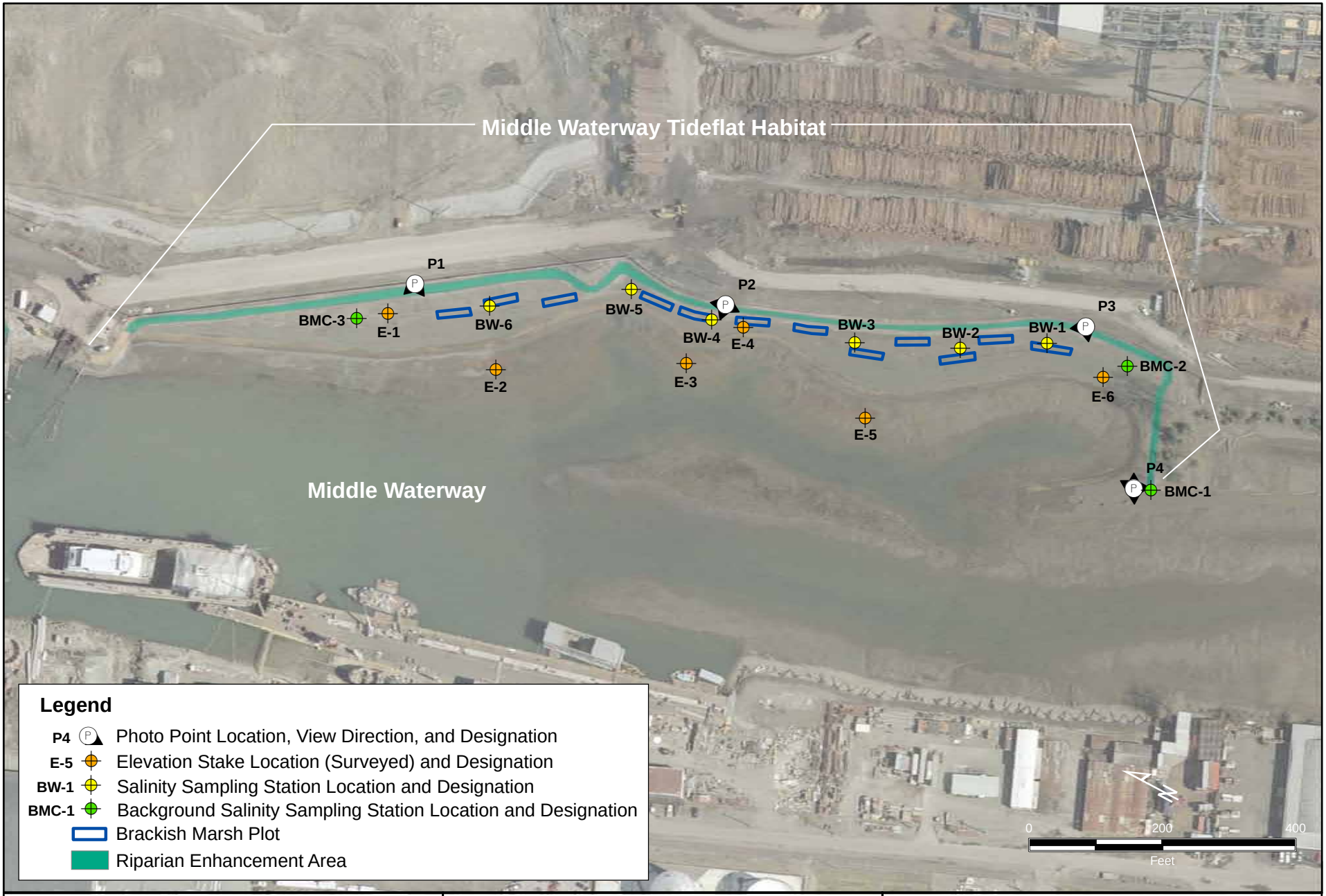

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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 6-2
Middle Waterway Tideflat Habitat

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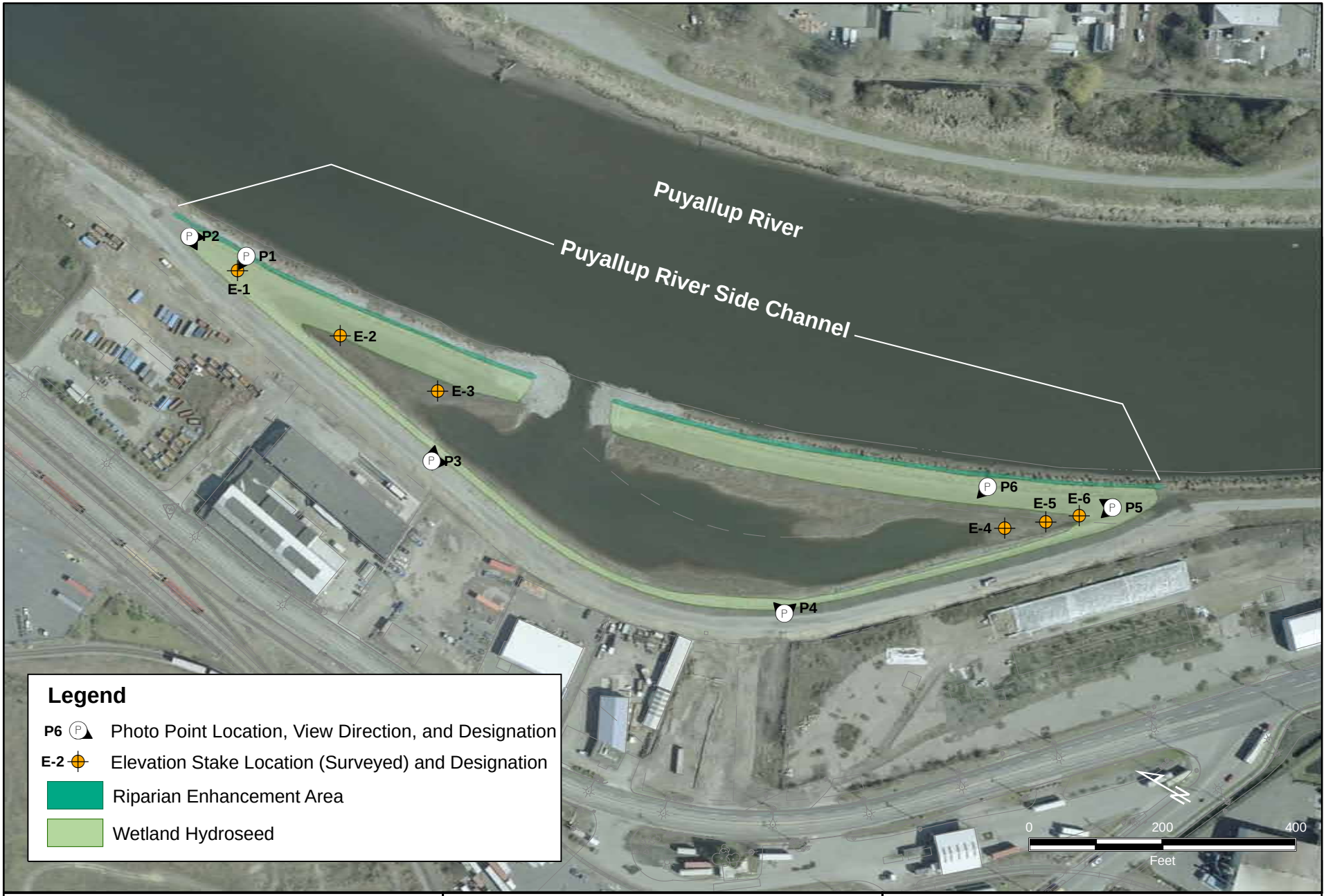

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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 6-3
Puyallup River Side Channel

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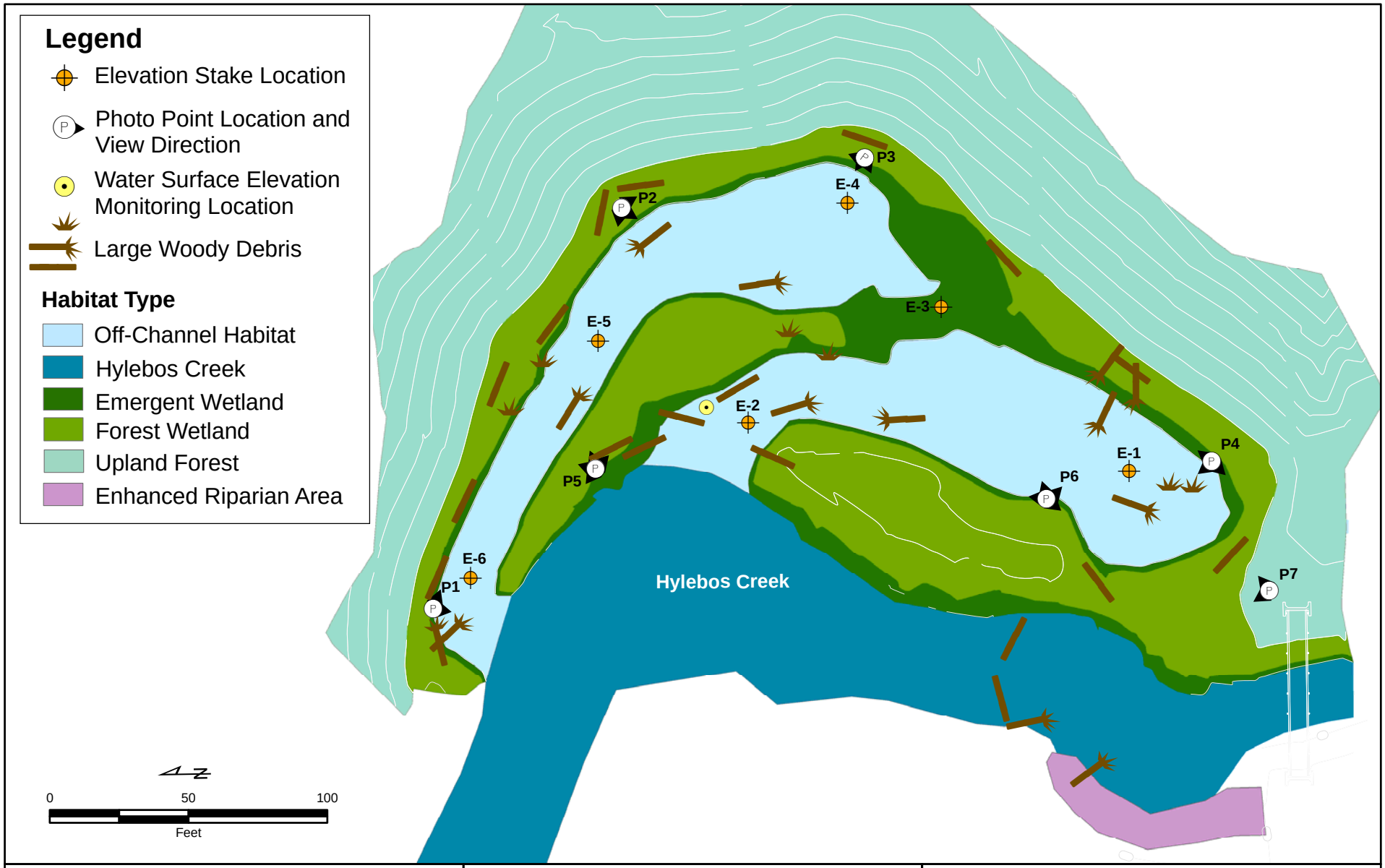

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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 6-4
Hylebos Creek Mitigation Site

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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 6-5
Johnny's Dock Habitat Enhancement

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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 6-6
Head of Thea Foss Shoreline Habitat

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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 6-7
SR 509 Esplanade Riparian Habitat

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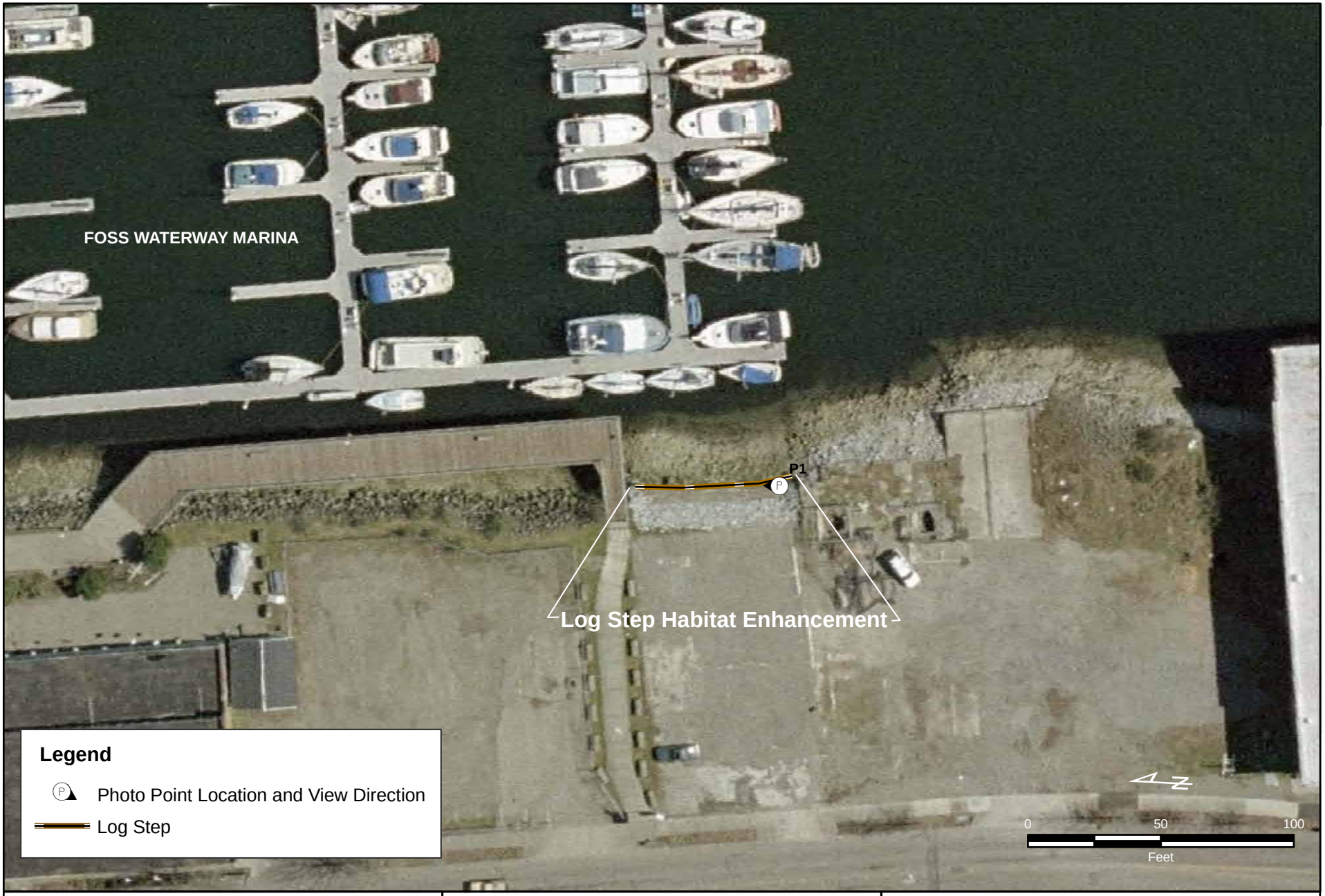

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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 6-8
Log Step Habitat Enhancement

DATE: 2/20/2007 3:11:40 PM
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7.0 ADDITIONAL PROJECT RELATED ACTIVITIES

7.1 Introduction

Numerous other activities were identified during the development of the OMMP that have some affect on the project. Therefore, status updates on these various activities will be provided for informational purposes in this section of the annual reports.

7.2 Institutional Controls

In September 2006, the City received EPA approval of an Institutional Controls Plan for the project. The objective of the plan is to ensure that contamination capped in the Thea Foss and Wheeler-Osgood Waterways and in the Confined Disposal Facility within the St. Paul Waterway, and contamination which is otherwise left in place in the Thea Foss and Wheeler-Osgood Waterways (i.e., in natural recovery areas), remains contained and/or undisturbed for the purpose of:

- Reducing the potential exposure of marine organisms to contaminated sediments disposed of and confined in aquatic disposal sites or confined by capping; and
- Reducing the potential exposure of marine organisms to contaminated sediments left in place in the Thea Foss and Wheeler-Osgood Waterways.

To date, the following elements of the plan have been implemented by the City:

- The plan requires that restrictive covenants be placed on that portion of a property abutting the Thea Foss and Wheeler-Osgood Waterways where active remediation took place. The purpose of these covenants is to ensure that others refrain from activities that may interfere with or adversely affect the implementation, integrity, or protectiveness of the remedial measures and/or habitat improvements constructed as a part of this project. On January 12, 2007, restrictive covenants were recorded for all City-owned properties abutting the waterway. In addition, the City worked with the two parties who did not sign the Consent Decree, the Foss Waterway Development Authority (FWDA) and Foss Landing LLC, to place restrictive covenants on these properties. To date, the restrictive covenants have been recorded on properties within the City's work area owned by the FWDA. Foss Landing LLC recently recorded a boundary line adjustment for their properties, so there is a short delay in filing their restrictive covenants until the Pierce County Auditor assigns new parcel numbers. EPA is working with other parties who did sign the Consent Decree to record covenants on these properties. Many of these have been filed and others are currently in process.
- The City provided a copy of the Institutional Controls Plan to the Washington State Department of Transportation with the intent to assure that maintenance of the 11th Street Bridge and the SR 509 Bridge is undertaken in a manner that protects the remedial actions within the waterways.
- The City provided notice, and a copy of the Institutional Controls Plan, to all parties who signed the Consent Decree (i.e., the settling parties). The notice indicated that EPA had issued their Certification of Completion of Remedial Action Construction and reminded property owners to refrain from any actions that would adversely affect the protectiveness of the remedy.

- Project representatives worked with the City's Building and Land Use Services (BLUS) division to develop procedures to ensure that future development in and adjacent to the areas of the waterways where remedial actions and habitat mitigation work have been completed, are undertaken in a manner that protects the remedy. Specifically, the following actions were undertaken:
    - An informational handout was drafted and submitted to the agencies for approval. Once finalized, the handout will be given to persons seeking a building, shoreline, and/or wetlands permit in affected areas;
    - Copies of the City's, the Utilities', and DNR's Institutional Controls Plans were provided to the City's Land Use Administrator and the Division Manager of BLUS;
    - Training sessions were conducted with applicable permitting and inspection staff to provide information and to help ensure that projects being proposed in affected areas are "flagged" by BLUS for additional review; and
    - A data layer was added to the City's govME website showing cleanup, sediment disposal, and mitigation areas. In addition, links to the Institutional Controls Plan and to additional information about the cleanup were added;
- The City submitted a request to update navigational charts to the National Oceanic and Atmospheric Administration (NOAA);
- The City submitted a request to the United States Coast Guard (USCG) to establish a regulated navigation area prohibiting anchorage and other activities that could disturb the cap;
- The City is working with the USCG on the potential placement of additional signage in the waterway;
- Informational signs are being produced and will be installed in the upland area; and
- A training session with the Tacoma Police Marine Unit was conducted to share information about the cleanup and to exchange contact information for potential use in the event of activities that could impact the remedy.

To date, only one development proposal has come in where the proposal needed to be evaluated relative to its potential impact on cleanup areas. This occurred in early 2007 at the Foss Waterway Marina property where the owner had previously been issued a Hydraulic Project Approval (HPA) and a Corps of Engineers Permit for removal and replacement of several boathouses. In a letter dated January 31, 2007, EPA provided conditions related to piling removal and replacement, along with requirements for monitoring during the work. The work is currently underway and is expected to be completed by the end of February.

7.3 Stormwater Source Control

The City has an ongoing source control program that has been underway for over 20 years. The stormwater monitoring and source control program for the municipal storm drainage system tributary to the Thea Foss and Wheeler-Osgood Waterways is being conducted as required by the Consent Decree and in cooperation with Ecology. The need for and prioritization of specific additional source controls is evaluated in conjunction with the monitoring of the sediments being performed under the OMMP.

The following activities are currently underway.

Stormwater Monitoring Program – The City continues to evaluate potential source(s) of the chemicals of concern in the Thea Foss Basin through monitoring of stormwater, baseflow, and particulate matter in seven outfalls. Results for each outfall are evaluated relative to other outfalls to establish the chemicals of concern for each basin. Based on this analysis, the chemicals of concern for each basin are:

- Mercury, PAHs, phthalates and PCBs/pesticides in Basin 230;
- LPAHs in Basin 237A;
- Mercury, PAHs, and phthalates in Basin 235;
- Acenaphthene, mercury and phthalates in Basin 243;
- PAHs in Basin 254; and
- Acenaphthene and phthalates in Basin 245.

The stormwater monitoring program is only one part of the Thea Foss Post-Remediation Source Control Strategy. This strategy is set forth in the Stormwater Control Remedial Design Work Plan Addendum dated November 2001, which is included by reference in the Consent Decree. The priority of continuing source control actions are set as part of the City's Thea Foss Post-Remediation Source Control Strategy and are presented in the Thea Foss Waterway Annual Source Control Reports.

Spills, Complaints, and Inspections – City staff responded to 577 spills/complaints in 2006 including conducting investigations as well as providing technical assistance. This included 142 spills/complaints in the Thea Foss Basin. In addition, staff conducted 162 business inspections in 2006. Information from various source control field activities are entered into a database. This database continues to expand and includes many data points making it an effective tool for retrieving historical information and examining trends.

Sediment Phthalate Work Group – The City, EPA, Ecology, King County/Metro, and Seattle Public Utilities continue to work together to discuss and evaluate phthalates and their affect on sediments. Topics being evaluated by this group include sources in the environment, source control, toxicity, and response actions. A Policy Group, including representatives from each of these agencies approved a work plan and schedule on October 9, 2006. The work group has met numerous times to date, and several additional meetings are planned for Spring and Summer 2007.

EvTec Stormwater Structural Control Study – The City is continue to work on the evaluation of possible stormwater treatment options using a test facility located adjacent to the Ship Canal in Seattle. Data collection was completed on the StormFilter Unit in December 2005, and a report is currently being prepared for expected submittal for agency review in April 2007. Sampling of the AquaFilter is currently underway.

City of Tacoma Staffing – In 2006, the City's Stormwater section hired two permanent, full time Source Control Representatives. In addition, the City is moving forward with a reorganization of the Source Control workgroup with the intent of assimilating the storm and sanitary sections. This newly formed Environmental Compliance Support section will include separate units dedicated to inspections, investigations/field services and enforcement. The Source Control Representatives from the combined section will perform spill/complaint responses and business inspections to meet the requirements of Tacoma's Phase I Municipal Stormwater NPDES

Permit and wastewater pretreatment monitoring. The representatives will assist the Foss Source Control Senior Environmental Specialists as needed.

Additional information on the various ongoing stormwater source control activities can be found in the Annual Stormwater Source Control Reports. In addition, in January 2007, the City of Tacoma submitted the August 2001-August 2006 Thea Foss Stormwater Monitoring Report to Ecology and EPA for review and approval.

7.4 Recontamination in the Head of the Thea Foss Waterway

As described in Section 1.0, operations, maintenance, and monitoring of remedial activities in the head of the Thea Foss Waterway are being performed by the Utilities as part of the Head of the Thea Foss Waterway Remediation Project (Figure 1-1). These activities are being performed under the Operations, Maintenance, and Monitoring Plan for the Head of the Thea Foss Waterway Remediation Project (Tetra Tech 2003). OMMP activities in this area include cap integrity, recontamination, and recolonization monitoring. An increased level of monitoring has been incorporated into the OMMP for the Head of the Thea Foss Waterway to evaluate recontamination in the area where additional cap material was placed in response to construction residuals and to evaluate the presence and concentration of BEHP and PAHs.

7.4.1 Placement and Monitoring of Additional Cap Material

As part of remedial activities in the City's work area, additional cap material was placed in the Utilities' work area (i.e., the head of the Thea Foss Waterway) between approximate Stations 70+10 and 73+00 in response to the presence of dredge residuals containing chemical concentrations greater than the SQOs. The additional cap material was placed by the City in December 2005. Documentation of the placement of additional cap material and post-placement confirmation sampling and analysis is presented in Construction Correspondence Memorandum 2230 (CR 2230) provided in the Remedial Action Construction Report (RACR) (City of Tacoma 2006).

In response to a request by EPA (November 30, 2005), the Utilities' OMMP for the Head of the Thea Foss Waterway was subsequently revised to include additional sampling locations and sampling and analysis frequency to monitor the effectiveness of the additional cap material placement. The revision to the Utilities' OMMP was identified in a plan that was cooperatively developed by the City and representatives of the Utilities. This plan was approved by EPA on May 4, 2006. The plan was incorporated into the OMMP for the Head of the Thea Foss Waterway Remediation Project as an amendment.

Monitoring was performed in the area of additional cap material placement in 2006 (OMMP Year 2 for the Head of the Thea Foss Waterway) by the Utilities with City oversight in accordance with the approved amendment to the Utilities' OMMP. Compliance monitoring samples (i.e., 0 to 10 cm) were collected from WC-10, WC-11, WC-12, S-15, S-17, S-19, and S-24 and analyzed for SVOCs, metals, DDT compounds, PCBs, and conventionals (Figure 7-1). The detected chemical concentrations in compliance monitoring samples collected from the area of additional cap material placement were less than the SQOs. Additionally, benthic recolonization monitoring was performed by the Utilities in the area of additional cap material placement at WC-10, WC-11, WC-12, and S-19 as part of their Year 2 monitoring. This monitoring indicates that recolonization is taking place in the area where additional cap material was placed. The results for monitoring of the area of additional cap material placement are

presented in the Head of the Thea Foss Waterway Remediation Project, Results of Year 2 Operations, Maintenance and Monitoring Plan Sampling (Tetra Tech 2006).

7.4.2 Bis(2-ethyhexyl)Phthalate Monitoring

An additional plan was developed for bioassay testing in the head of the Thea Foss Waterway in response to the presence of BEHP at concentrations greater than the SQO in samples collected at WC-08 and WC-09. The samples were collected at WC-08 and WC-09 (located south of the additional cap material placement area) in December 2005 as part of post-placement confirmation monitoring. Documentation of sample collection and analysis is presented in Construction Correspondence Memorandum 2230 (CR 2230) provided in the RACR (City of Tacoma 2006).

The plan for bioassay testing was prepared in accordance with the OMMP for the Head of the Thea Foss Waterway. The Utilities' OMMP states that if chemical SQO exceedances are observed or predicted to occur, a plan will be developed and submitted to EPA that identifies additional field sampling to be performed to evaluate the nature, extent, and severity of SQO exceedances. The plan for bioassay testing was cooperatively developed by the City and representatives of the Utilities and submitted to EPA on March 23, 2006. The plan for bioassay testing was approved by EPA on May 1, 2006.

Based on the bioassay plan, four locations with BEHP concentrations exceeding the SQOs in samples collected as part of the Utilities' Year 2 (i.e., 2006) monitoring were selected for bioassay testing. Sample material from WC-02, WC-04, WC-05, and WC-06 were submitted for bioassay testing in accordance with the Quality Assurance Project Plan provided in the Utilities' OMMP. The results of bioassay testing showed some biological effects associated with the test sediments from the head of the waterway where BEHP is present at concentrations greater than the SQO.

A meeting was held on September 14, 2006, including representatives from EPA, Washington State Department of Ecology, Army Corps of Engineers, the Utilities, and the City to discuss the results of chemical and bioassay testing and to develop a response plan to address the test results. Subsequent to the meeting, a plan was cooperatively developed by the City and representatives of the Utilities for additional compliance monitoring within the head of the Thea Foss Waterway. The plan was submitted to EPA for review on November 28, 2006. Because the head of the waterway has not reached equilibrium, the proposed plan includes additional compliance monitoring for phthalates and PAHs in the head of the Thea Foss Waterway as part of the Utilities' Year 3 (i.e., 2007) monitoring. Sampling is expected to be performed in May 2007, pending EPA approval of the plan.

The additional sampling proposed to evaluate phthalate and PAH recontamination in the head of the Thea Foss Waterway includes collection and analysis of compliance samples (0 to 10 cm) from 11 sampling locations that were not identified for sampling as part of the Utilities' Year 3 OMMP activities. The additional compliance samples will be collected from the locations below and south of the SR 509 Bridge at the head of the Thea Foss Waterway where previous sampling and analysis identified detected BEHP at concentrations greater than the SQO (i.e., WC-01 through WC-09, WC-13, and WC-14) during Year 2. The additional compliance monitoring samples are proposed to be analyzed for total organic carbon, total solids, phthalates, and PAHs. The analyses for these parameters will be performed in accordance with the OMMP for the Head of the Thea Foss Waterway. To ensure data comparability, the

additional recontamination sampling being proposed is to be performed consistent with and in conjunction with the Utilities' Year 3 OMMP (i.e., 2007) sampling.

The results of phthalate and PAH analyses of compliance samples performed as part of the Utilities' Year 3 OMMP monitoring activities will be compared to the results of previous monitoring to evaluate temporal and spatial concentration trends within the head of the waterway. An evaluation will be performed to identify whether phthalate and PAH concentrations are continuing to change over time and aerial extent or have equilibrated. The results will be used to inform the next steps in response to phthalate and PAH recontamination at the head of the waterway. This evaluation and any associated response actions will also consider the findings and recommendations of the Sediment Phthalate Work Group (Section 7.3).

7.5 Deauthorization of Navigation Channel in Encroachment Areas

In accordance with a Memorandum of Agreement between the Army Corps of Engineers and EPA, the City was required to initiate an informal process to deauthorize portions of the federally authorized channel where capping materials encroach on the authorized width. On December 22, 2006, the City distributed a letter to adjacent property owners which included a map of the area proposed for deauthorization, an explanation of why deauthorization is proposed and what it might mean to waterway users, a questionnaire for them to fill out and return to the City, and a date for a public meeting to discuss the proposal.

To date, questionnaires have been received from the majority of affected parties. The City is continuing to gather information from remaining affected parties and will be discussing next steps with the agencies in the near future.

7.6 Simpson Log Haul Out Operations, Maintenance, and Monitoring

Since relocation of the Log Haul Out Facility to the Middle Waterway was completed in 2004, Simpson is required to monitor this area for presence of wood debris. The City received copies of their Baseline Pre-Operations Monitoring Report from October 2004, and the Year 1 Post-Operation Report from April 2005. Copies of these reports can be found in Appendix G. The City's interest in these reports is primarily related to the presence of wood debris in the area, to the extent that it could have an impact on the success of the adjacent mitigation sites.

During Simpson's monitoring surveys, divers record observations along transects generally parallel to the shoreline. Observations include substrate type, presence of wood or other debris, and presence of vegetation. The reports include a summary of the observations made during the surveys, and no follow-up actions were identified in the documents.

It should be noted that some degree of wood accumulation was identified at the Middle Waterway Tideflat Habitat in Summer 2006. This wood debris did not appear to be impacting plant establishment at the mitigation site. During a later observation at the site in the winter, this wood debris was no longer present. According to David Adams, who has been Simpson's mitigation site steward for several years, this is an annual phenomenon due to the seasonal winds and has not impacted other mitigation site development in the area.

7.7 Tacoma Metals Waste Management

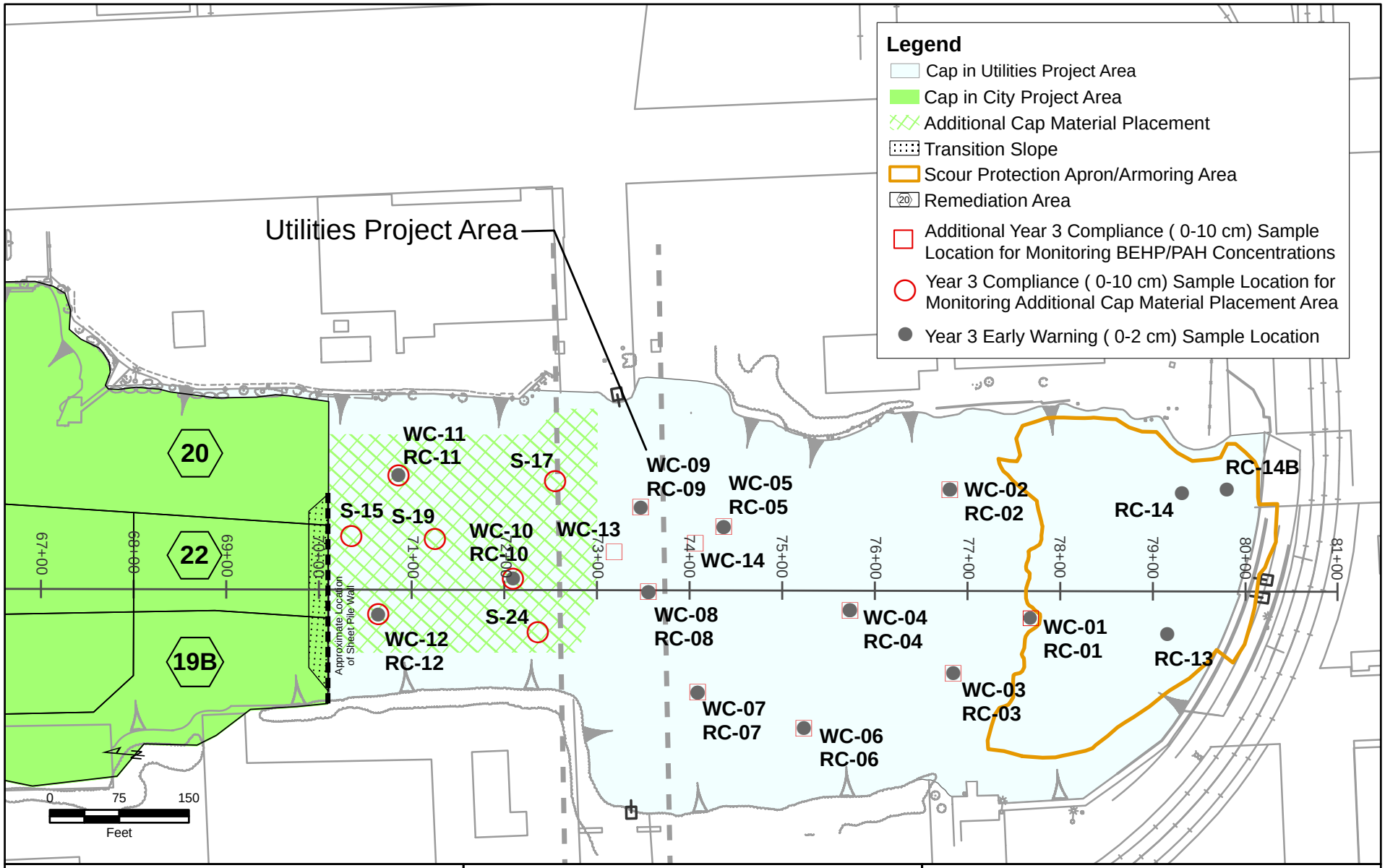
During construction of the Puyallup River Side Channel habitat mitigation site, materials being removed from the southern portion of the site were found to contain battery casings and debris. The debris was suspected as having come from a non-ferrous metal reclamation facility previously operated by Tacoma Metals on the adjacent property.

Through an agreement with Tacoma Metals' successors, and with agency approval, a lined Temporary Containment Unit (TCU) was constructed on the Tacoma Metals Property. A June 9, 2005 letter from the Washington Department of Ecology to the property owners' representative outlined the work plan for the handling of this material. In all, an estimated 2,000 CY of material excavated from the Puyallup River Side Channel site was placed in the TCU. The disposal option for this material is to be determined as part of the Tacoma Metals Model Toxics Control Act (MTCA) site cleanup.

As of the date of this report, the property owners are continuing to work with Ecology on the development of a cleanup plan for the site. It is currently anticipated that the stored material will be dealt with in summer 2007.

FIGURE

7-1 – Head of the Thea Foss Waterway Year 3, (2007) OMMP Sample Locations



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Thea Foss and Wheeler-Osgood Waterways
Year 0 Baseline OMMP Report

Figure 7-1
Head of the Thea Foss Waterway
Year 3, (2007) OMMP Sample Locations

DATE: 2/22/2007 8:34:33 AM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\Baseline Report Figures\Figure 7-1 Head of the Thea Foss Yr 3 OMMMP Locations 022207.mxd

Appendix A

Physical Cap Integrity Monitoring

Attachment A-1

Low Tide Slope Cap Inspection Preliminary Findings Memorandum

(on enclosed CD)

THEA FOSS AND WHEELER-OSGOOD WATERWAYS REMEDIATION PROJECT

YEAR 0 BASELINE MONITORING

LOW TIDE SLOPE CAP INSPECTION PRELIMINARY FINDINGS MEMORANDUM

OCTOBER 26, 2006

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY

Prepared by:

CITY OF TACOMA
FLOYD|SNIDER

PRELIMINARY FINDINGS MEMORANDUM
LOW TIDE SLOPE CAP INSPECTIONS

Introduction

This memorandum presents the findings from Year 0, baseline low tide slope cap inspection performed in the Thea Foss and Wheeler-Osgood Waterways. Low tide slope cap inspections are required as part of Cap Integrity Monitoring specified in the EPA-approved Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006). The OMMP requires that low tide slope cap inspections be conducted during Years 0 (baseline), 2, 4, 7, and 10. This memorandum presents the findings from the Year 0, baseline low tide slope cap inspections.

The following sections summarize the low tide inspection requirements and the findings of low tide inspections performed. As described in the OMMP, slope caps were inspected during low tide conditions in RAs 1, 3, 8, 14, 19A, 19B, 20, and the Sheen Source Removal Area in the Wheeler-Osgood Waterway. The low tide slope cap inspections were performed in accordance with the OMMP. Provided with this memorandum are attachments that contain the field forms and photographs documenting observations during the inspections.

Summary of Low Tide Slope Cap Inspection Requirements

The OMMP specifies that low tide slope cap inspections be performed to verify the physical integrity of the intertidal portion of slope caps and containment of underlying contaminated sediment. Low tide slope cap inspections are to be performed on the exposed shoreline portion of slope caps (including grout mat caps) in RAs 1, 3, 8, 14, 19A, 19B, and 20 when tidal elevations are at or below 0.0 feet Mean Lower Low Water (MLLW) (Figure 1). Additionally, a low tide cap inspection is to be performed in the Sheen Source Removal Area located in the Wheeler-Osgood Waterway in accordance with the OMMP.

Standardized field forms and photographs are used to document observations of slope caps at approximate 100-foot monitoring intervals along the designated shoreline areas. The inspections are to document the following observations;

- Slope cap surface characteristics (i.e., rip rap, quarry spalls, habitat mix, etc.);
- Area of slope cap coverage;
- Presence/absence of habitat mix;
- Any areas of exposed sediment due to washout of the slope cap;
- Any areas of sediment accretion;
- Evidence of groundwater seepage;
- Any apparent loss of slope cap material;
- Any apparent down-slope movement of cap materials;
- Presence of debris on the cap surface;
- Indicators of potential contamination (i.e., sheen or staining) within the surface sediment; and

- Verification that grout mat slope cap areas are effectively containing the underlying contaminated sediments.

The OMMP requires that low tide slope cap inspections be conducted during Years 0 (baseline), 2, 4, 7, and 10.

Summary of Field Activities

Year 0, low tide slope cap inspections were initiated in July 2006 and completed in October 2006. Initial inspections were performed July 10-12, 2006, in RAs 1, 3, 8, 14, 19A, 19B, and 20 when tidal elevations were at or below 0.0 feet MLLW. Additional photographs were subsequently taken in several areas on August 9, 2006, as photographs for several monitoring intervals taken during the July monitoring were not of satisfactory quality (i.e., were too dark) or did not provide adequate coverage of specific areas. Finally, a low tide inspection was performed at the Sheen Source Removal Area on October 3, 2006, when the tidal elevation was 0.0 feet MLLW. The low tide inspection of the Sheen Source Removal Area was added to post-construction monitoring activities during finalization of the OMMP in September 2006.

Prior to initiation of inspection activities performed July 10-12, 2006, a quality control check was performed on coordinates recorded by the Global Positioning System (GPS) unit used to document monitoring interval endpoints and photograph points. The GPS readings were within 10 feet of the recorded benchmark coordinates as required in the OMMP.

The low tide inspections of RAs 1, 3, 8, 14, 19A, 19B, 20, and the Sheen Source Removal Area were begun from the southern boundary of each area. In each area, a 100-foot long rope sectioned into 25-foot intervals and marked with red and yellow buoys (i.e., red buoys at either end and yellow buoys at 25 foot intervals) was stretched out to identify the monitoring interval to be inspected. The monitoring interval was then inspected and observations were documented on field forms and with photographs. Coordinates for the ends of each monitoring interval and photograph location were recorded on the field forms. The procedure was repeated until each monitoring interval was inspected.

The following sections summarize the findings from the Year 0 low tide slope cap inspections.

RA 1

Low tide slope cap inspection of the shoreline in RA 1 was performed on July 12, 2006, at tidal elevations between approximately -1.7 feet MLLW and -3.0 feet MLLW. Five, approximately 100-foot monitoring intervals were established for inspection and documentation of the integrity of the slope cap and upper shoreline area in RA 1 (i.e., RA1-1 through RA1-5) (Figure 1).

Prior to remedial construction, the shoreline slope in RA 1 was comprised of rip rap armoring and concrete piers. A thick slope cap was constructed in RA 1 over the existing armoring from elevation 2.0 feet MLLW to the toe of the slope (i.e., approximately -33 feet MLLW) as part of remedial actions. Additionally, habitat mix was placed over the pre-existing rip rap armoring and the thick slope cap from 13 feet MLLW to -10 feet MLLW.

No deficiencies were identified upon inspection of the thick slope cap in RA 1. Rip rap, with habitat mix contained within the voids of the rip rap, was observed during inspection of RA 1 (Attachment A, RA 1). A benched area was observed at approximately 2.0 feet MLLW where the upper boundary of the slope cap intersects with the pre-existing rip rap slope. One apparent

piece of flotsam, a plastic pipe, was observed during the inspection. No response actions are warranted based on the Year 0, baseline low tide slope cap inspection.

RA 3

Low tide slope cap inspection of the shoreline in RA 3 was performed on July 12, 2006, at tidal elevations between approximately -1.0 feet MLLW and 0.0 feet MLLW. Four, approximately 100-foot monitoring intervals were established for inspection and documentation of the integrity of the slope cap in RA 3 (i.e., RA3-1 through RA3-4) (Figure 1).

The slope cap in RA 3 is comprised of a combination of an exposed grout mat and thick slope cap constructed from the top of the bank (i.e., an elevation of approximately 17.0 feet MLLW to approximately -22 feet MLLW). Additionally, habitat mix was placed over the thick slope cap (i.e., not the grout mat) from elevation 13 feet MLLW to -10 feet MLLW.

No deficiencies were identified upon inspection of the exposed grout mat as no visual signs of disruption (i.e., cracking, etc.) were observed (Attachment A, RA 3, Monitoring Intervals RA3-2 and RA3-3). Rip rap, with habitat mix contained within the voids of the rip rap, was observed during inspection of the thick slope cap portion of RA 3. No deficiencies were identified upon inspection of the thick slope cap in two of the four inspection intervals (i.e., Monitoring Intervals RA3-1 and RA3-4). In two small areas, one area on either side of the grout mat, underlying geotextile or metal and foundry slag material were observed to be exposed in the capped area (Attachment A, RA 3, Monitoring Intervals RA3-2 and RA3-3). Additional photographs were taken of the slope cap areas where geotextile or metal and foundry slag material were observed in RA 3 (Attachment B, RA 3).

South and adjacent to the grout mat, at an elevation predominantly between approximately 13.0 feet MLLW and 17.0 feet MLLW, geotextile material can be seen at the surface of the shoreline or through the slope cap material. Most of the area is above the ordinary high water (OHW) line so is not actually part of the confining slope cap (Attachment B, RA 3, Monitoring Interval RA3-2, Photographs 22 and 23). During remedial activities, geotextile was placed beneath the slope cap in the area extending from the south edge of the grout mat to approximately 40 feet south of the grout mat and from the top of the bank down to approximate elevations between 5.0 feet MLLW and 10.0 feet MLLW. Then the slope cap filter material, rip rap, and habitat mix were placed over the geotextile. Based on inspection observations, it appears that some material present in this upper slope area where the geotextile was placed has moved downslope. The underlying geotextile is exposed in places but is observed to be intact.

Approximately 50 feet north of the northern boundary of the grout mat, at an elevation between approximately 10.0 feet MLLW and 13.0 feet MLLW, a solid mass of metal and foundry slag material can be seen protruding through the cap (Attachment B, RA 3, Monitoring Interval RA3-3, Photographs 24, 25, and 263). During remedial activities, filter material, rip rap, and habitat mix were placed over the metal and foundry slag material. Based on inspection observations, it appears that the slope cap (i.e., filter material, armoring, and habitat mix) has settled around the material exposing the underlying mass of metal or foundry slag. The area where this material can be observed through the cap is approximately 10 feet in diameter.

The two areas of the slope cap in RA 3 where geotextile and metal or foundry slag material are observed at the cap surface require repair to confine the exposed materials and stabilize the slope in the area of the exposed geotextile. A plan for repair of these areas will be submitted to the Environmental Protection Agency (EPA) for review in a separate memorandum.

RA 8

Low tide slope cap inspection of the shoreline in RA 8 was performed on July 10-12, 2006, at tidal elevations between approximately -3.2 feet MLLW and -0.1 feet MLLW. Sixteen, approximately 100-foot monitoring intervals and one 50-foot interval were established for inspection and documentation of the integrity of the slope cap in RA 8 (i.e., RA8-1 through RA8-17) (Figure 1).

The remedial action in RA 8 consists of a thick slope cap constructed from the top of the bank to the bottom of the shoreline slope except beneath the Colonial Fruit Warehouse and the wood esplanade at Foss Waterway Marina where habitat mix was placed over existing shoreline armoring.

No deficiencies were identified upon inspection of the thick slope cap in 15 of 17 monitoring intervals in RA 8 (Attachment A, RA 8, Monitoring Intervals RA8-1 through RA8-13, RA8-15, and RA8-17). Habitat mix or rip rap and quarry spalls with habitat mix contained within the voids of the rip rap and quarry spalls were observed during inspection of RA 8 including the areas beneath the Colonel Fruit Warehouse and wood esplanade at the Foss Waterway Marina. In two areas in the northern portion of RA 8, adjacent to the Foss Waterway Marina, piling or debris were observed at the cap surface (Attachment A, RA 8, Monitoring Intervals RA8-14 and RA8-16). Additionally, groundwater seeps were observed in the same general area as the piling (Attachment A, RA 8, Monitoring Interval RA8-14). Finally, a thin layer of sediment accretion and/or settlement of fines from capping material was observed in localized areas in RA 8 (Attachment A, RA8, Monitoring Intervals RA8-1, RA8-3 through RA8-5, RA8-11, RA8-12, RA8-14, and RA8-15). Additional photographs were taken of the areas in RA 8 where piling, debris, and seeps were observed at the surface of the slope cap (Attachment B, RA 8).

Beneath and adjacent to the southernmost Foss Waterway Marina gangway and southern end of the wood esplanade, two piling were observed to protrude between approximately one foot and two feet above the cap surface (Attachment B, RA 8, Monitoring Interval RA8-14, Photograph 10). The piling are present at approximate elevations of 2.5 feet MLLW and -3.0 feet MLLW. During remedial activities, slope cap filter material, quarry spalls, and habitat mix were placed on the slope to cap the area. Based on inspection observations, it appears that the piling may not have been cut off at an elevation that allowed complete coverage by cap materials. The piling that is at the approximate elevation of -3.0 feet MLLW does not appear to have been cut off and was likely submerged and not seen during construction. The piling at the approximate elevation of 2.5 feet MLLW was cut off during construction (i.e., a pre-construction photograph shows a full length piling at this location) but does not appear to have been cut off at an elevation that allowed complete coverage by cap material. It may also be that the slope cap materials have settled around the piling helping to expose the piling at the cap surface.

Several groundwater seeps were observed in the area at the southern end of the wood esplanade and adjacent to the southernmost Foss Waterway Marina gangway (Attachment B, RA 8, Monitoring Interval RA8-14, Photographs 9 and 11). The water discharging from the seeps was clear and the volume of water discharging was not observed to be causing erosion or disruption of cap materials.

At the northern end of RA 8, adjacent to the water-ward face of the wood esplanade, debris was observed protruding through the cap in an area approximately two feet high by three feet wide (Attachment B, RA 8, Monitoring Interval RA8-16, Photographs 7 and 8). The debris is a

cohesive mass that is orange indicating an iron component (i.e., oxidized iron or rust). The debris is present at an elevation of approximately 2.0 feet MLLW. Based on inspection observations, it appears that the cap materials have settled and/or moved downslope exposing the debris.

Sediment accretion and/or settlement of fines from capping material were observed intermittently in RA 8 (Attachment A, RA8, Monitoring Intervals RA8-1, RA8-3 through RA8-5, RA8-11, RA8-12, RA8-14, and RA8-15). The sediment accretion or fines are present as a thin layer (i.e., generally between 1/8 and 1/4-inch thick) in discontinuous, localized areas and were observed at elevations from approximately 2.0 feet MLLW to -2.0 feet MLLW. The sediment accretion or fines were generally observed in relatively flat areas where marina floats are present that are positioned parallel to the shoreline. The areas shoreward of where the marina floats are located parallel to the shoreline are likely quiescent and not subject to significant wave action allowing settlement of fines.

Finally, two boats were observed to be grounded on the slope cap in the Foss Waterway Marina (Attachment A, RA 8, Monitoring Interval RA8-15). Representatives of the Foss Waterway Marina were notified. The boats were subsequently relocated from the area where grounding on the cap had occurred.

The areas in RA 8 where piling and debris were observed at the cap surface require repair to remove or confine the materials. A plan for repair of these areas will be submitted to EPA for review in a separate memorandum. No other response actions are warranted at this time.

RA 14

Low tide slope cap inspection of the shoreline in RA 14 was performed on July 11, 2006, at tidal elevations between approximately -2.5 feet MLLW and -1.0 feet MLLW. Six monitoring intervals were established for inspection and documentation of the integrity of the slope cap in RA 14 (i.e., RA14-1 through RA14-6). Monitoring intervals in RA 14 were established based on structural features at Martinac Shipbuilding. A separate monitoring interval was established for each pier and shipway area (i.e., a separate interval for each of the three piers and two shipways) and a separate interval for the semi-circular cap area on the south side of the southernmost pier (Figure 1)

The remedial action in RA 14 consists of a thick slope cap constructed from bulkheads or shipways located beneath piers and buildings at Martinac Shipbuilding to the bottom of the shoreline slope in the navigation channel.

No deficiencies were identified upon inspection of the six monitoring intervals in RA 14 (Attachment A, RA 14, Monitoring Intervals RA14-1 through RA14-6). Habitat mix or rip rap and quarry spalls with habitat mix contained within the voids of the rip rap and quarry spalls were observed during inspection of RA 14.

Sediment accretion and/or settlement of fines from capping material were observed intermittently in RA 14 (Attachment A, RA14, Monitoring Intervals RA14-2 through RA14-6). The sediment accretion or fines are present as a thin layer (i.e., generally between 1/8 and 1/4-inch thick) in discontinuous, localized areas and were observed at elevations below approximately 5.0 feet MLLW. The sediment accretion or fines were generally observed in relatively flat areas where facility structures (i.e., piers, shipways, etc.) are present that enclose

or partially enclose portions of the shoreline. The enclosed shoreline areas are likely quiescent and not subject to significant wave action allowing settlement of fines.

Based on the inspections, no response actions are warranted in RA 14 at this time.

RA 19A

Low tide slope cap inspection of the shoreline in RA 19A was performed on July 10, 2006, at tidal elevations between approximately -2.8 feet MLLW and -1.1 feet MLLW. Ten, approximately 100-foot monitoring intervals and one 65-foot interval were established for inspection and documentation of the integrity of the slope cap in RA 19A (i.e., RA19A-1 through RA19A-11) (Figure 1).

The remedial action for the shoreline in RA 19A consists of a thick slope cap constructed from elevation 0.0 feet MLLW to the toe of the shoreline slope in the adjacent harbor / marina area. A pre-existing habitat enhancement area is present from elevation 0.0 feet MLLW to the top of the bank adjacent to the esplanade.

No deficiencies were identified upon inspection of 10 of 11 monitoring intervals in RA 19A (Attachment A, RA 19A, Monitoring Intervals RA19A-1, and RA19A-3 through RA19A-11). Habitat mix or rip rap and quarry spalls with habitat mix contained within the voids of the rip rap and quarry spalls were observed during inspection of RA 19A. Within the southern portion of RA 19A and the adjacent pre-existing habitat enhancement area, two depressions were present at the surface of the shoreline (Attachment A, RA 19A, Monitoring Interval RA19A-2). A piling was also present at the surface of the existing habitat enhancement area. Additional photographs were taken of the depressions and piling in RA 19A and the adjacent habitat enhancement area (Attachment B, RA 19A).

The two depressions are approximately 1.5 feet in depth and located at elevations between approximately 5.0 feet MLLW to -1.0 feet MLLW (Attachment B, RA 19A, Monitoring Interval RA19A-2, Photographs 1 through 4) primarily in the no action area where the pre-existing habitat enhancement was constructed. Based on inspection observations, it appears that the slope may have settled and/or material has been redistributed by tide and wave action creating the depressions.

The piling extends approximately 1.5 feet above the surface of the shoreline and is located at an approximate elevation of 5.0 feet MLLW (Attachment B, RA 19A, Monitoring Interval RA19A-2, Photographs 1 and 4 through 6). The piling is present in the pre-existing habitat enhancement area and was observed above the habitat surface during remedial activities. As the piling was not within the remedial action area it was not removed or cut off during construction.

Sediment accretion and/or settlement of fines from capping material were observed intermittently in RA 19A (Attachment A, RA19A, Monitoring Intervals RA19A-2 through RA19A-7). The sediment accretion or fines are present as a thin layer (i.e., generally between 1/8 and 1/4-inch thick) in discontinuous, localized areas and were observed at elevations from approximately 2.0 feet MLLW to -2.0 feet MLLW. The sediment accretion or fines were generally observed in relatively flat areas where marina floats are present that are positioned parallel to the shoreline. The areas shoreward of where the marina floats are located parallel to the shoreline are likely quiescent and not subject to significant wave action allowing settlement of fines.

The area where two depressions were present in RA 19A and the adjacent habitat enhancement area require monitoring to observe whether additional settlement or material movement is occurring. Additionally, a plan for removing the portion of the piling that is present above the surface of the habitat enhancement area will be submitted to EPA for review in a separate memorandum. No other response action is warranted in RA 19A at this time.

RA 19B

Low tide slope cap inspection of the shoreline in RA 19B was performed on July 10, 2006, at tidal elevations between approximately -2.6 feet MLLW and -0.25 feet MLLW. Eight, approximately 100-foot monitoring intervals were established for inspection and documentation of the integrity of the slope cap in RA 19B (i.e., RA19B-1 through RA19B-8) (Figure 1).

The remedial action for the shoreline in RA 19B consists of grout mat and thick slope capping. A grout mat cap was placed from approximately 3.0 feet MLLW along the shoreline and down to the harbor / marina area and out to the navigation channel from the southern boundary of RA 19B (i.e., Station 70+10) to approximate Station 65+50. Then a thick slope cap was constructed from the top of the bank to the bottom of the shoreline slope in the harbor / marina area including the area where the grout mat was placed.

No deficiencies were identified upon inspection of the eight monitoring intervals in RA 19B (Attachment A, RA 19B, Monitoring Intervals RA19B-1, through RA19B-8). Habitat mix or rip rap and quarry spalls with habitat mix contained within the voids of the rip rap and quarry spalls were observed during inspection of RA 19B.

Sediment accretion and/or settlement of fines from capping material were observed intermittently in RA 19B (Attachment A, RA19B, Monitoring Intervals RA19B-4 through RA19B-8). The sediment accretion or fines are present as a thin layer (i.e., generally between 1/8 and 1/4-inch thick) in discontinuous, localized areas and were observed at elevations from approximately 2.0 feet MLLW to -2.0 feet MLLW. The sediment accretion or fines were generally observed in relatively flat areas where marina floats are present that are positioned parallel to the shoreline. The areas shoreward of where the marina floats are located parallel to the shoreline are likely quiescent and not subject to significant wave action allowing settlement of fines.

No response actions are warranted in RA 19B at this time.

RA 20

Low tide slope cap inspection of the shoreline in RA 20 was performed on July 11, 2006, at tidal elevations between approximately -3.0 feet MLLW and 0.0 feet MLLW. Nine, approximately 100-foot monitoring intervals and one approximately 40-foot monitoring interval were established for inspection and documentation of the integrity of the slope cap in RA 20 (i.e., RA20-1 through RA20-10) (Figure 1).

The remedial action for the shoreline in RA 20 consists of a thick slope cap constructed from the top of the slope to the toe of the shoreline slope in the adjacent harbor / marina area except beneath the Johnny's Seafood Restaurant where habitat mix was placed over existing shoreline armoring. Additionally, a habitat enhancement area (i.e., Johnny's Dock Habitat Enhancement) is present on the shoreline and slope cap area between the Johnny's Dock and Foss Landing Marina's (Figure 1).

No deficiencies were identified upon inspection of 9 of 10 monitoring intervals in RA 20 (Attachment A, RA 20, Monitoring Intervals RA20-1 through RA20-8 and RA20-10). Habitat mix or rip rap and quarry spalls with habitat mix contained within the voids of the rip rap and quarry spalls were observed during inspection of RA 20 except at the habitat enhancement area where sand is present at the surface of the habitat. Within the southern portion of RA 20, a piling is present at the surface of the slope cap (Attachment A, RA 20, Monitoring Interval RA20-9). Additional photographs were taken of the piling in RA 20 (Attachment B, RA 20). Additional photographs were also taken in two monitoring intervals (i.e., Monitoring Intervals RA20-3 and RA20-4) where several photographs taken on July 11, 2006, were too dark to clearly document slope cap conditions.

The piling observed in RA 20 extends approximately six inches above the surface of the shoreline and is located at an approximate elevation of -2.5 feet MLLW (Attachment B, RA 20, Monitoring Interval RA20-9, Photographs 19 through 21). Based on inspection observations, it appears that the piling may not have been cut off at an elevation that allowed complete coverage by cap materials. The piling is at the approximate elevation of -2.5 feet MLLW and was likely submerged and not seen during construction. It may also be that the slope cap materials have settled around the piling helping to expose the piling at the cap surface.

Sediment accretion and/or settlement of fines from capping material were observed along the slope cap area in RA 20 (Attachment A, RA20, Monitoring Intervals RA20-1 through RA20-4 and RA20-6 through RA20-10). The sediment accretion or fines are present as a thin layer (i.e., generally between 1/8 and 1/4-inch thick) in the lower portions of the slope cap at elevations below approximately 5.0 feet MLLW. The sediment accretion or fines were generally observed in relatively flat areas where marina floats are present that are positioned parallel to the shoreline. The areas shoreward of where the marina floats are located parallel to the shoreline are likely quiescent and not subject to significant wave action allowing settlement of fines.

A plan for evaluating and repairing the area where the piling is present above the cap surface will be submitted to EPA for review in a separate memorandum. No other response actions are warranted in RA 20 at this time.

Sheen Source Removal Area

A low tide cap inspection of the Sheen Source Removal Area in the Wheeler-Osgood Waterway was performed on October 3, 2006, at a tidal elevation of approximately 0.0 feet MLLW. One, approximately 65-foot monitoring interval was established for inspection and documentation of the integrity of the cap in the Sheen Source Removal Area (i.e., Sheen Source-1) (Figure 1).

The remedial action in the Sheen Source Removal Area consists of a thick cap comprised of channel sand cap material from the toe of the shoreline slope to the northern boundary of RA 12 and from approximate Station 15+50 to Station 16+15.

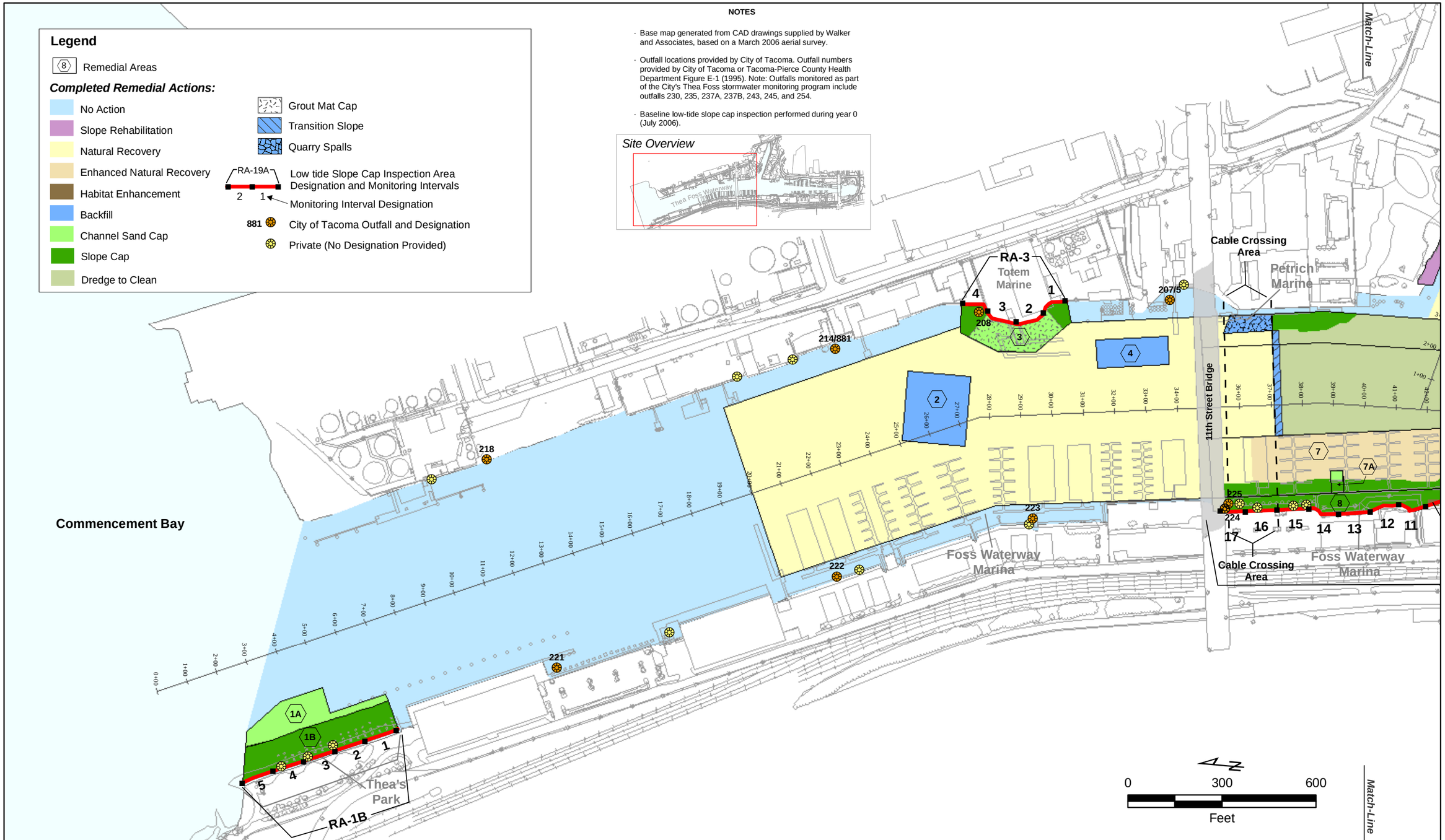
No deficiencies were identified upon inspection of the monitoring interval for the Sheen Source Removal Area (Attachment A, Sheen Source Removal Area, Monitoring Interval Sheen Source-1). Channel sand cap material with a layer of sediment accretion on the surface was observed during inspection of the Sheen Source Removal Area. The sediment accretion is present as a thin layer (i.e., approximately 1/4-inch thick) covering the surface of the capped area. The Sheen Source Removal Area is relatively flat and the Wheeler-Osgood Waterway is relatively quiescent and not subject to significant wave action allowing settlement of fines.

No response action is warranted in the Sheen Source Removal Area at this time.

Summary of Preliminary Findings

The following summarizes the preliminary findings from the Year 0, baseline low tide inspections:

- No deficiencies were identified upon inspection of RAs 1, 14, 19B, and the Sheen Source Removal Area.
- No deficiencies were identified in two of four monitoring intervals in RA 3. Two areas are present in RA 3 where geotextile or metal and foundry slag material are present at the surface of the capped area (Attachment A, RA 3, Monitoring Intervals RA3-2 and RA3-3).
- No deficiencies were identified upon inspection of 15 of 17 monitoring intervals in RA 8. Two areas are present in RA 8 where piling or debris are present at the surface of the capped area (Attachment A, RA 8, Monitoring Intervals RA8-14 and RA8-16).
- No deficiencies were identified upon inspection of 10 of 11 monitoring intervals in RA 19A. Two depressions are present at the surface of the shoreline in RA 19A and the adjacent habitat enhancement area. A piling is also present at the surface of the existing adjacent habitat enhancement area (Attachment A, RA 19A, Monitoring Interval RA19A-2).
- No deficiencies were identified upon inspection of 9 of 10 monitoring intervals in RA 20. A piling is present at the surface of the slope cap in the southern portion of RA 20 (Attachment A, RA 20, Monitoring Interval RA20-9).
- A thin layer of sediment accretion and/or fines from capping material was present on relatively flat, enclosed portions of the slope cap areas at elevations generally below 5.0 feet MLLW.
- A plan for evaluating and repairing the areas where the piling or debris are present above the surface of the cap in RAs 3, 8, 20 and the pre-existing habitat area adjacent to RA 19A will be prepared and submitted to EPA for review in a separate memorandum.
- No other response actions are warranted in at this time.



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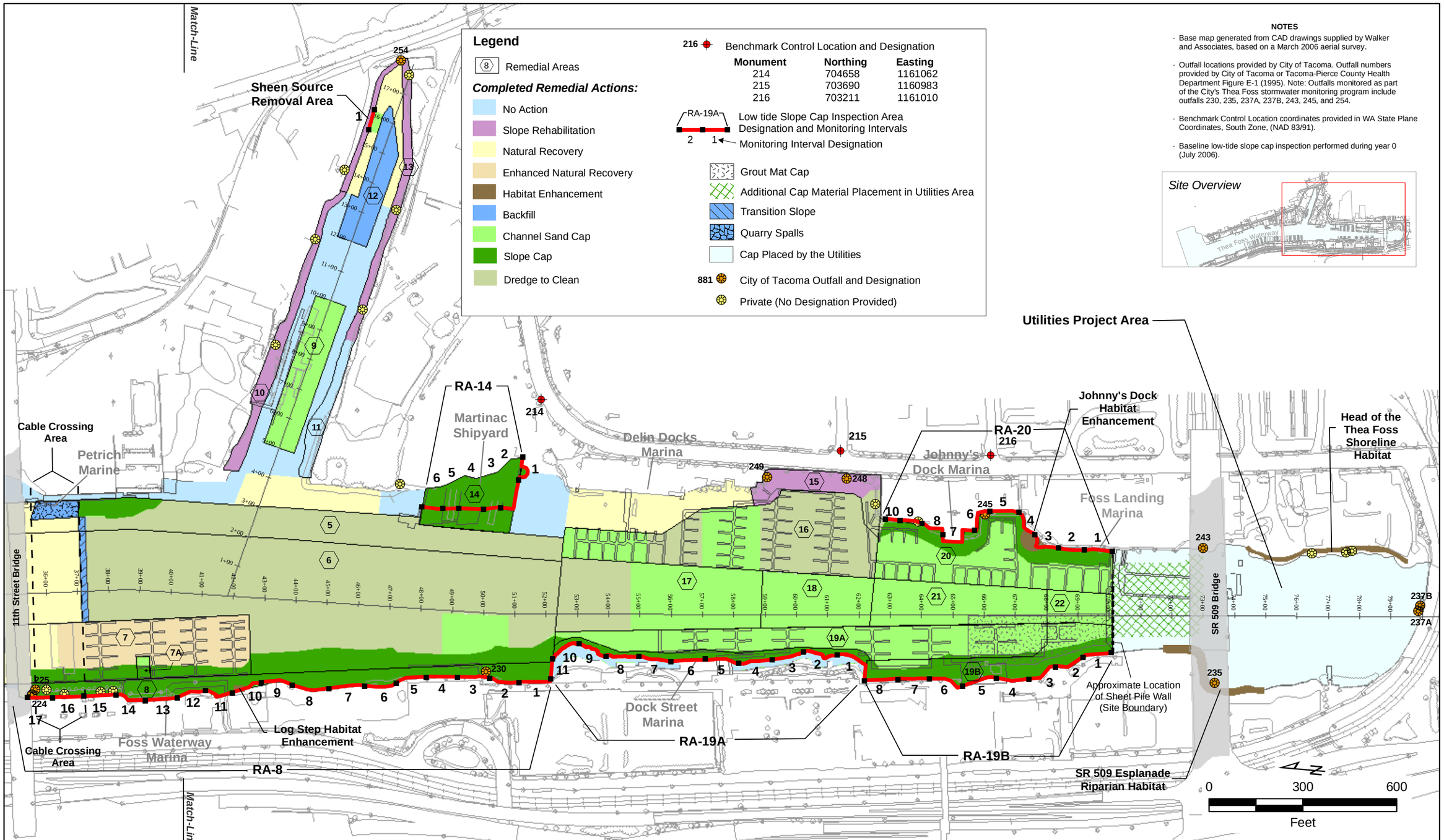
Tacoma

Thea Foss and Wheeler-Osgood Waterways OMMP

Figure 1 (Page 1 of 2)
Low Tide Slope Cap Inspection Monitoring Intervals

DATE: 10/23/2006 5:02:40 PM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\Sediment Remediation Area Performance Monitoring\Low Tide Inspection Memo Oct06\Figure 1 Low-tide Slope Cap Inspections (1of2).mxd



NOTES

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995). Note: Outfalls monitored as part of the City's Thea Foss stormwater monitoring program include outfalls 230, 235, 237A, 237B, 243, 245, and 254.
- Benchmark Control Location coordinates provided in WA State Plane Coordinates, South Zone, (NAD 83/91).
- Baseline low-tide slope cap inspection performed during year 0 (July 2006).

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Tacoma

Thea Foss and Wheeler-Osgood Waterways OMMP

Figure 1 (Page 2 of 2)
Low Tide Slope Cap Inspection Monitoring Intervals

DATE: 10/26/2006 3:07:05 PM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\Sediment Remediation Area Performance Monitoring\Low Tide Inspection Memo Oct06\Figure 1 Low-tide Slope Cap Inspections (2of2).mxd

Attachment A

Low Tide Slope Cap Inspection
Field Forms and Photographs

Remedial Area 1

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/12/2011

Remedial Area: RA 1B (PAGE 1 of 1)

Weather: RAINY ~65°F

Datum (Horiz/Vert): WA STATE PLANE SOUTH (NAD 83/91) / MLLW

Field Personnel: M. WOLTMAN

Benchmark(s) Used for Location Control: #214 & #215

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting)		Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
		START	FINISH			
RA 1B-1	100	708802/1159078	708895/1159037	1304	-3.0'	V. LARGE RIPRAP W/HAB MIX IN VOIDS
RA 1B-2	100	708895/1159037	708985/1159008	1318	-2.7'	V. LARGE RIPRAP W/HAB MIX IN VOIDS
RA 1B-3	100	708985/1159008	709080/1158969	1327	-2.5'	V. LARGE RIPRAP W/HAB. MIX IN VOIDS
RA 1B-4	100	709080/1158969	709172/1158922	1340	-2.0'	LARGE RIPRAP W/HAB. MIX IN VOIDS
RA 1B-5	100	709172/1158922	709259/1158872	1350	-1.7'	HAB MIX & LARGE RIPRAP

Monitoring Interval	CHECK ALL THAT APPLY								Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
	Sediment Accretion	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	
RA 1B-1	☐	☐	☐	☐	☐	☐	☐	☐	VOIDS RESULT IN LARGE RIPRAP, HAB MIX VISIBLE
RA 1B-2	☐	☐	☐	☐	☐	☐	☐	☐	VOIDS IN LARGE RIPRAP, SOME HAB MIX VISIBLE
RA 1B-3	☐	☐	☐	☐	☐	☐	☐	☐	HAB MIX BENCH FROM ~ ELEV 0' TO +3'
RA 1B-4	☐	☐	☐	☐	☐	☐	☐	☐	HAB MIX BENCH EXTENDS ABOUT 40' NORTH
RA 1B-5	☐	☐	☐	☐	☐	☐	☐	☐	HAB MIX BENCH EXTENDS ANOTHER 100 FT TO END OF SHORELINE
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterway LMMP

PHOTO DOCUMENTATION

Date: 7/12/2006

Weather: Sprinkles

Remedial Area: RA-1

Field Personnel: Bill Essmeier, Tim Chenoweth, Felicity, Mark Bostick

Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes
RA1 - 1	1495	-10 South	NW	708799 / 1159102	1304	0 - 40' from boat
	1496	45	NW	708846 / 1159086	1309	50 - 70' "
↓	1497	85	NW	708865 / 1159071	1313	75 - 100' "
RA1 - 2	1498	-10 South	NW	708890 / 1159064	1318	0 - 35' "
	1499	40	NW	708938 / 1159044	1322	50 - 100' "
RA1 - 3	1500	-10 South	NW	708983 / 1159022	1328	0 - 60' "
	1501	28	NW	709026 / 1159011	1333	50 - 100' "
	1502	60	SE	709037 / 1158971	1337	Shows bench between concrete pillars
	1503	60	N	709034 / 1158970	~~1338~~ 1340	"
RA1 - 4	1504	-10 South	NW	709078 / 1158987	1345	0 - 70'
↓	1505	60	NW	709132 / 1158959	1347	70 - 100'
RA1 - 5	1506	-10 South	NW	709171 / 1158939	1350	0 - 90'

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

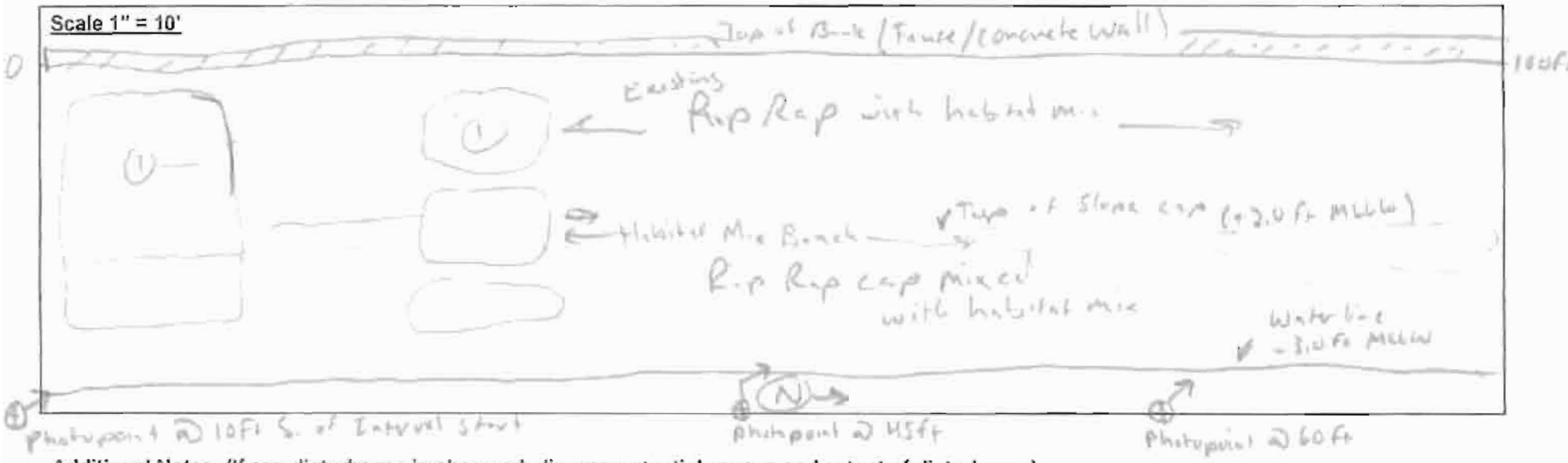
Date: 7-12-06

Field Personnel: T. Chontofalsky

Monitoring Interval: RA1-1

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Concrete monolith
Note: Habitat mix has settled into the cracks of the Rip Rap

P0001495 7/12/2006 1:04:11 PM

P0001496 7/12/2006 1:09:38 PM

P0001497 7/12/2006 1:13:18 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06

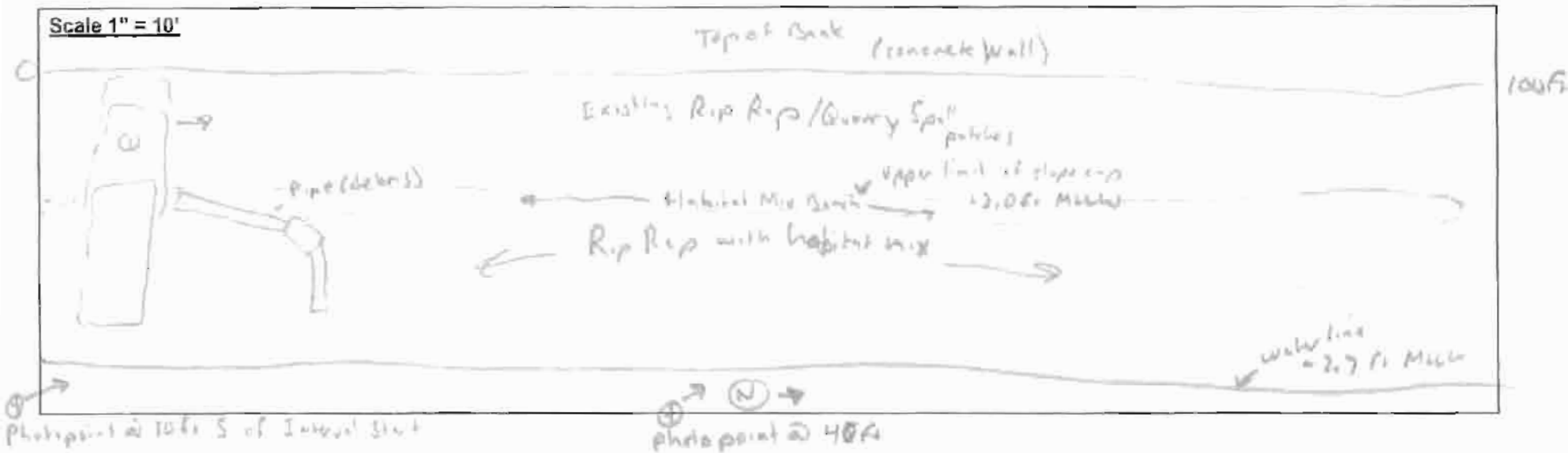
Field Personnel: T. Chmiotowicz

Monitoring Interval: RA1-2

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Concrete monolithic (these are found throughout interval RA2)

P0001498 7/12/2006 1:18:36 PM

P0001499 7/12/2006 1:22:07 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-16

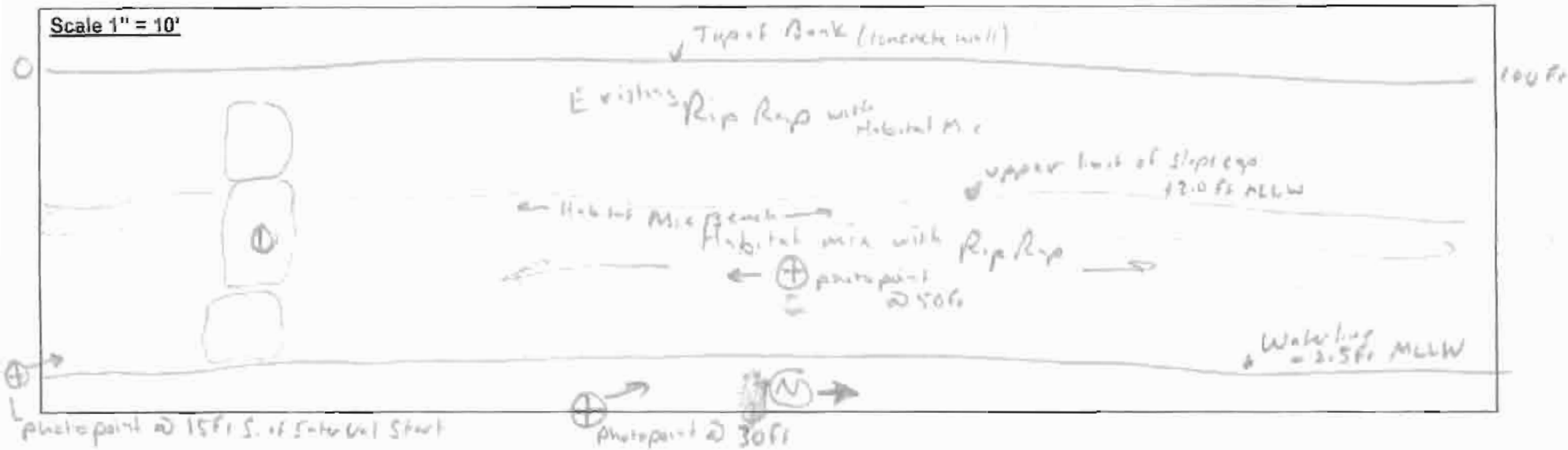
Field Personnel: T. Chontofalsky

Monitoring Interval: RA1-3

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'

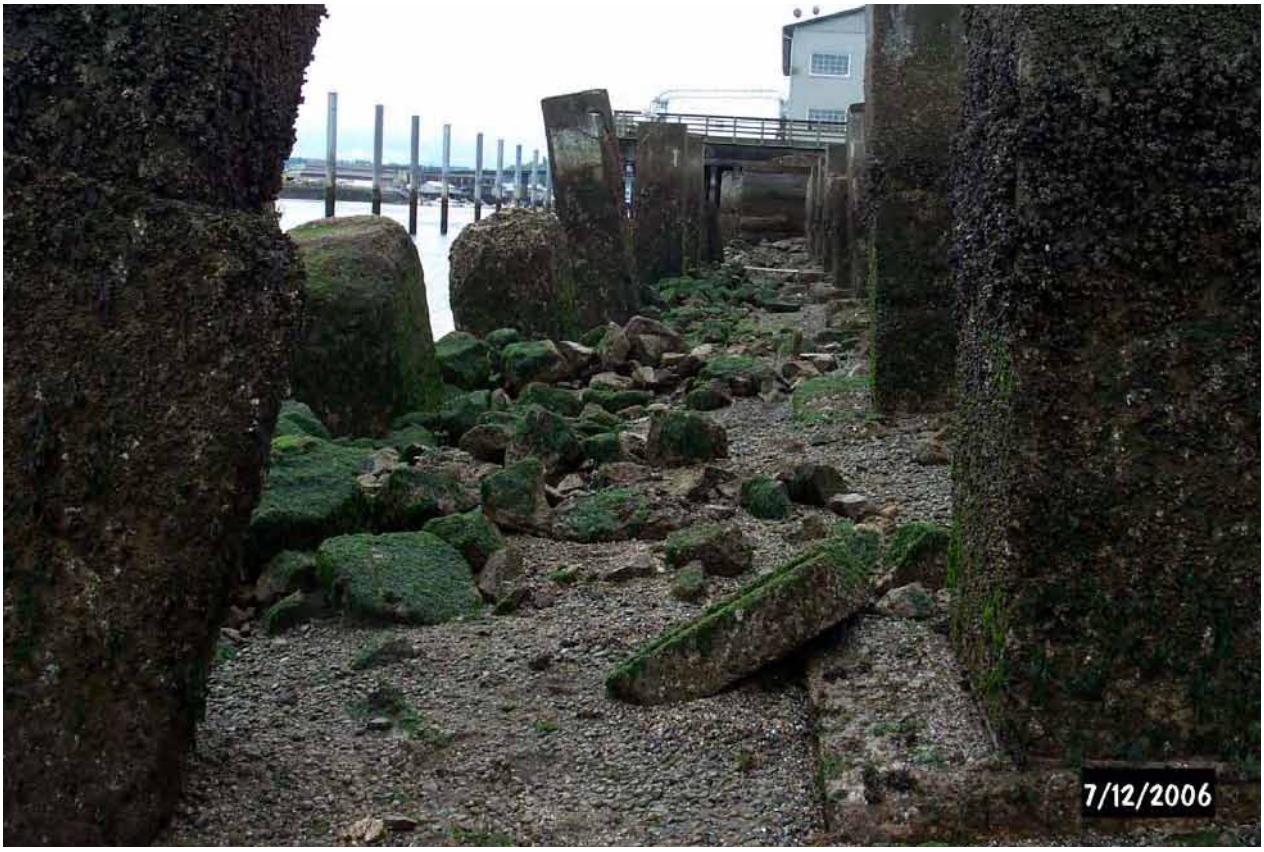


Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

@ Concrete monolithic throughout interval
Note: A photopoint was take @ 50ft of the habitat mix bench. It was taken on the slope

P0001500 7/12/2006 1:28:02 PM

P0001501 7/12/2006 1:33:03 PM



P0001502 7/12/2006 1:37:13 PM

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LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06

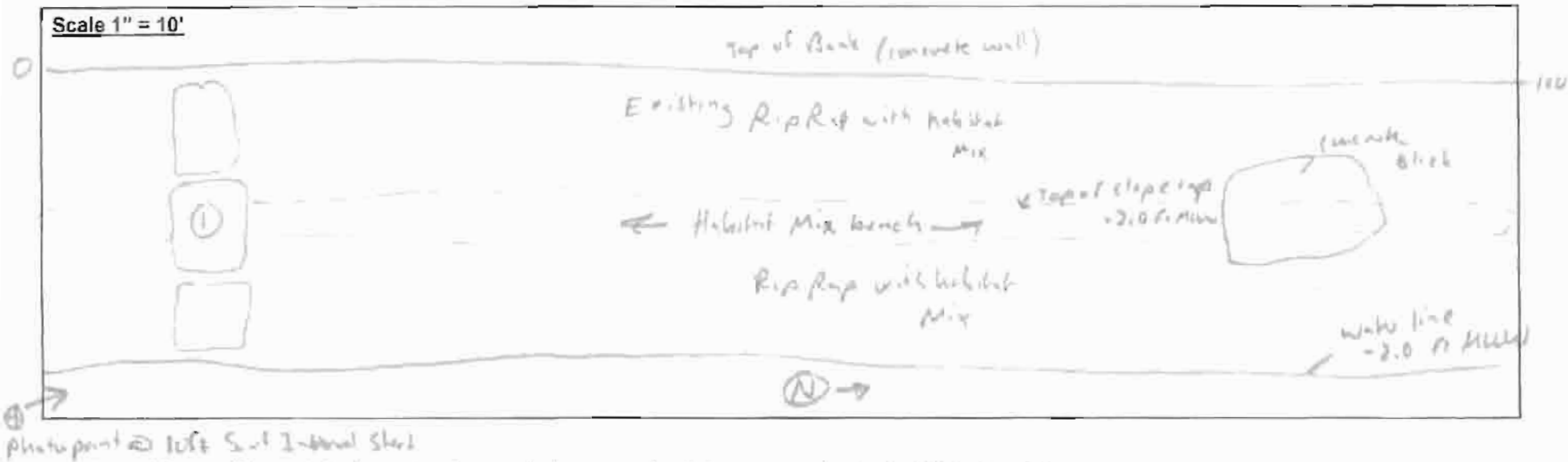
Field Personnel: T. Chontofalsky

Monitoring Interval: RA1-4

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

(1) concrete monolith
Note: Habitat mix bench increased in size after 75 ft.

P0001504 7/12/2006 1:45:18 PM

P0001505 7/12/2006 1:47:27 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06

Field Personnel: T. Chontofalsky

Monitoring Interval: RA 1-5

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: Habitat mix bench extends in this interval. Concrete monoliths are not present in this interval

P0001506 7/12/2006 1:50:43 PM

Remedial Area 3

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/12/2006

Remedial Area: RA3 (PAGE 1 OF 1)

Weather: RAINY ~65°F

Datum (Horiz/Vert): WA STATE PLANE SOUTH (NAD 83/91) / MLLW

Field Personnel: M. WOLTMAN

Benchmark(s) Used for Location Control: #214 & #215

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting)		Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
		START	FINISH			
RA3-1	100	706930/1160590	706834/1160524	1407	-1.1	LARGE RIPRAP W/HABITAT MIX
RA3-2	100	706834/1160524	706930/1160498	1415	-0.8	RIPRAP W/HAB MIX. GROUTMAT @ 25' ON TRANSECT
RA3-3	100	706930/1160498	707024/1160520	1424	-0.4	GROUTMAT TO ~45' ON TRANSECT. LEFT CAP/HAB TO ~20'
RA3-4	100	707024/1160520	707112/1160532	1430	-0.1	RIPRAP W/HABITAT MIX

Monitoring Interval	CHECK ALL THAT APPLY								Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
	Sediment Accretion	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	
RA3-1	☐	☐	☐	☐	☐	☑	☐	☐	HABITAT MIX PRESENT IN LARGE RIP RAP VOIDS 1)
RA3-2	☐	☐	☐	☐	☐	☐	☒	☐	MOVEABLE EXPOSED @ TOE OF SLOPE NEAR GROUT MAT
RA3-3	☐	☐	☒	☐	☐	☐	☒	☐	UNDERLYING SEDIMENT EXPOSED @ ~100' ON TRANSECT 2)
RA3-4	☐	☐	☐	☐	☐	☐	☐	☐	HABITAT MIX MORE PREVALENT @ LOWER ELEVS 3)
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	

NOTES: 1) WHERE SLOPE NEAR END OF TRANSECT - GEOTEXTILE VISIBLE BENEATH. POTENTIAL MOVEMENT HABITAT MIX DOWN TO ELEV. ~-4.5 FT?
2) APPEARS TO BE SLAG RELIC OR SOMETHING SIMILAR
3) OUTFALL @ ~25' ON TRANSECT

RA BOUNDARIES VERIFIED W/CONSTRUCTION PLAN DRAWINGS.

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

PHOTO DOCUMENTATION

Date: 7/12/2006

Weather: Cloudy

Remedial Area: RA-3

Field Personnel: Bill Eismeier, Tom Ch, Mark Bozler

Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes
RA3-1	1507	25	E	706782 / 1160479	1407	15-50' from boat tied to dock.
↓	1508	25	NE	706781 / 1160479	1410	50-100' "
RA3-2	1509	-20 South	NE	706789 / 1160477	1416	0-75' from boat
↓	1510	105	E	706922 / 1160450	1421	75-100' from dock North of crane.
RA3-3	1511	30	NE	706926 / 1160447	1423	20-75' "
	1512	75	NE	706976 / 1160455	1426	75-100' "
RA3-4	1513	0	NE	707010 / 1160529	1435	Taken from shore above cap bowl.
↓	1514	+25 North	S	707132 / 1160509	1441	0-50 from boat beyond rope.
	1515	+25 North	SE	707132 / 1160509	1443	50-100' from boat.

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06

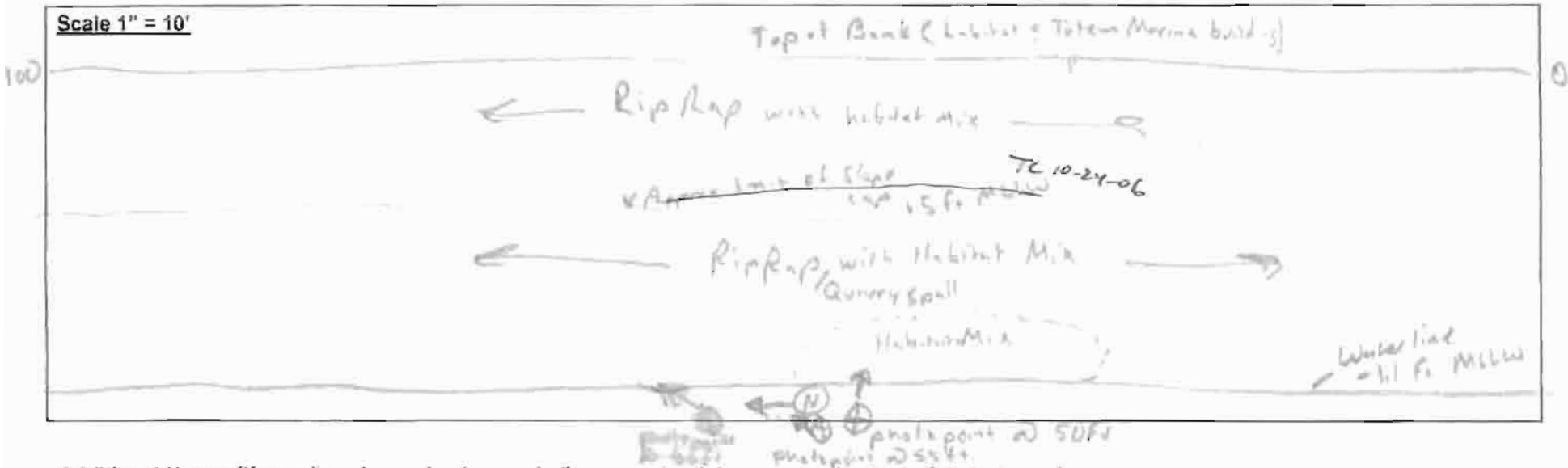
Field Personnel: T. Chonte Falsley

Monitoring Interval: RA3-1

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001507 7/12/2006 2:07:44 PM

P0001508 7/12/2006 2:10:06 PM

LOW-TIDE SLOPE CAP INSPECTION FORM | **Thea Foss and Wheeler Osgood Waterways OMMP**

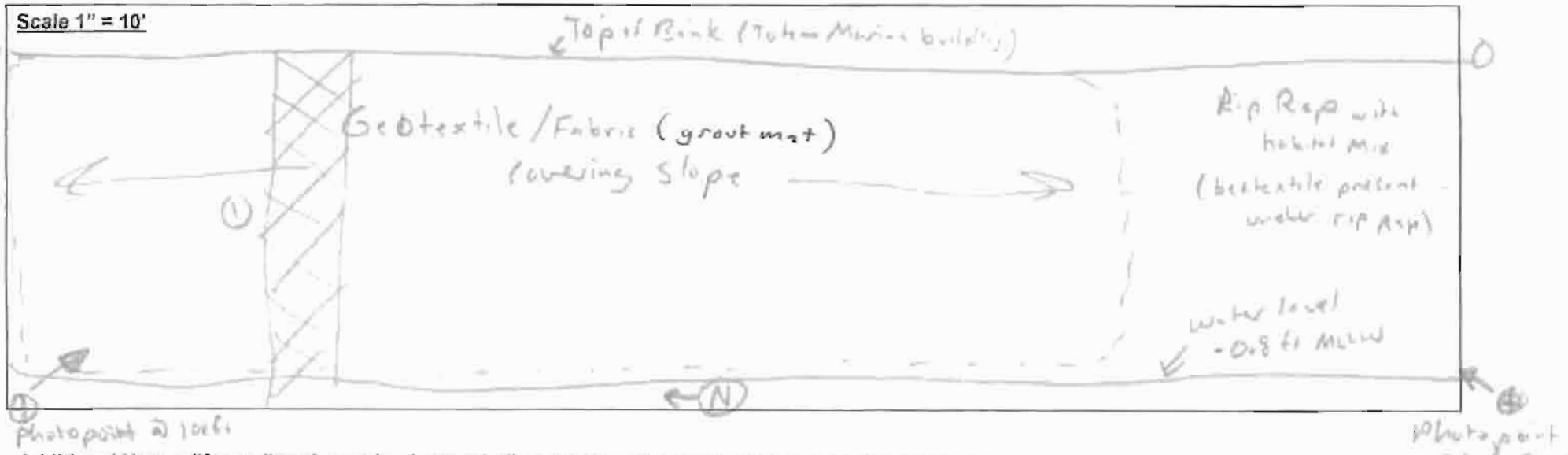
MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06
Field Personnel: T. Schantz/Foley
Monitoring Interval: RA3-2

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1 Walkway onto float

P0001509 7/12/2006 2:16:03 PM

P0001510 7/12/2006 2:21:02 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-17-06

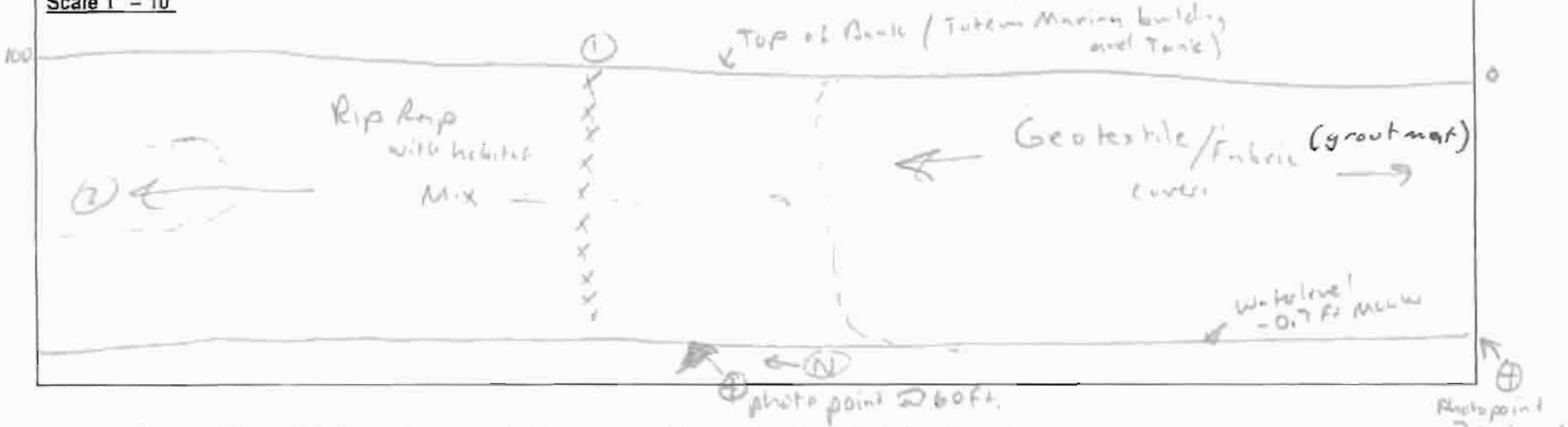
Field Personnel: T. Chastefalsky

Monitoring Interval: RA 7-3

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

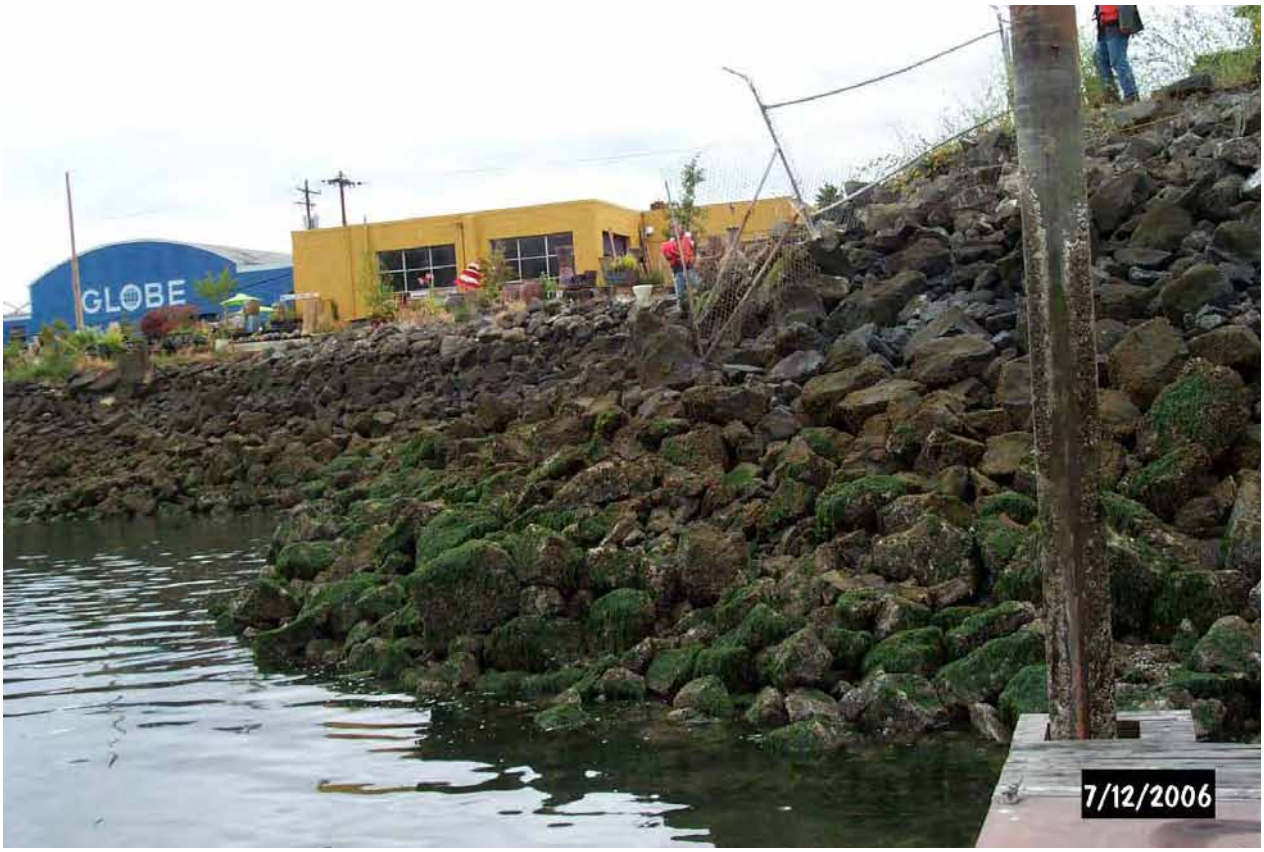
Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1. Fence
2. Underlying slag pile

P0001511 7/12/2006 2:23:28 PM



P0001512 7/12/2006 2:26:13 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-04

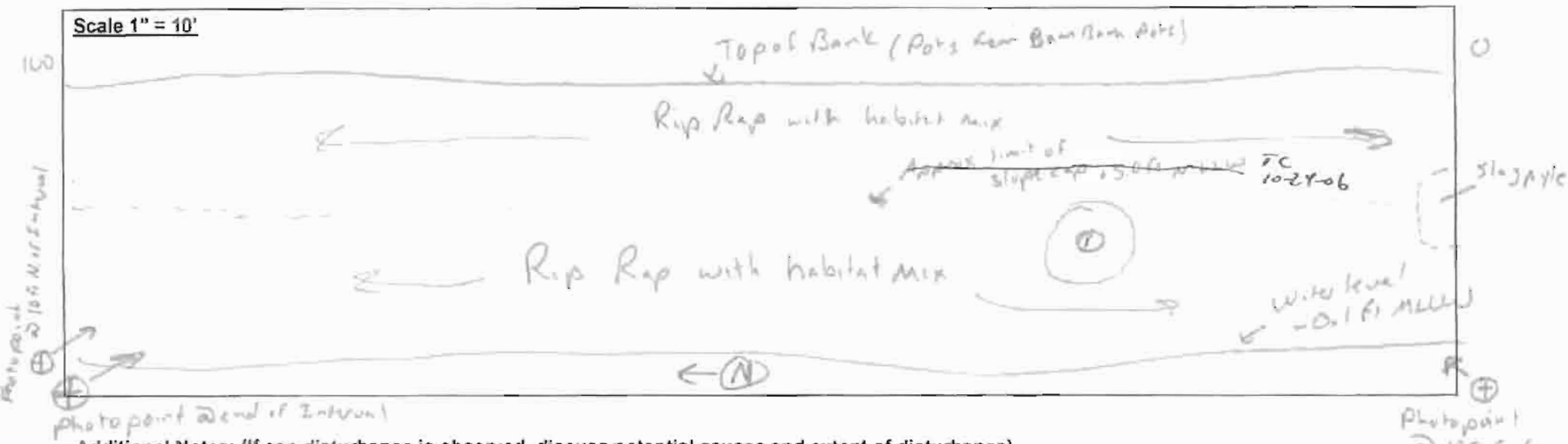
Field Personnel: T. Chastofalsky

Monitoring Interval: RA3-4

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Outfall structure

P0001513 7/12/2006 2:35:17 PM

P0001514 7/12/2006 2:41:29 PM

P0001515 7/12/2006 2:43:41 PM

Remedial Area 8

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/10/2006

Remedial Area: RAB (PAGE 1 OF 1

Weather: CLOUDY ~65°F

Datum (Horiz/Vert): NAD83/91 (WA STATE PLANE SOUTH) / MLLW

Field Personnel: M. WOLTMAN

Benchmark(s) Used for Location Control: #214, #216

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting) START	FINISH	Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
* RAB-1	100	704564/1160212	704678/1160196	12:37	-1.0'	HAB. MIX @ DEL. RIPRAP (INC. RIPRAP @ LOWER ELEV)
* RAB-2	100	704678/1160196	704781/1160187	12:41	-0.8'	HAB MIX ABOVE ELEV +0' / MOSTLY QUARRY SPALL BELOW 0'
RAB-3	100	704781/1160187	704874/1160172	12:50	-0.4'	HAB. MIX @ & RIP RAP BELOW SHEET PILE WALL
RAB-4	100	704874/1160172	704970/1160161	12:57	-0.1'	HAB. MIX & RIPRAP BELOW SHEET PILE WALL

Monitoring Interval	CHECK ALL THAT APPLY: * Sediment Accretion	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
RAB-1	☒	☐	☐	☐	☐	☐	☐	☐	INCREASING RIPRAP / QUARRY SPALLS @ LOWER ELEV
RAB-2	☐	☐	☐	☐	☐	☐	☐	☐	PATCHY AREAS OF MATURE QUARRY SPALL MATL BELOW 0 FT
RAB-3	☒	☐	☐	☐	☐	☐	☐	☐	GOOD COVERAGE OF HAB MIX OVER RIP RAP SURFACE.
RAB-4	☒	☐	☐	☐	☐	☐	☐	☐	GOOD HABITAT COVERAGE OVER RIP RAP SURFACE.
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	

* THIN ACCRETION NEAR H_2O SURFACE

NOTE: OUTFALL #230 @ END OF RAB-2

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

PHOTO DOCUMENTATION

Date: 7/10/2006

Weather: Cloudy ~65°F

Remedial Area: RA-8

Field Personnel: Bill Ecumbier

Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes
RA-8 -1	1408	-10 South	N	704563 / 1160 221	1237	Complete Int
RA8 -2	1409	-10 South	N	704662 / 1160202	1241	Complete Int.
"	1410	70	NW	704743 / 1160198	1245	Shot at OF 230 structure.
RA8 -3	1411	35	SW	704814 / 1160200	1251	Shot back to OF 230.
"	1412	~~30~~ 20	NW	704796 / 1160206	1253	Rest of Int.
RA8 -4	1413	-15 South	N	704859 / 1160195	1257	Complete Int.

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

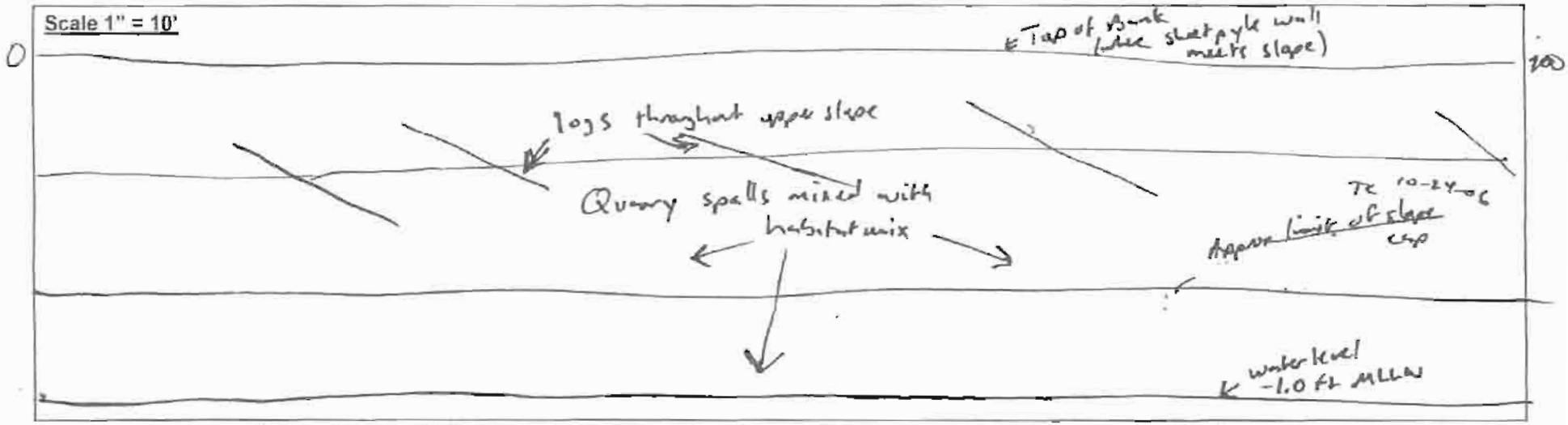
Date: 7-10-06

Field Personnel: T. Chantofalsky

Monitoring Interval: RA8-1

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Φ photopoint approx. 10 ft South of Interval Start.

N →

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: Logs throughout upper slope

P0001408 7/10/2006 12:37:26 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

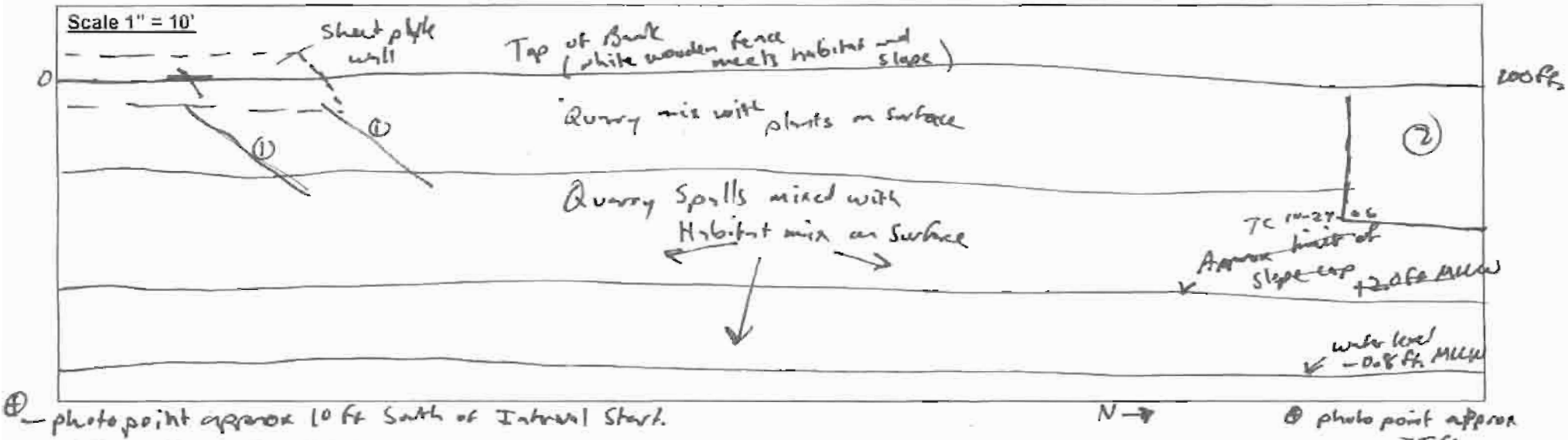
Date: 7-10-06

Field Personnel: T. Chontofalsky

Monitoring Interval: RA8-2

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



⊕ – photo point approx 10 ft South of Interval Start.

⊕ photo point approx 75 ft.

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Logs from 0-25ft.

② Outfall structure at end of Interval

P0001409 7/10/2006 12:42:22 PM

P0001410 7/10/2006 12:46:10 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

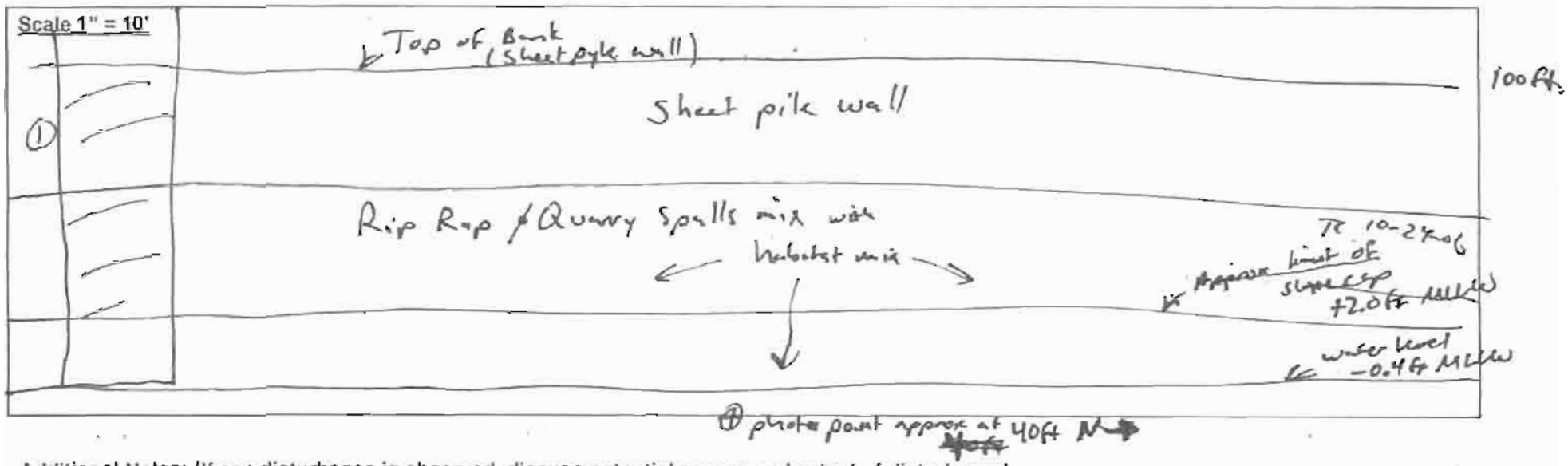
Date: 7-10-06

Field Personnel: T. Chontosky

Monitoring Interval: RA8-3

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Dock structure.

P0001411 7/10/2006 12:51:50 PM

P0001412 7/10/2006 12:54:16 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-10-06

Field Personnel: T. Chamberlain

Monitoring Interval: RA8-4

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'

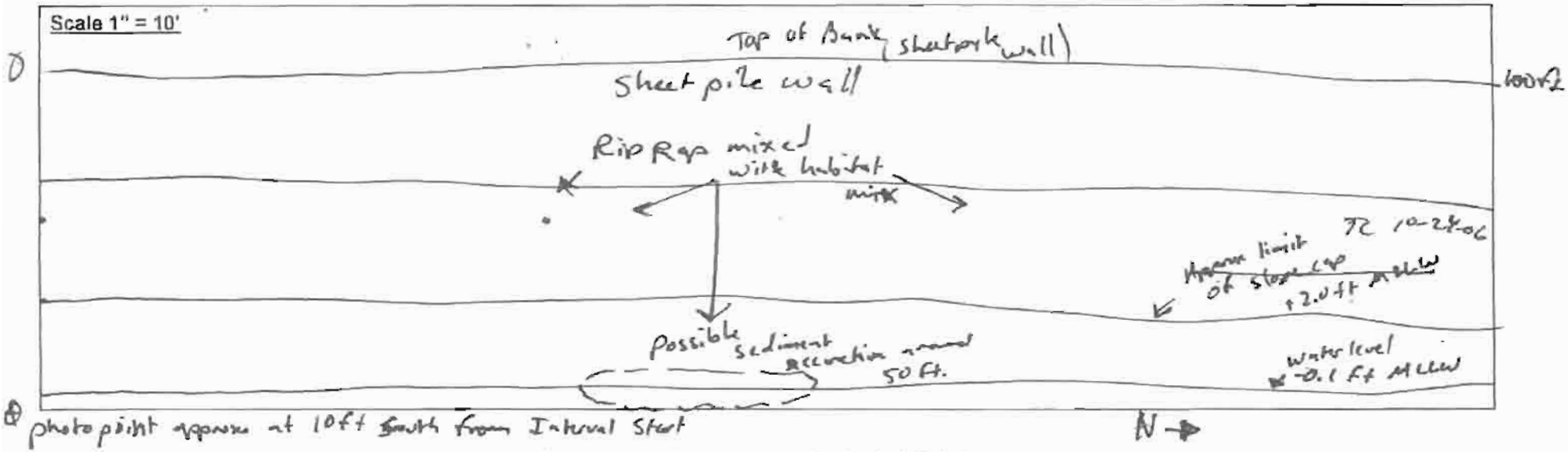


photo point approx at 10 ft South from Interval Start

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: No observed transition Between slope cap and existing habitat

P0001413 7/10/2006 12:58:18 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/12/06

Remedial Area: RAB (PAGE 2 OF 3)

Weather: 15 RAIN ~60°F

Datum (Horiz/Vert): WA STATE PLANE (NAD 83/91) SOUTH / MLLW

Field Personnel: M. WOLTMAN

Benchmark(s) Used for Location Control: # 214 & # 215

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting)		Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
		START	FINISH			
RAB-5	100'	704959/1160152	705060/1160147	1032	-0.2'	RIPRAP W/HABITAT MIX
RAB-6	100'	705060/1160147	705160/1160147*	1041	-0.7'	RIPRAP & QUARRY SPALLS W/HAB. MIX
RAB-7	100'	705160/1160147 *	705260/1160147*	1055	-1.2'	HAB MIX UNDER PIER / QUARRY SPALL & HAB MIX UPRIGHT
RAB-8	100'	705260/1160147*	705350/1160103	1104	-1.5'	QUARRY SPALL, RIPRAP & HABITAT MIX
RAB-9	100'	705350/1160103	705442/1160099	1114	-1.9'	QUARRY SPALL, RIPRAP & HABITAT MIX
RAB-10	100'	705442/1160099	705539/1160077	1128	-2.3'	RIPRAP & SCATTERED HABITAT MIX
RAB-11	100'	705539/1160077	705619/1160061	1142	-2.7'	HABITAT MIX W/ QUARRY SPALL & DEL. ESP CAP
RAB-12	100'	705619/1160061	705732/1160050	1150	-2.9'	HABITAT MIX W/ QUARRY SPALL

Monitoring Interval	CHECK ALL THAT APPLY								Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
	* Sediment Accretion	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	
RAB-5	☒	☐	☐	☐	☐	☐	☐	☐	SLOPE CAP APPEARS INTACT
RAB-6	☐	☐	☐	☐	☐	☐	☐	☐	APPEARS TO QUARRY SPALLS - NO SED. ACCRETION
RAB-7	☐	☐	☐	☐	☐	☐	☐	☐	NO DEBRIS UNDER PIER - SLOPE CAP APPEARS INTACT
RAB-8	☐	☐	☐	☐	☐	☐	☐	☐	UNDER PIER AREA C MINERAL FEATURE (LIST INTERVAL)
RAB-9	☐	☐	☐	☐	☐	☐	☐	☐	SLOPE APPEARS INTACT
RAB-10	☐	☐	☐	☐	☐	☐	☐	☐	SMALL NO ACTION AREA IN INTERVAL (SEE DIAGRAM)
RAB-11	☒	☐	☐	☐	☐	☐	☐	☐	RAILROAD TIES UNDER MARINA GANGWAY @ ~50'
RAB-12	☒	☐	☐	☐	☐	☐	☐	☐	SLOPE APPEARS INTACT; SLT ACCRETION UNDER MARINA GANGWAY.

* THIN VENEER SEDIMENT ACCRETION (VISIBLE IN RIPRAP) @ HATCHLINE

* CAP UNDERSIDE ESTIMATED DUE TO OVER-WATER STRUCTURE INTERFERENCE

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/12/00

Remedial Area: RA B (PAGE 3 OF 3)

Weather: HAZY ~60°F

Datum (Horiz/Vert): WA STATE PLANE SOUTH (NAD83/91) / MLLW

Field Personnel: MILLSPAUGH

Benchmark(s) Used for Location Control: #214, #215

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting)		Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
		START	FINISH			
RA B-13	100	705752 / 1160050	705840 / 1160040	1200	-3.0'	HABITAT MIX & REP CAP
RA B-14	100	705840 / 1160040	705925 / 1160036	1207	-3.1'	HAB MIX & REP CAP (HAB MIX ONLY UNDER PIER AREA)
RA B-15	100	705925 / 1160045	706025 / 1160045*	1216	-3.2'	HAB MIX, REP CAP / HAB MIX ONLY UNDER PIER
RA B-16	100	706025 / 1160045*	706125 / 1160045*	1232	-3.2'	HAB MIX, QUARRY SPALL & REP CAP
RA B-17	50	706125 / 1160045*	706175 / 1160045*	1243	-3.2'	HAB MIX, QUARRY SPALL & REP CAP

Monitoring Interval	CHECK ALL THAT APPLY								Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
	* Sediment Accretion	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	
RA B-13	☐	☐	☐	☐	☐	☐	☐	☐	OVERSTEEPENED SLOPE APPEARS INTACT
RA B-14	☒	☒	☐	☐	☒	☐	☐	☐	MINOR ACCRETION NEAR H.O. SEEPAGE
RA B-15	☒	☒	☐	☐	☒	☐	☐	☐	ON SEEPAGE, SCATTERED DEBRIS
RA B-16	☐	☐	☐	☐	☒	☐	☐	☐	SCATTERED DEBRIS UNDER PIER AREA
RA B-17	☐	☐	☐	☐	☒	☐	☐	☐	SCATTERED DEBRIS UNDER PIER
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	

* NOTE: THERE SEDIMENT ACCRETION NEAR WATER LINE
RA BOUNDARY C OUTFALL ADJACENT TO 11th ST BRIDGE

* GPS COORDINATE ESTIMATED DUE TO OVER-WATER STRUCTURE INTERFERENCE

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways LMMP

PHOTO DOCUMENTATION

Date: 7/12/2006

Weather: Sprinkling

Remedial Area: RA-8

Field Personnel: Bill Ess[illegible], Tom Ch, Mark Bazlee

Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes
RA8 - 5	1466	-25' South	NW	704940 / 1160182	1033	1st 50' of Int. from dock.
↓	1467	25	NW	704988 / 1160177	1038	2nd 50' of Int from dock
RA8 - 6	1468	-25' South	NW	705042 / 1160168	1047	1st 50' of Int from boat.
↓	1469	40	NW	705079 / 1160152	1050	2nd 50' of Int from boat
RA8 - 7	1470	-20 South	NW	705137 / 1160150	1056	1st 50' of Int from boat
↓	1471	40	NW	705191 / 1160144	1101	2nd 50' of Int from boat
RA8 - 8	1472	-20 South	NW	705236 / 1160137	1103	1st 50 of Int from boat.
↓	1473	25	NW	705278 / 1160134	1108	50-80' of Int from boat
RA8 - 9	1474	-20 South	NW	705322 / 1160127	1117	1st 50' of Int from boat
↓	1475	25	NW	705372 / 1160129	1119	2nd 50' of Int from boat
RA8 - 10	1476	-15 South	NW	705435 / 1160131	1127	1st 50' of Int from boat.
↓	1477	+30 North	SW	705570 / 1160101	1140	2nd 50' from dock
RA8 - 11	1478	-25 South	NW	705520 / 1160106	1144	0-35' of Int from dock.
↓	1479	0	NW	705552 / 1160101	1148	40-100' of Int from dock
RA8 - 12	1480	-40 South	NW	705601 / 1160092	1151	0-50' of Int from dock.
↓	1481	20	NW	705631 / 1160079	1154	50-100' of Int from dock

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

* 1468 taken from boat touching shore. 1469, 1470, 1471, 1472, 1473

1473 boat touch South East piling furthest in waterway under Colonial Fruit.

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways SMMP

PHOTO DOCUMENTATION

Date: 7/12 / 2006

Weather: Rain

Remedial Area: RA-8

Field Personnel: Bill Ecumeier, Tom Ch, Mark Barber

Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes
RA8-13	1482	-30 South	NW	705707/ 1160079	1201	0-50' offset from dock
↓	1483	28	NW	705769/ 1160068	1204	50-100' from dock
RA8-14	1484	-25 South	NW	705816/ 1160065	1208	0-50' from dock
↓	1485	30	NW	705867/ 1160054	1210	50'-100' from dock
↓	1486	85	W	705925/ 1160047	1214	Piling at 80', from dock
RA8-15	1487	-25 South	NW	705920/ 1160046	1217	0-50' from dock.
↓	1488	-25 South	N	705963/ 1160032	1220	Along Shore showing grounded boats
↓	1489	80	SW	706017/ 1160034	1226	50-75' from dock.
RA8-15	1490	60	NW	706004/ 1160035	1228	75-100' from dock
RA8-16	1491	65	SW	706085/ 1160026	1233	0-50' from dock
↓	1492	45	NW	706072/ 1160029	1238	50-75' from dock
↓	1493	50	NW	706070/ 1160030	1239	75-100' from dock
RA8-17	1494	-15 South	NW	706105/ 1160026	1243	0-50' from dock

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

LOW-TIDE SLOPE CAP INSPECTION FORM

MONITORING INTERVAL TRANSECT DIAGRAM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7-12-06

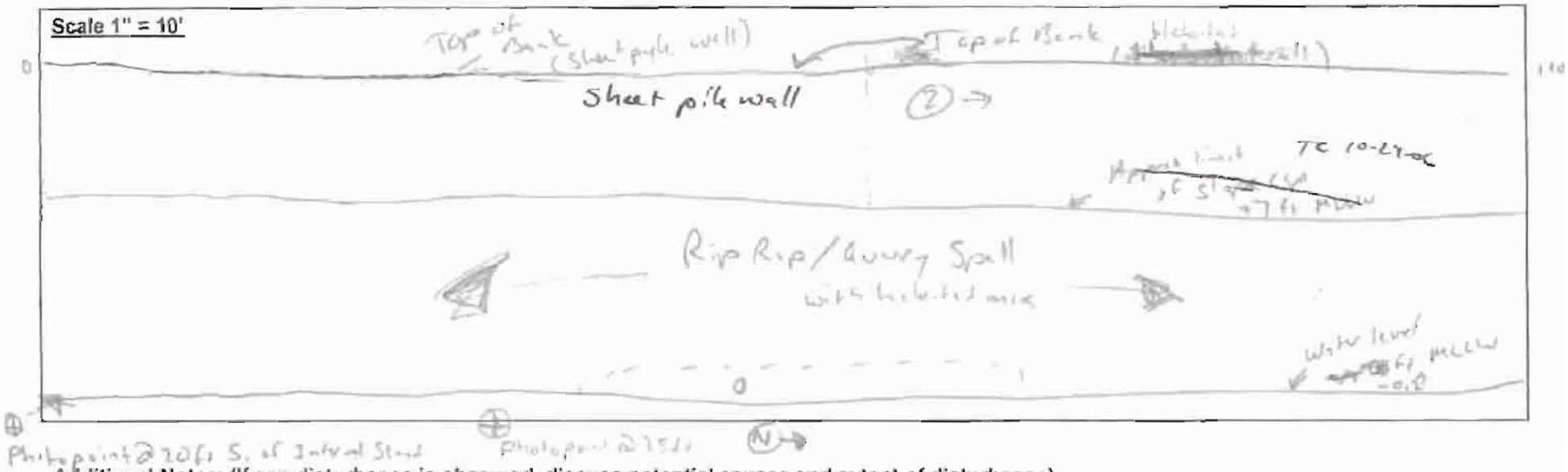
Field Personnel: T. Chontofalsky

Monitoring Interval: RA8-5

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1 possible sediment accretion

2 ~~Sheet pile~~ Sheet pile wall ends @ 50 ft

P0001466 7/12/2006 10:33:55 AM

P0001467 7/12/2006 10:38:10 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: [illegible]

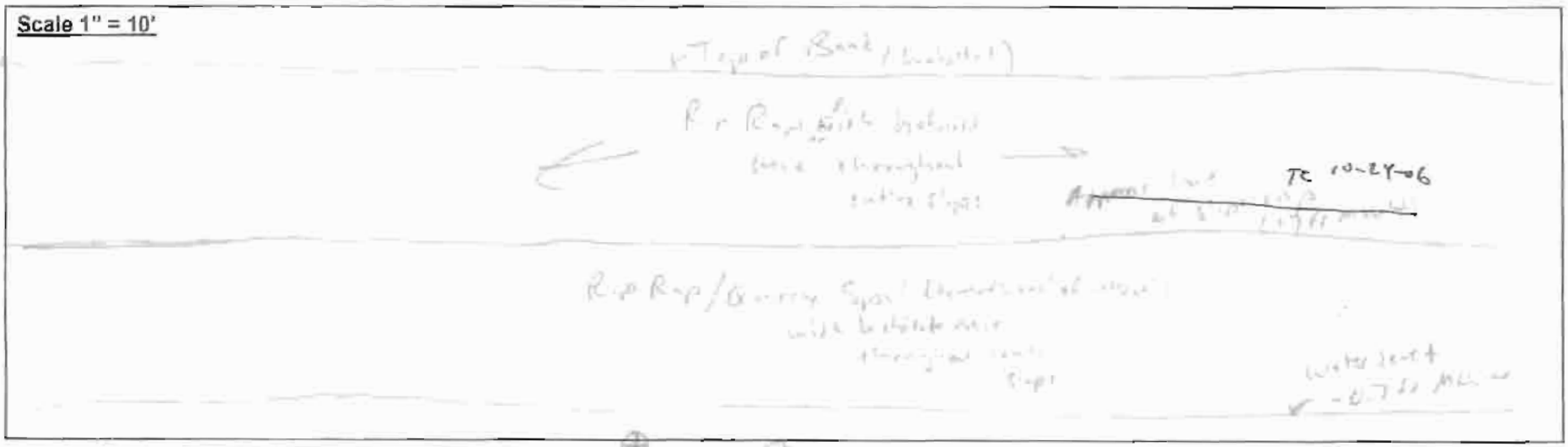
Field Personnel: [illegible]

Monitoring Interval: RAB-6

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001468 7/12/2006 10:47:27 AM

P0001469 7/12/2006 10:50:57 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06

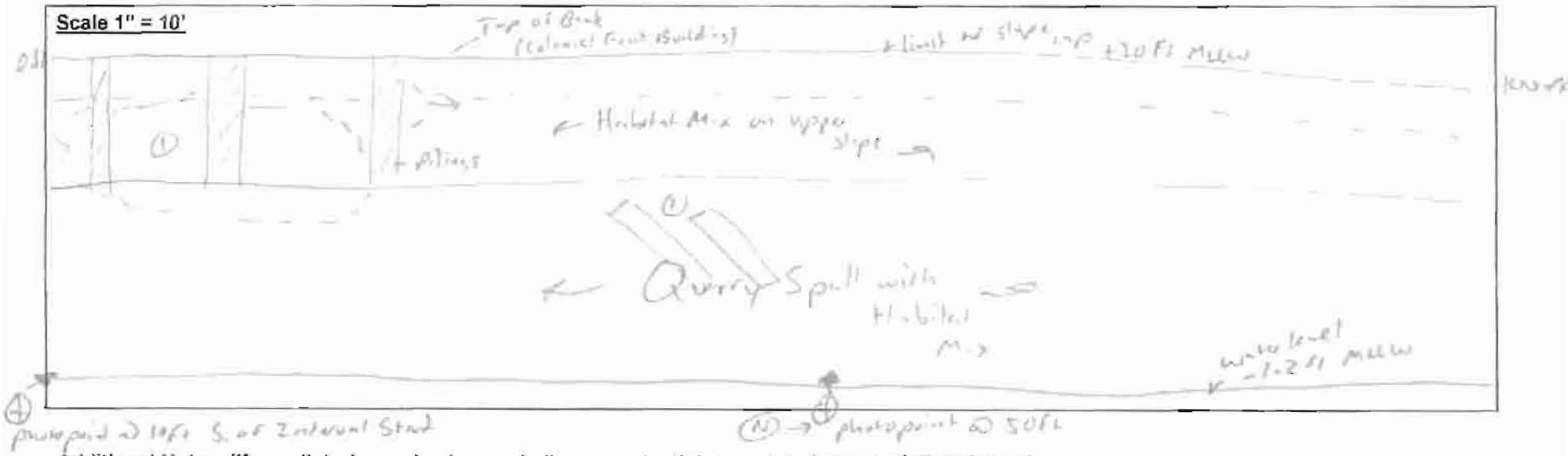
Field Personnel: T. Chartofalsky

Monitoring Interval: RA8-7

Monitoring Interval Transect Notes:

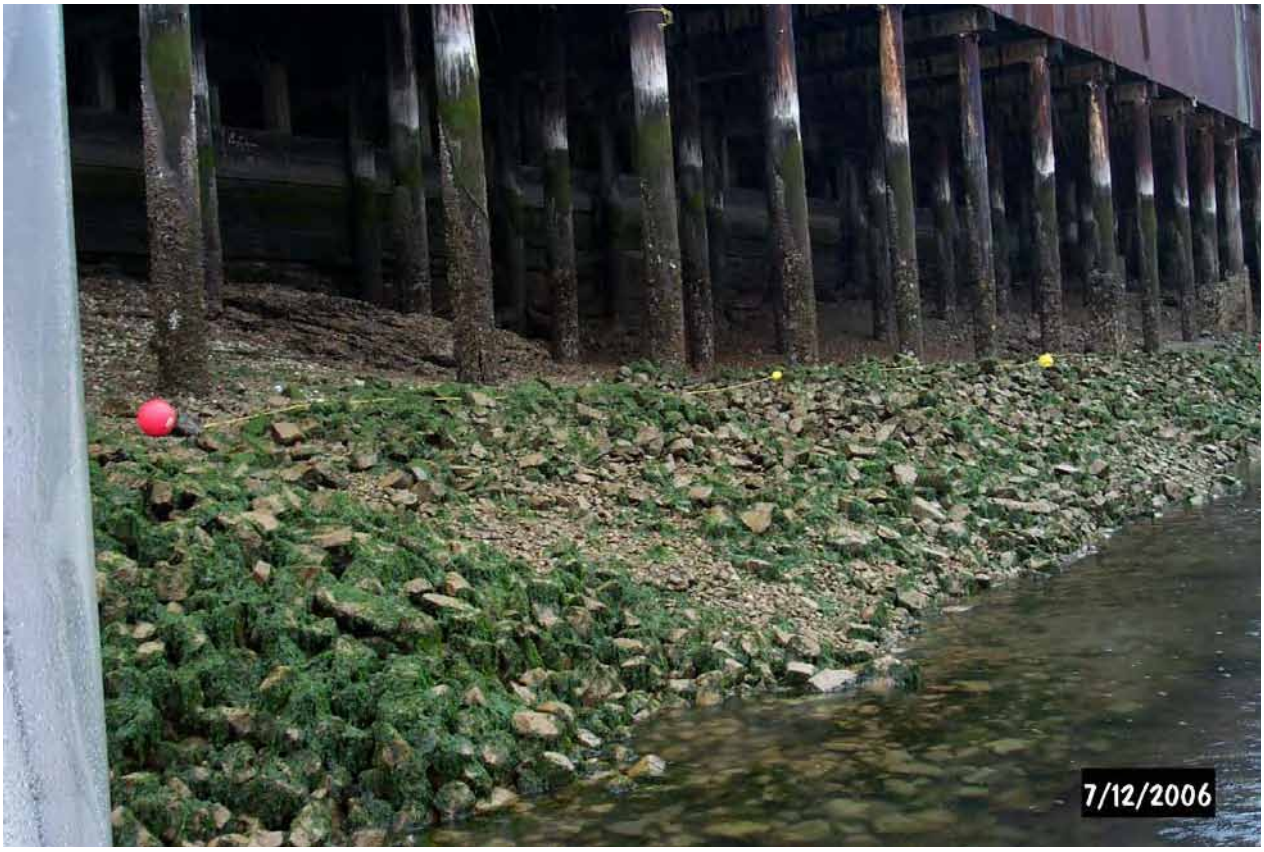
1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Concrete runoff
② Note: Bulkhead on upper slope above habitat mix
③ 2 sheets of metal debris



P0001470 7/12/2006 10:56:11 AM

P0001471 7/12/2006 11:01:09 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 2-17-06

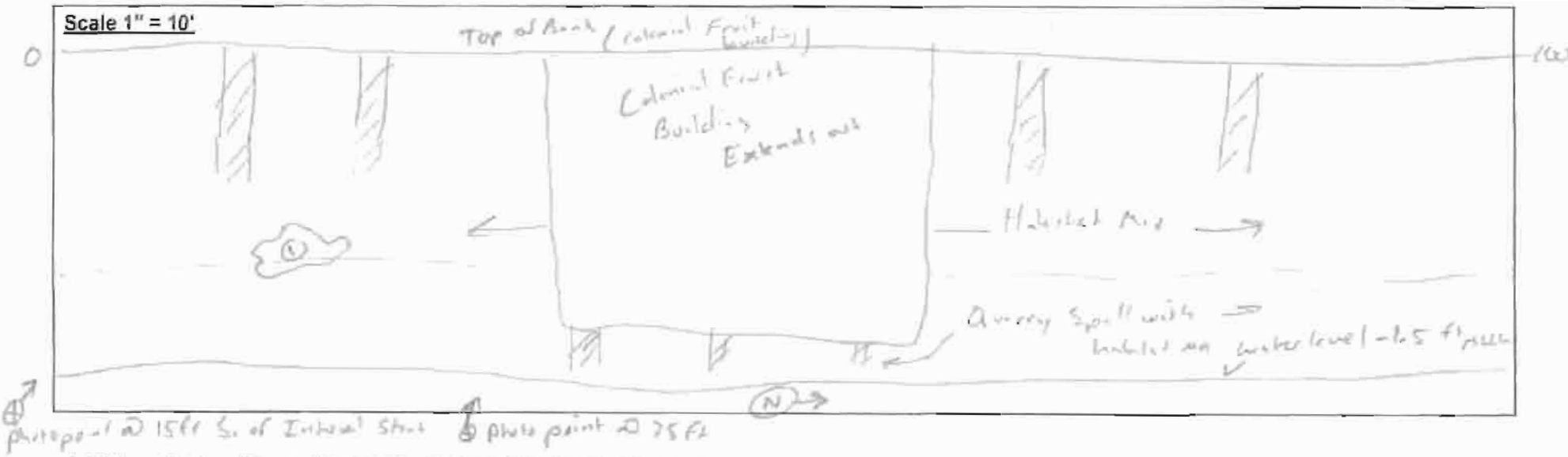
Field Personnel: T. Schantz, Fitzk

Monitoring Interval: RA8-5

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Blanket (debris)

P0001472 7/12/2006 11:03:44 AM

P0001473 7/12/2006 11:08:07 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06

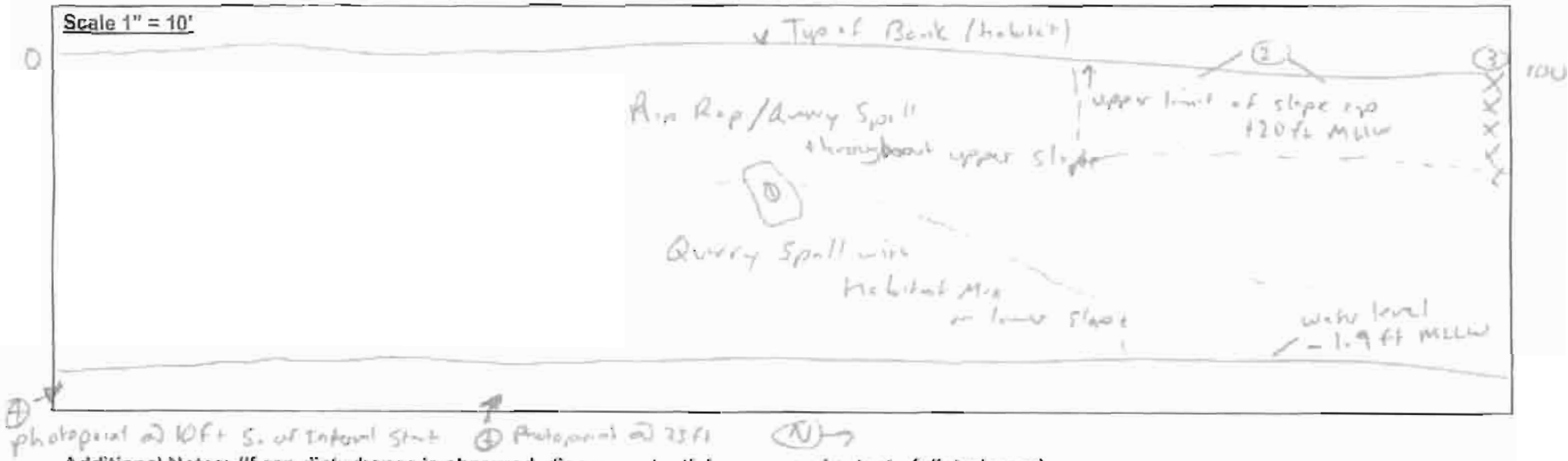
Field Personnel: J. Chamberlain

Monitoring Interval: RAS-9

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Bucket (debris)
② Concrete Structure
③ Fence

P0001474 7/12/2006 11:17:02 AM

P0001475 7/12/2006 11:19:50 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

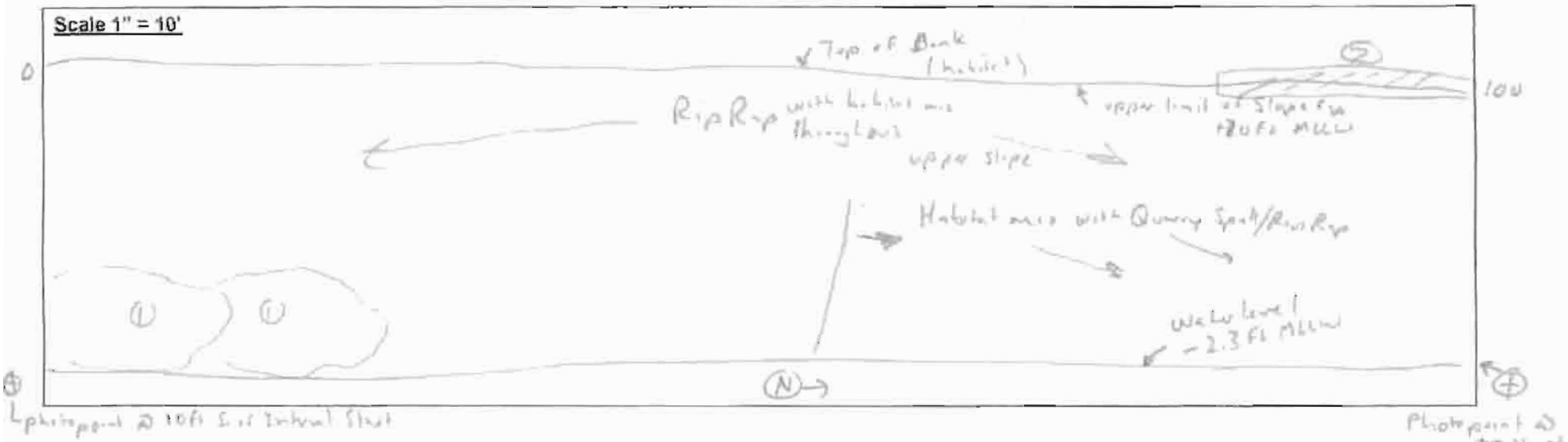
MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06
Field Personnel: T. Chontukalsky
Monitoring Interval: RAB-10

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Concrete monolith
② log on top of slope bank

P0001476 7/12/2006 11:27:28 AM

P0001477 7/12/2006 11:40:24 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

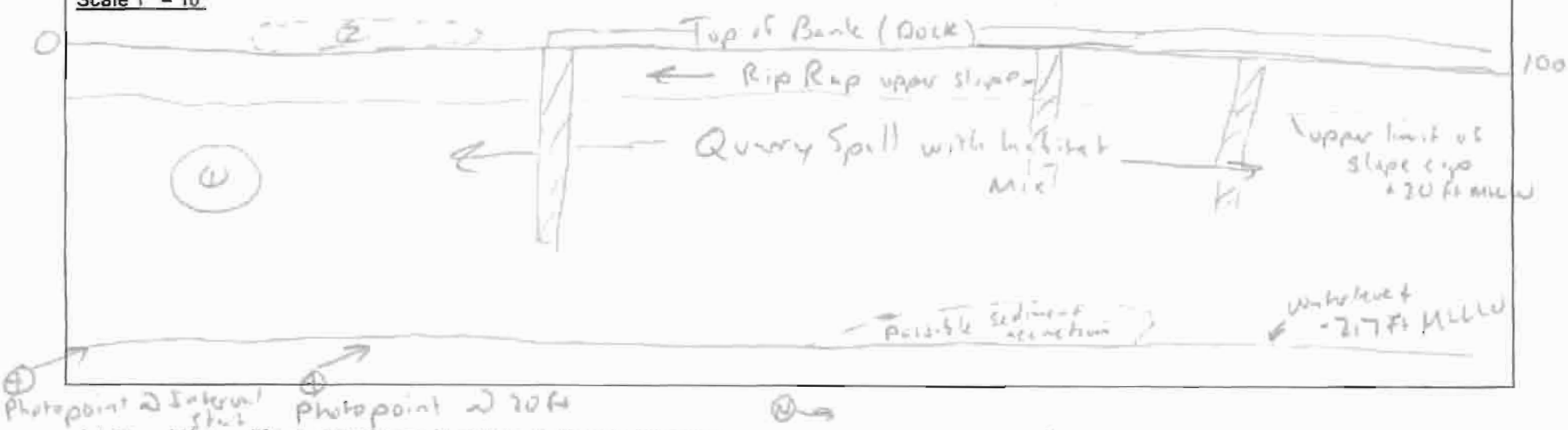
MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-17-06
Field Personnel: T. Chontofsky
Monitoring Interval: RAB-11

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Outfall structure
② Habitat area

P0001478 7/12/2006 11:44:42 AM

P0001479 7/12/2006 11:48:35 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06

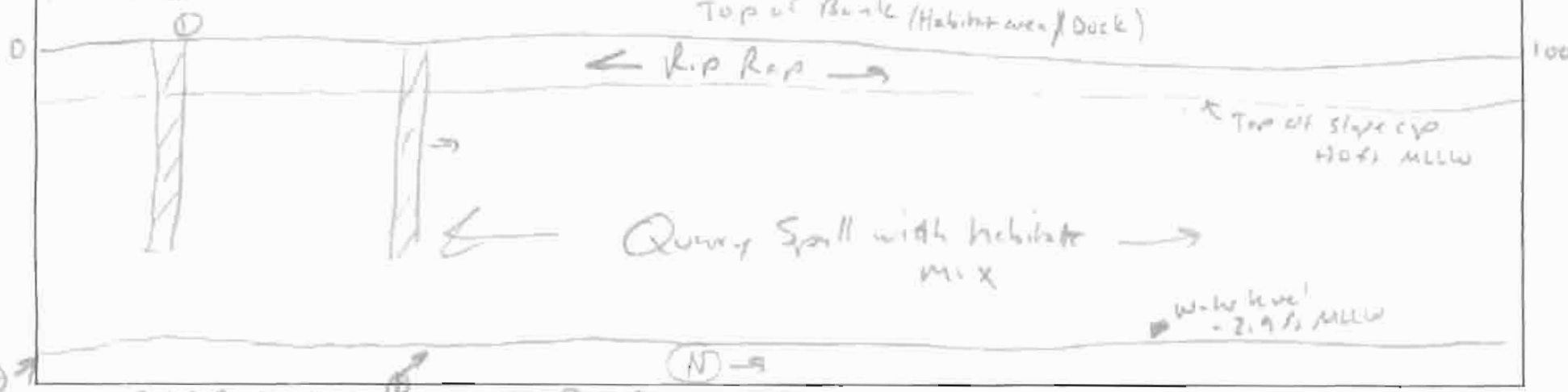
Field Personnel: T. Chunta/Fulsley

Monitoring Interval: RAS-12

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Pilings throughout interval

P0001480 7/12/2006 11:51:36 AM

P0001481 7/12/2006 11:54:25 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

MONITORING INTERVAL TRANSECT DIAGRAM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7-12-06

Field Personnel: T. Chartofalsky

Monitoring Interval: RA8-13

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: Fibrous "mat" found on habitat mix. This is not accretion

P0001482 7/12/2006 12:01:23 PM

P0001483 7/12/2006 12:04:43 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06

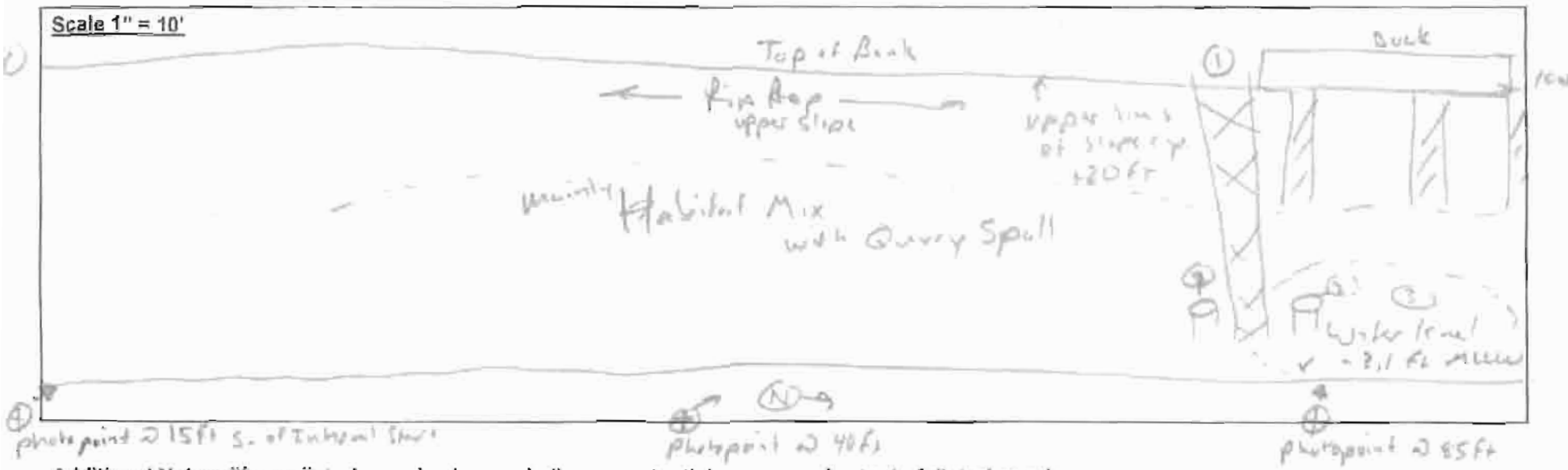
Field Personnel: T. Schuster, Bailey

Monitoring Interval: RAB-14

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (if cap disturbance is observed, discuss potential causes and extent of disturbance)

(1) Walkway from Top of Bank to Dock
(2) old broken pilings
(3) Possible sediment accretion

Note: Some groundwater seepage @ 85 ft

P0001484 7/12/2006 12:08:04 PM

P0001485 7/12/2006 12:10:46 PM

P0001486 7/12/2006 12:14:18 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06

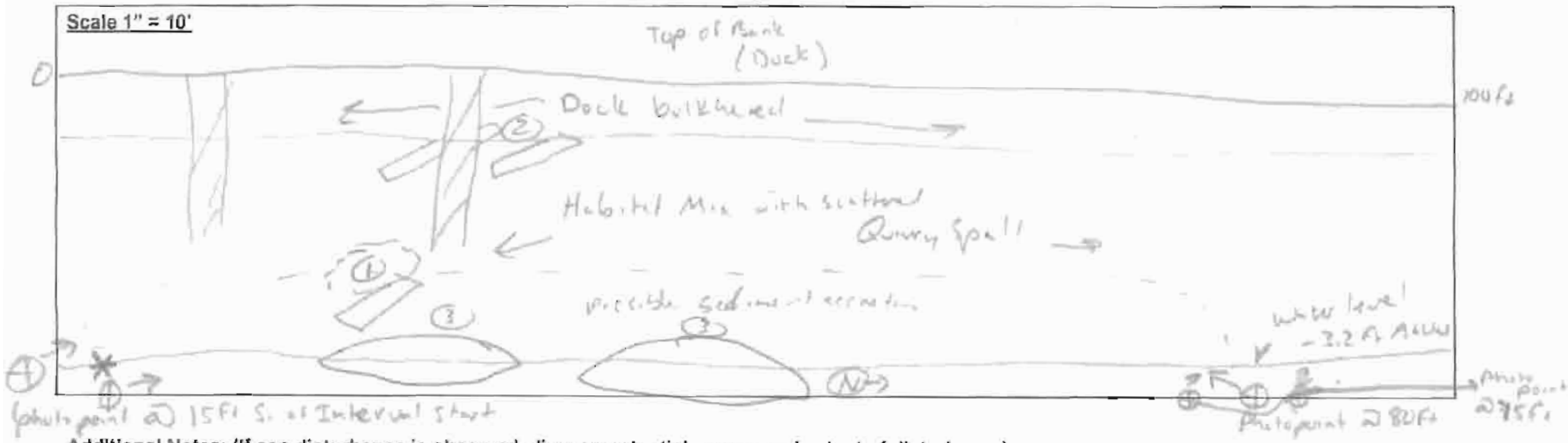
Field Personnel: T. Schantofsky

Monitoring Interval: RA8-15

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① groundwater seepage and wood debris
② Concrete
③ Boats along water line

* Photopoint taken at Interval start if Boats on water line

P0001487 7/12/2006 12:17:52 PM

P0001488 7/12/2006 12:20:10 PM

P0001489 7/12/2006 12:26:09 PM

P0001490 7/12/2006 12:28:46 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-06

Field Personnel: T. Chantefalsky

Monitoring Interval: RAB-16

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note - Pilings throughout this interval

P0001491 7/12/2006 12:33:41 PM

P0001492 7/12/2006 12:38:08 PM

P0001493 7/12/2006 12:39:44 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-12-16

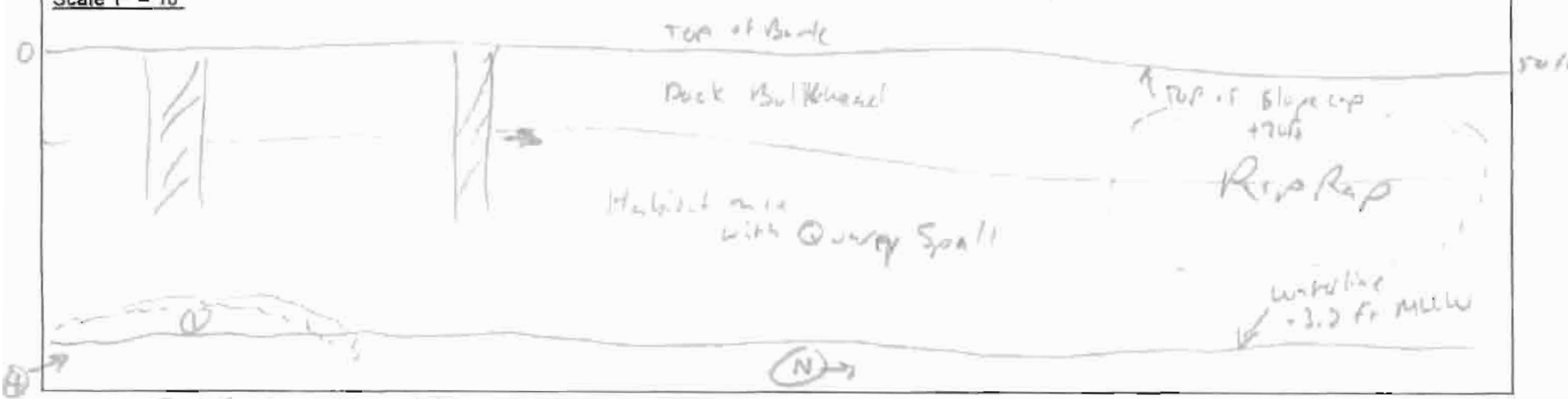
Field Personnel: [illegible]

Monitoring Interval: RA8-17

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Photopoint @ 15 ft S. of Interval start

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: 50 ft transect

① Possible sediment accretion

P0001494 7/12/2006 12:43:49 PM

Remedial Area 14

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/11/2006

Remedial Area: RA 14 (PAGE 1 OF 1)

Weather: SUNNY ~ 70°F

Datum (Horiz/Vert): WA STATE PLANE SOUTH (NAD 83/91) / MLLW

Field Personnel: M. WOLFMAN

Benchmark(s) Used for Location Control: #214 & #215

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting) START 1160834	FINISH	Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
RA 14-1	100	704675 / [illegible]	704706 / 1160782	1227	-2.9'	HABITAT MIX W/SOME RIP RAP
RA 14-2	NA	NA	NA	1240	-2.6'	QUARRY SPALLS W/HABITAT MIX COVERENC
RA 14-3	NA	NA	NA	1247	-2.4'	QUARRY SPALLS & HABITAT MIX
RA 14-4	NA	NA	NA	1258	-2.1'	QUARRY SPALLS, SMALL RIPRAP & HABITAT MIX.
RA 14-5	NA	NA	NA	1307	-1.8'	QUARRY SPALLS & HABITAT MIX
RA 14-6	NA	NA	NA	1315	-1.5'	HABITAT MIX, QUARRY SPALLS & RIPRAP

Monitoring Interval	CHECK ALL THAT APPLY: Sediment Accretion *	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
RA 14-1	☐	☐	☐	☐	☒	☐	☐	☐	SOME DEBRIS PILED AROUND RAZOR WIRE FENCE.
RA 14-2	☒	☐	☐	☐	☐	☐	☐	☐	CAP APPEARS INTACT. NO DEBRIS IN UNDER PIER AREA.
RA 14-3	☒	☐	☐	☐	☐	☐	☐	☐	CAP LOWER THAN UNDER PIER AREAS - APPEARS INTACT
RA 14-4	☒	☐	☐	☐	☐	☐	☐	☐	THICK CAP, NO DEBRIS, CONTINUOUS UNDER-PIER COVERAGE
RA 14-5	☒	☐	☐	☐	☐	☐	☐	☐	CAP LOWER THAN UNDER PIER AREAS - APPEARS INTACT
RA 14-6	☒	☐	☐	☐	☐	☐	☐	☐	HAB MIX @ LOWER ELEVS / QUARRY SPALL & RIPRAP W/HAB MIX ABOVE
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	

NOTES: RA 14-1 ON SOUTH END OF FACILITY (SEE FIGURE FOR PLAN LOCATION).
RA 14-2 UNDER PIER AREA OF WHARF NO. 2
RA 14-3 IN SOUTH SHIPWAY NORTH OF WHARF 2
RA 14-4 UNDER-PIER AREA OF WHARF NO 1
RA 14-5 IN NORTH SHIPWAY SOUTH OF PIER 3.
RA 14-6 UNDER PIER 3 AREA @ NORTH END OF RA

* NORTH BOUNDARY RA 14 @ NORTHERN EXTENT OF PIER 3 @ MARTINAC SHIPYARD SITE.

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways SMMP

PHOTO DOCUMENTATION

Date: 7/11/2006

Weather: Clear 70°F

Remedial Area: RA-14

Field Personnel: Bill Fassmann, Tom Ch, CG

Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes
RA14-1	1450	0	NE	704667 / 1160804	1230	3 photos taken from 1 location
"	1451	0	N	704667 / 1160804	1231	
"	1452	0	NW	704667 / 1160804	1234	
RA14-2	1453	ZZ	E	704739 / 1160702	1241	Setup on West end of Wharf #2
"	1454	ZZ	E	704747 / 1160702	1245	Just North of photo 1453.
RA14-3	1455	ZZ	E	704785 / 1160686	1250	South ship way, South side
"	1456	ZZ	E	704791 / 1160684	1254	South ship way, North side
RA14-4	1457	ZZ	E	704799 / 1160680	1257	South side of Wharf #1
"	1458	—	NW	704808 / 1160715	1301	"
"	1459	—	E	No Coordinates	1306	Beneath Wharf #1. ~~(+35' North of GPS)~~
RA14-5	1460	—	E	~~No Coordinates~~	1314	South side of North Shipway
"	1461	—	E	704938 / 1160677	1319	North side of North Ship way.
RA14-6	1462	—	E	ZZ	1321	South side of Wharf #3.
	1463	—	NE	ZZ	1323	"
	1464	—	NW	ZZ	1324	"

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

RA14-1 is pie-shaped raised area on South west corner.
RA14-2 is under Wharf #2. Measurements are 3' SW of camera location.
RA14-3 is South Shipway. RA14-4 is Wharf #1
RA14-5 is North Shipway. First shot is 20' ~~North~~ South of 1467 (704918 / 1160672)
RA14-6 is under Wharf #3.

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

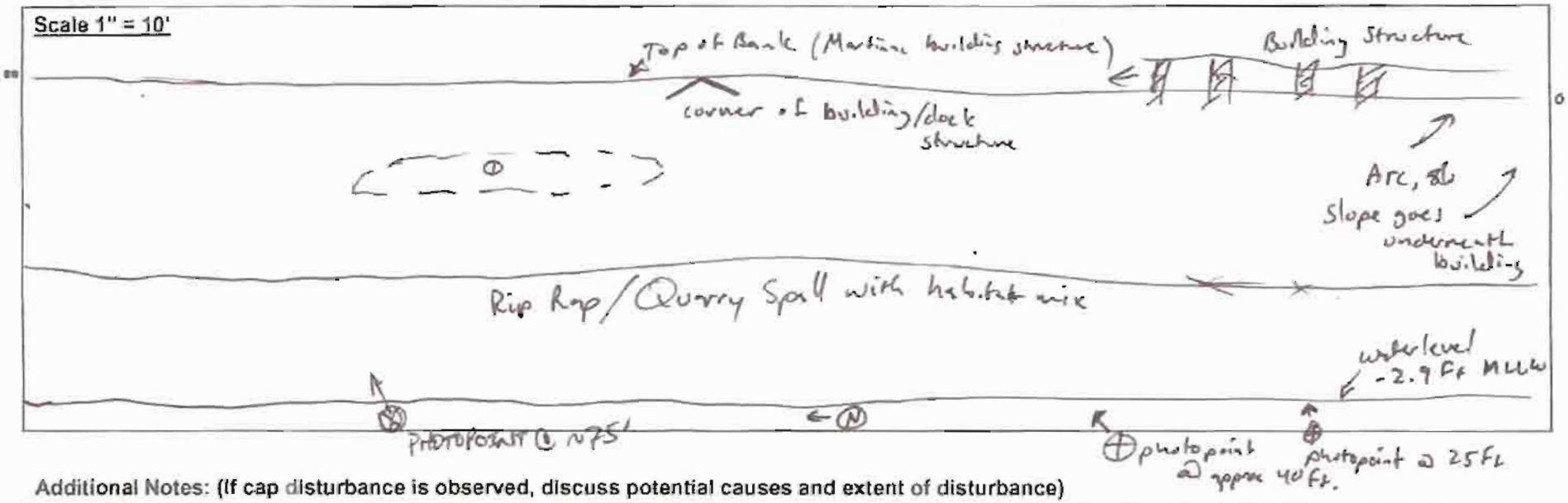
MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-11-06
Field Personnel: T. Chontofalsky
Monitoring Interval: RA14-1

Monitoring Interval Transect Notes:

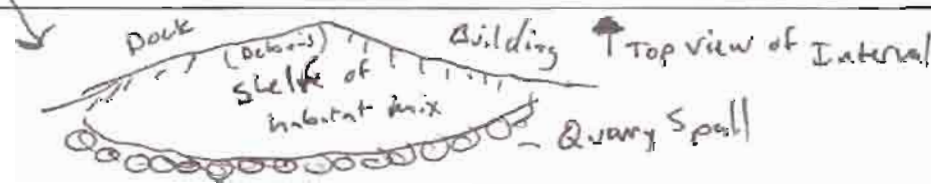
1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

(1) Debris collects in corner of interval @ approx 40-50 Ft
Note: Interval covers an area where it "shelves" as it goes ~~up~~ under the building.



P0001450 7/11/2006 12:30:24 PM

P0001451 7/11/2006 12:32:14 PM

P0001452 7/11/2006 12:34:26 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-11-06

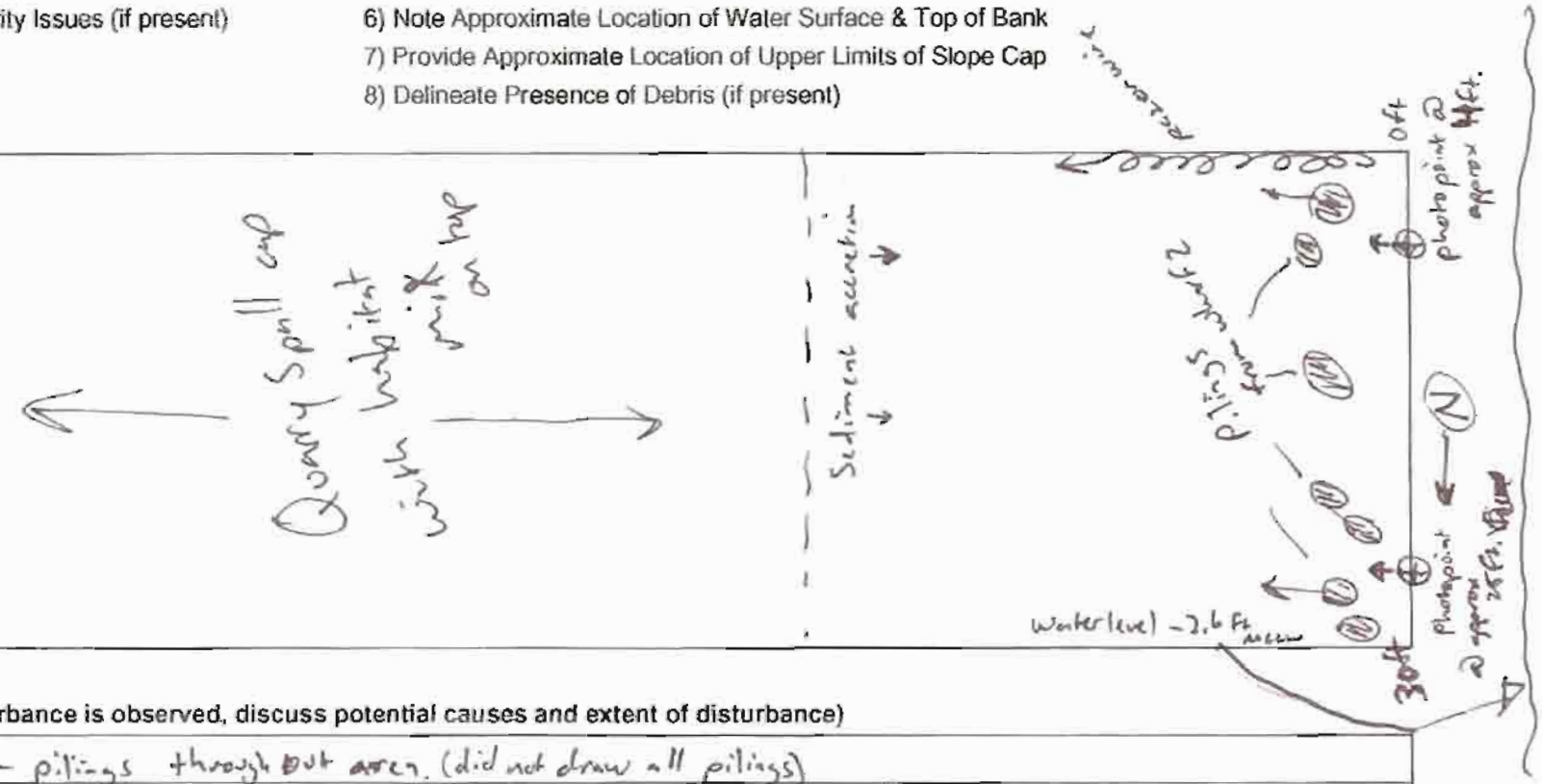
Field Personnel: T. Chontokalsky

Monitoring Interval: RA14-2 (Wharf 2)

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: Under Wharf 2 - pilings throughout area. (did not draw all pilings)

P0001453 7/11/2006 12:42:18 PM

P0001454 7/11/2006 12:45:42 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

MONITORING INTERVAL TRANSECT DIAGRAM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7-11-06

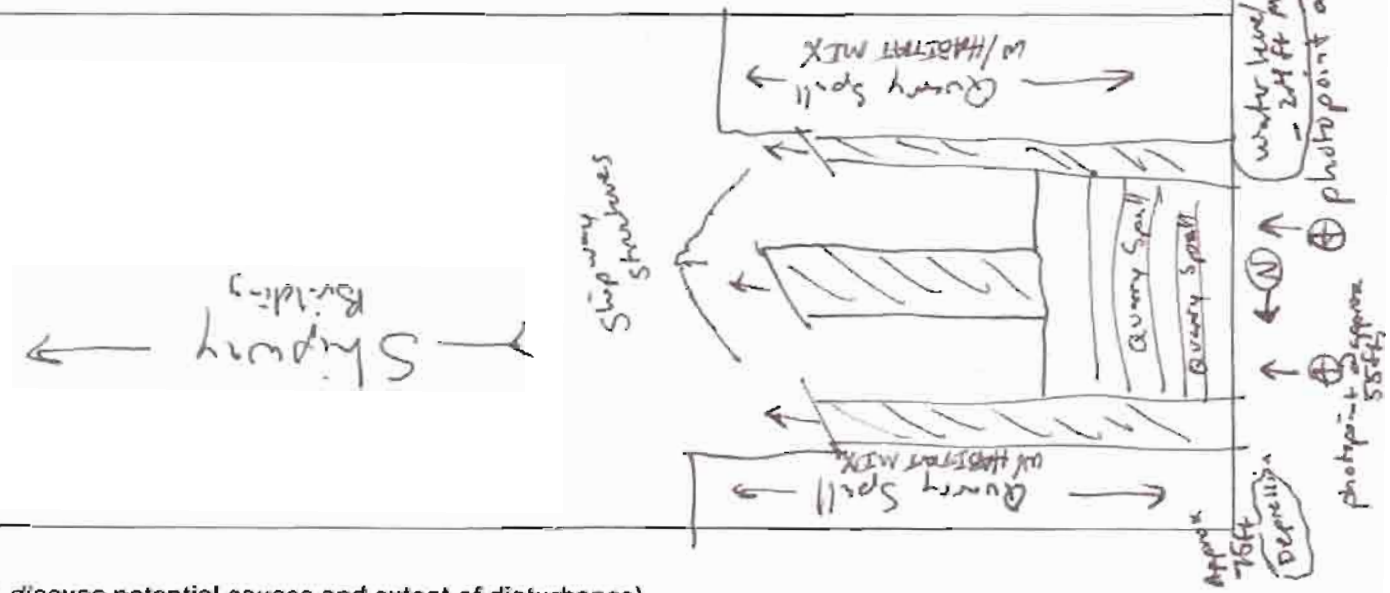
Field Personnel: T. Chartofalsky

Monitoring Interval: RA14-3 (Shipway South)

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001455 7/11/2006 12:51:14 PM

P0001456 7/11/2006 12:54:44 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-11-06

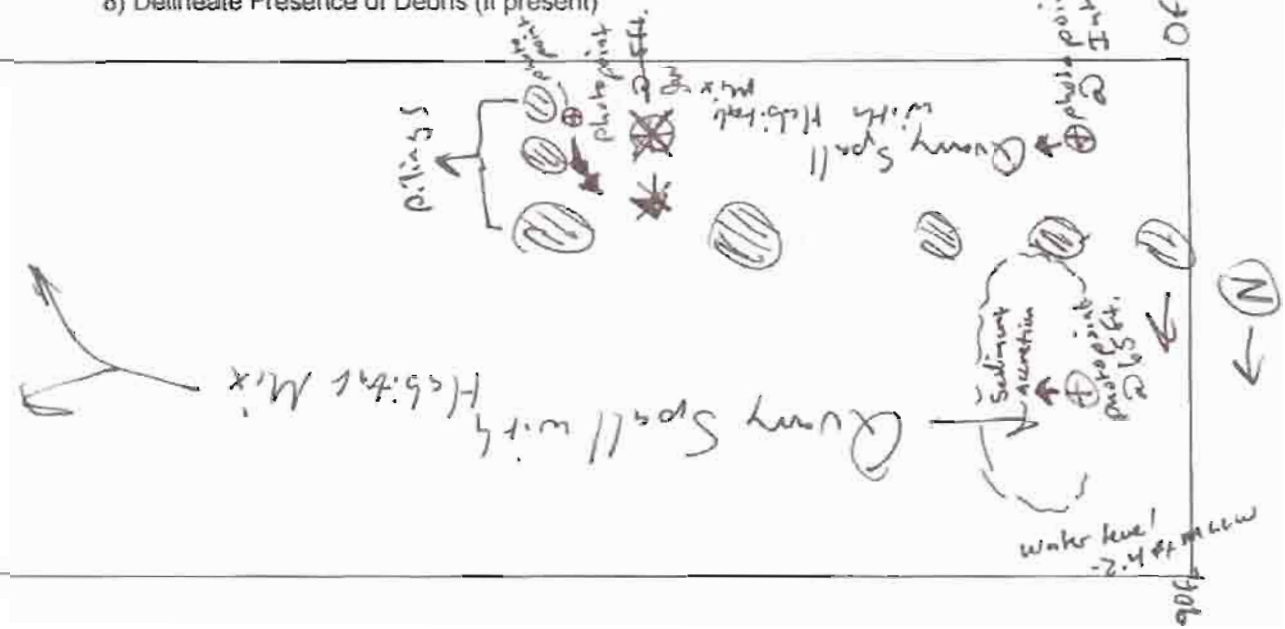
Field Personnel: T. Chonto Ailsley

Monitoring Interval: RA14-4 (Wharf 1)

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: Interval is under a wharf. All pilings are not shown. Mainly Quarry Spall with habitat mix.

P0001457 7/11/2006 12:57:54 PM

P0001458 7/11/2006 1:01:56 PM

P0001459 7/11/2006 1:06:46 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-11-06

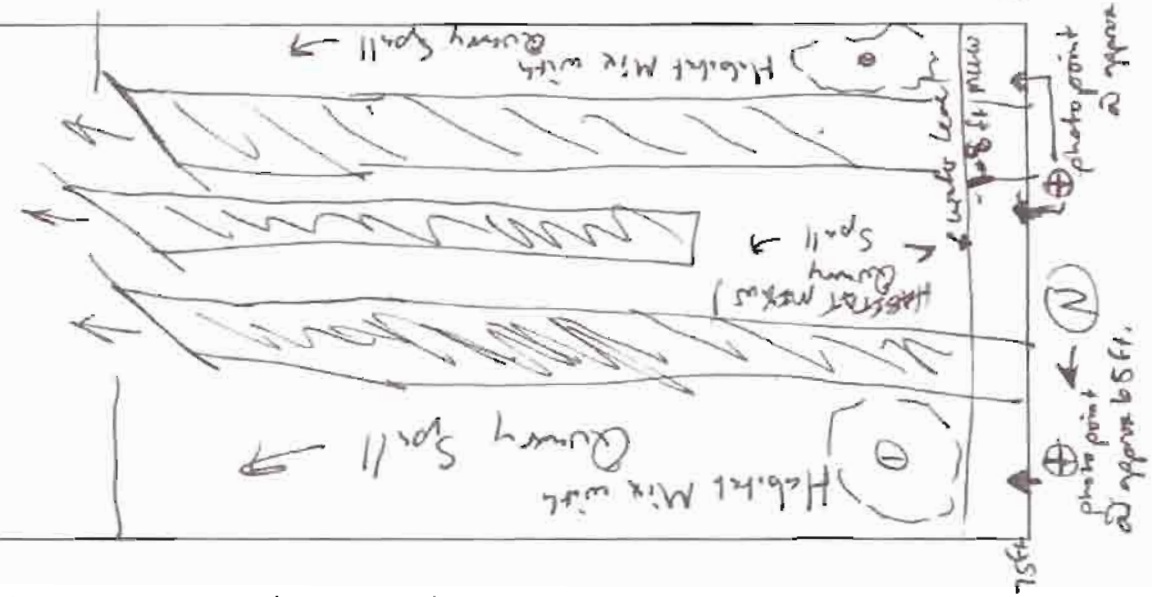
Field Personnel: T. Chmtofelsky

Monitoring Interval: RA14-5 (Shipyard North)

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Possible sediment accretion (from the waterline up into the Shipyard Building)

P0001460 7/11/2006 1:14:56 PM

P0001461 7/11/2006 1:19:36 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-11-06

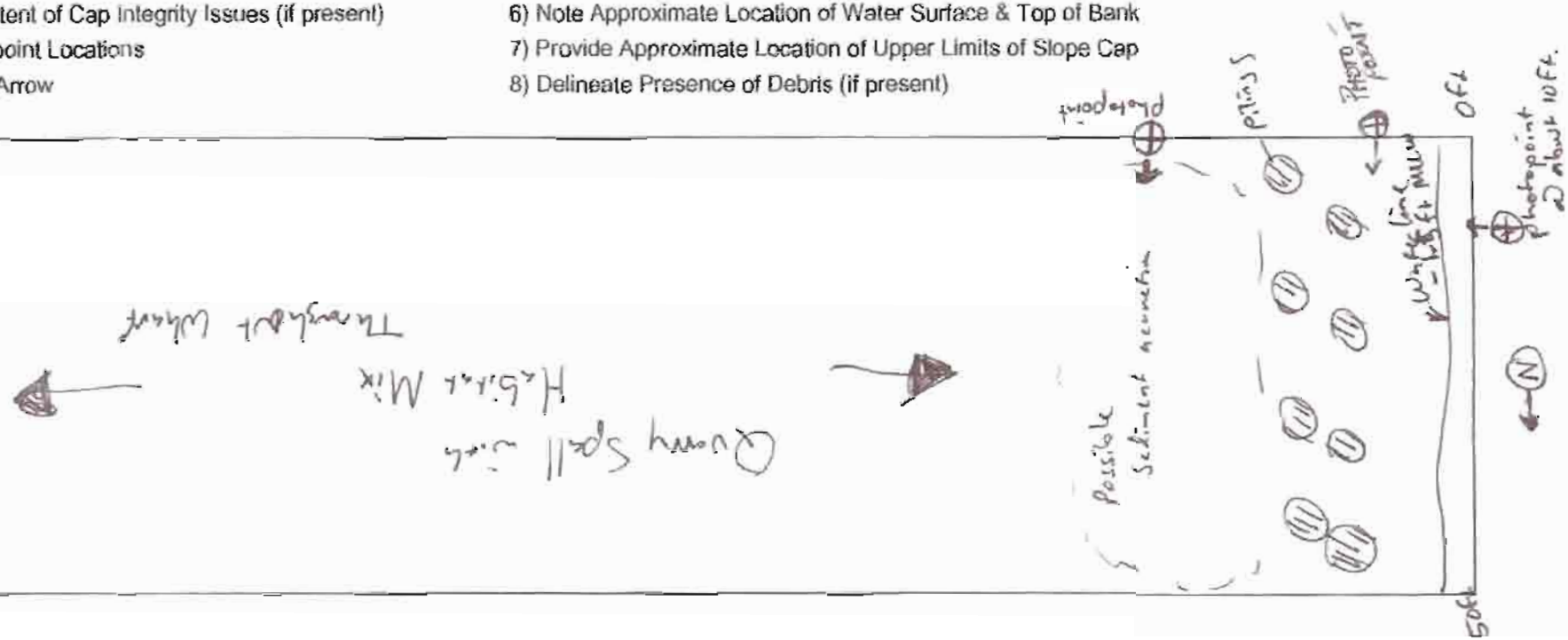
Field Personnel: T. Chontofalsky

Monitoring Interval: RA14-6 (wharf 3)

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: Interval is underneath a Wharf. Mainly Quarry Spall with habitat mix. Some sediment accretion towards the water line

P0001462 7/11/2006 1:21:28 PM

P0001463 7/11/2006 1:23:42 PM

P0001464 7/11/2006 1:24:56 PM

Remedial Area 19A

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/10

Remedial Area: 19A (PAGE 1 OF 2)

Weather: CLOUDY ~ 65°F

Datum (Horiz/Vert): NAD 83 (WA STATE PLANE SOUTH) / MLLW

Field Personnel: M. WILLIAMS

Benchmark(s) Used for Location Control: #214 & #216

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting) START	FINISH	Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
RA 19A-1	100	703549/1160258	703631/1160330	10:35	-2.8'	HABITAT MIX W/ OCCASIONAL RIP RAP / QUARRY SPALL
RA 19A-2	100	703631/1160330	703724/1160320	10:55	-2.9'	HABITAT MIX W/ INCR. RIP RAP @ ~75'
RA 19A-3	100	703724/1160320	703822/1160304	11:15	-2.9'	RIP RAP / MINOR QUARRY SPALL (W) HABITAT MIX
RA 19A-4	100	703822/1160304	703921/1160288	11:25	-2.8'	PREDOMINANT HABITAT MIX (W) OCCA. RIP RAP
RA 19A-5	100	703921/1160288	704008/1160276	11:42	-2.6'	HABITAT MIX (W) OCCASIONAL RIP RAP
RA 19A-6	100	704008/1160276	704122/1160277	11:52	-2.4'	PREDOMINANT HABITAT MIX (W) OCC. RIP RAP
RA 19A-7	100	704122/1160277	704223/1160264	12:00	-2.2'	"
RA 19A-8	100	704223/1160264	704325/1160260	12:08	-2.0'	HABITAT MIX W/ OCCAS. RIP RAP

Monitoring Interval	CHECK ALL THAT APPLY: *Sediment Accretion	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
RA 19A-1	☐	☐	☐	☐	☐	☐	☐	☐	NO VISIBLE THICK SLOPE CAP MATL → GOOD HABITAT MIX COVERAGE
* RA 19A-2	☒	☐	☐	☐	☐	☐	☐	☐	POSSIBLE SETTLEMENT. 2 DEPRESSIONS ALONG TRANSECT (SEE DIAGRAM)
RA 19A-3	☒	☐	☐	☐	☐	☐	☐	☐	GOOD HABITAT MIX COVERAGE. SLOPE CAP APPEARS INTACT
RA 19A-4	☒	☐	☐	☐	☐	☐	☐	☐	MINOR ACCRETION @ CAP SURFACE BEHIND MARINA FLOATS
RA 19A-5	☒	☐	☐	☐	☐	☐	☐	☐	MINOR ACCRETION @ CAP SURFACE BEHIND MARINA FLOATS
RA 19A-6	☒	☐	☐	☐	☐	☐	☐	☐	THIN ACCRETION NEAR H_2O SURFACE BEHIND FLOATS
RA 19A-7	☒	☐	☐	☐	☐	☐	☐	☐	"
RA 19A-8	☐	☐	☐	☐	☐	☐	☐	☐	GOOD HAB. MIX COVERAGE DOWN TO H_2O LINE

* SEDIMENT ACCRETION IN RA 19A-2 IS LOCALIZED IN SETTLEMENT AREA.

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/10/2006

Remedial Area: RA19A (PAGE 2 OF 2)

Weather: CLOUDY ~ 65°F

Datum (Horiz/Vert): NAD 83/91 (WA STATE PLANE SOUTH) / MLLW

Field Personnel: M. WOLTMAN

Benchmark(s) Used for Location Control: #214, #216

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting)		Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
		START	FINISH			
RA19A-9	100	704325/1160260	704424/1160265	12:15	-1.7'	HAB. MIX @ INCREAS. RIPRAP @ ~60' MARK
RA19A-10	100	704424/1160265	704519/1160266	12:20	-1.5'	HAB MIX ABOVE ELEV. +2' / RIP RAP BELOW EL +2'
RA19A-11	65	704519/1160266	704564/1160212	12:30	-1.2'	HAB. MIX ABOVE ELEV +2' / RIPRAP BELOW EL+2'

Monitoring Interval	CHECK ALL THAT APPLY								Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
	Sediment Accretion	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	
RA19A-9	☐	☐	☐	☐	☐	☐	☐	☐	ABUNDANT RIP RAP @ ~ ELEV. 2' NEAR END OF TRANSECT
* RA19A-10	☐	☐	☐	☐	☐	☐	☐	☐	NO HABITAT MIX OBSERVED @ SURFACE BELOW ELEV +2 FT
* RA19A-11	☐	☐	☐	☐	☐	☐	☐	☐	NO HABITAT MIX OBSERVED @ SURFACE BELOW ELEV. +2 FT
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	

NOTE: BNDY W/ RA 19A & RA 8 @ NORTHERN EDGE AMPHITHEATER STEPS (SEE MAP)

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

PHOTO DOCUMENTATION

Date: 7/10/2006

Weather: Cloudy ~60° F

Remedial Area: RA-19 A

Field Personnel: Bill Essmeier, Tom Ch, CG

	Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes	
	RA19A-1	1393 /13	-15 South	N	703549/1160258	1041	1st Half Interval on shore.	
	"	1394 /14	40	NE	703578/1160308	1046	2nd Half Interval on shore	
2	RA19A-2	1395 /15	-10 South	N	703622/1160330	1107	Complete Interval on Shore	Ex002
3	"	1396 /16	8	NW	703633/1160331	1109	Depression #1.	EX003
4	"	1397 /17	25	N	703654/1160327	1112	Depression #2. (Great Depression	EX004
5	RA19A-3	1398 /18	-10 South	N	703710/1160327	1116	Complete Interval minus low tide side	EX005
6	"	1399 /19	Ø	N	703720/1160334	1119	Shore line Rip Rap Quarry spalls	EX006
1396 ✱	RA19A-4	1400 /20	-8 South	N	703816/1160306	1130	Complete Interval	
	RA19A-5	1398	-17 South	N	703905/1160298	1142	Complete Interval.	
	RA19A-6	1399	-6 South	N	704007/1160287	1153	Complete int.	
	"	1400	-2 South	N	703973/1160299	1155	Slightly downshore by 5'.	
	RA19A-7	1401	-12 South	N	704111/1160281	1202	Complete Int.	
	RA19A-8	1402	-10 South	N	704217/1160266	1208	Complete Int.	
	RA19A-9	1403	-10 South	N	704313/1160263	1215	Complete Int.	
	RA19A-10	1404	-10 South	NW	704415/1160268	1224	1st Half Int. upshore	
	"	1405	-10 South	N	"	1224	1st Half Int down shore.	
	"	1406	40'	N	704465/1160283	1227	2nd Half Int	

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

✱ During Photo 1400/20 the Kodak DC290 camera started mixing-up photo serial numbers. The time stamp seems OK.

RA19A-11 1407 -8 South NW 704519/1160276 1230 Complete Int = 65'.

LOW-TIDE SLOPE CAP INSPECTION FORM

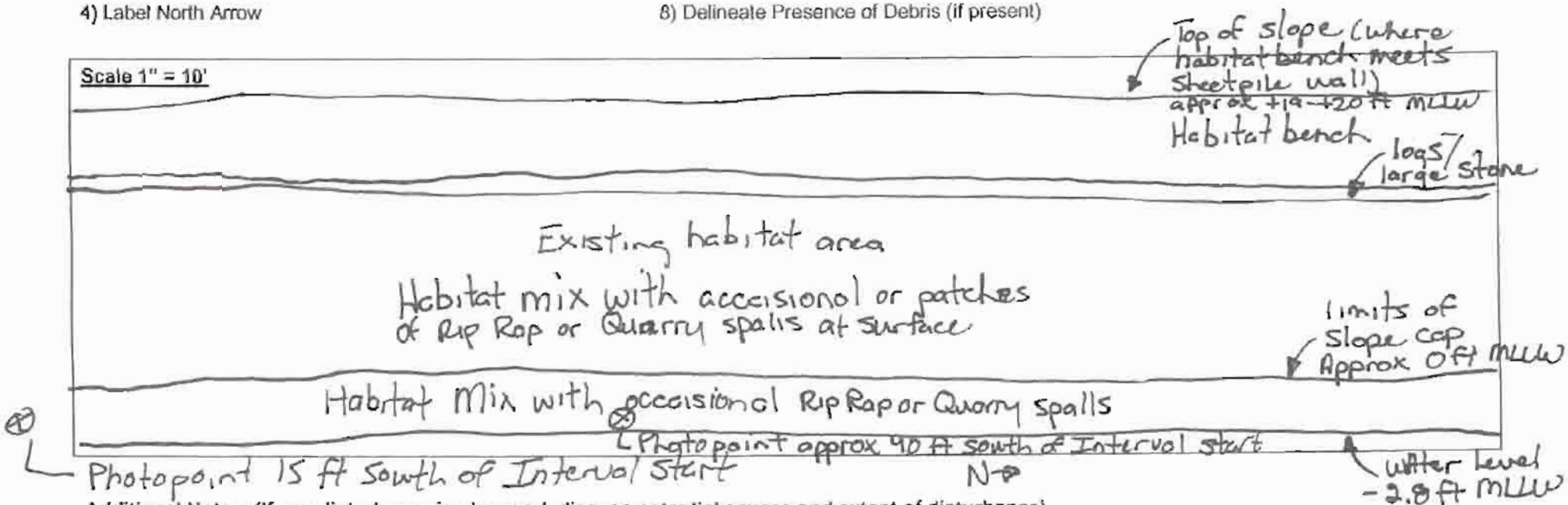
Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7/10/06
Field Personnel: Iain Wingard
Monitoring Interval: RA19A-1

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

No observed difference or transition from existing habitat area to slope cap

P0001393 7/10/2006 10:41:22 AM

P0001394 7/10/2006 10:46:36 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

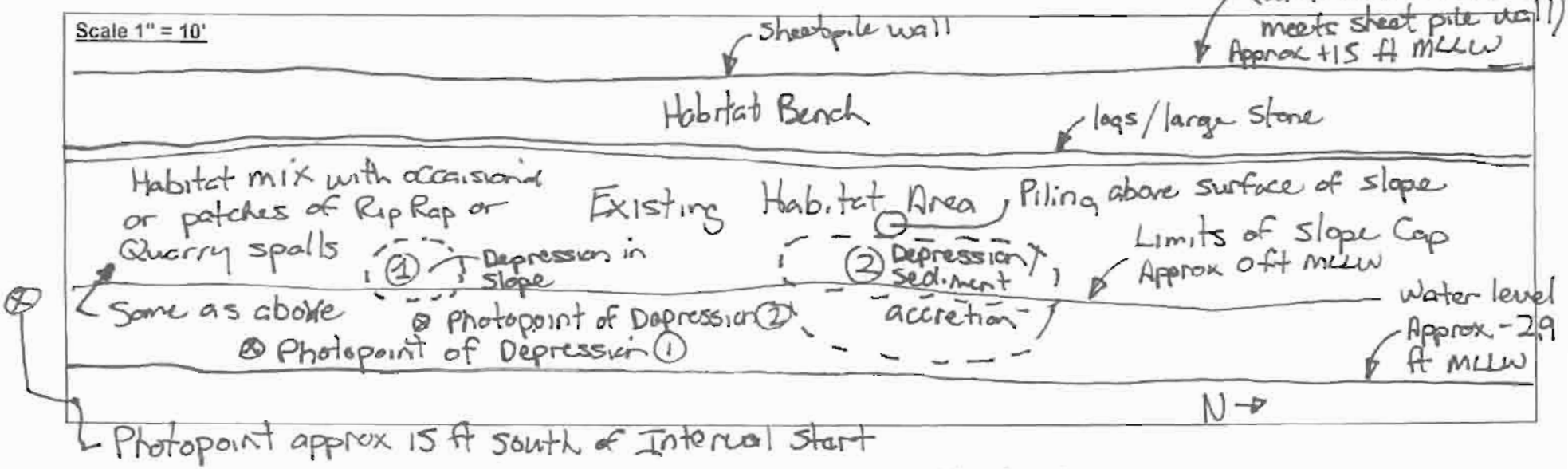
Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7/10/06
Field Personnel: Erin Wingard
Monitoring Interval: RA19A-2

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Depression in slope at approx upper limits of slope cap (dimension 5 ft wide)
② Depression in slope at between approx 55 to 75 ft South of interval start
Note: No observed difference or transition between slope cap and existing habitat

EX000002 7/10/2006 11:07:26 AM

EX000003 7/10/2006 11:10:16 AM

EX000004 7/10/2006 11:12:56 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

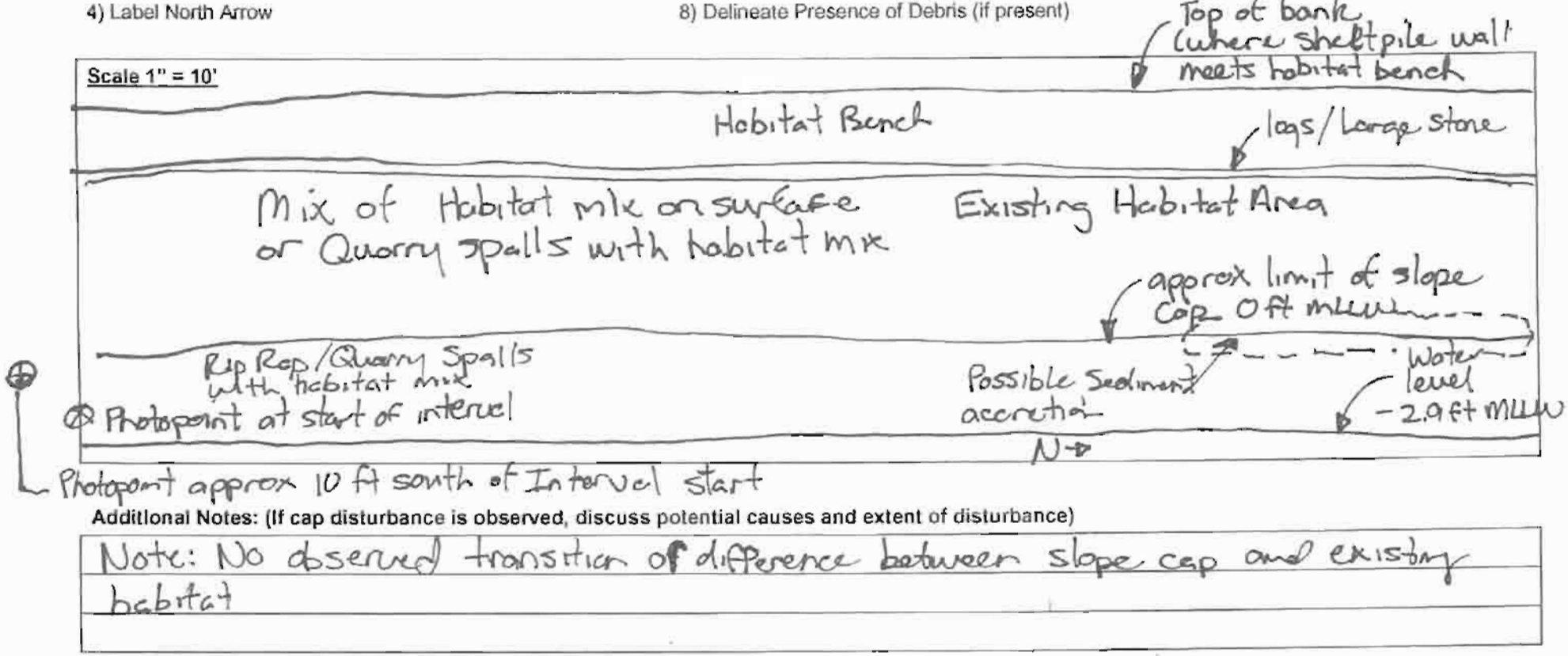
Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7/10/06
Field Personnel: Ian Wingard
Monitoring Interval: RA19A-3

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: No observed transition of difference between slope cap and existing habitat

EX000005 7/10/2006 11:17:08 AM

EX000006 7/10/2006 11:19:54 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

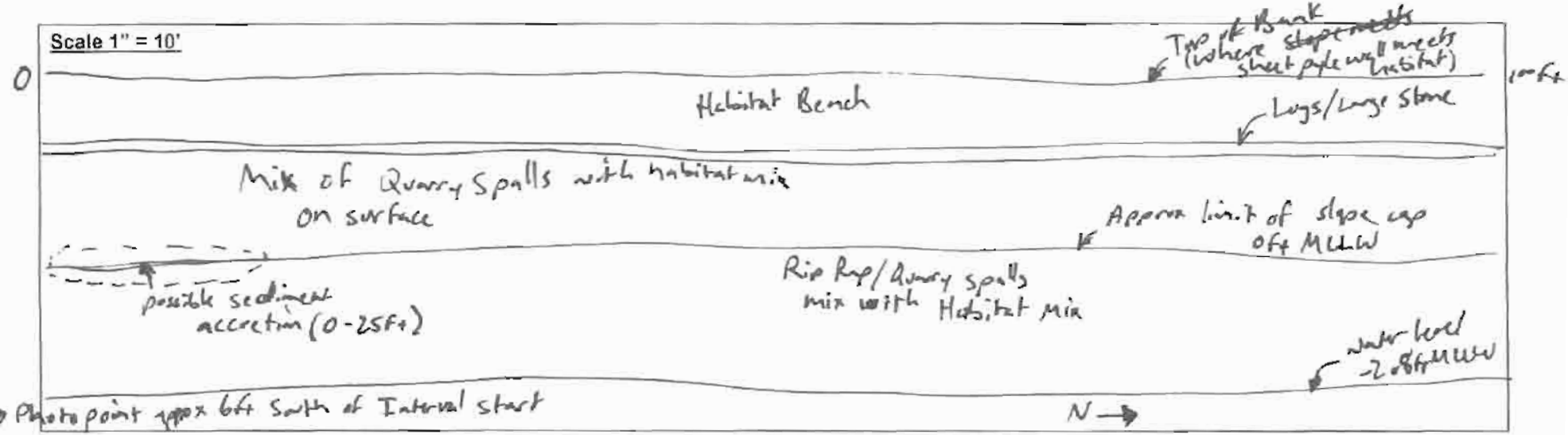
Date: 7-10-06

Field Personnel: T. Chantofalsky

Monitoring Interval: RA19A-4

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: No observed transition between slope cap and existing habitat

P0001396 7/10/2006 11:31:12 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

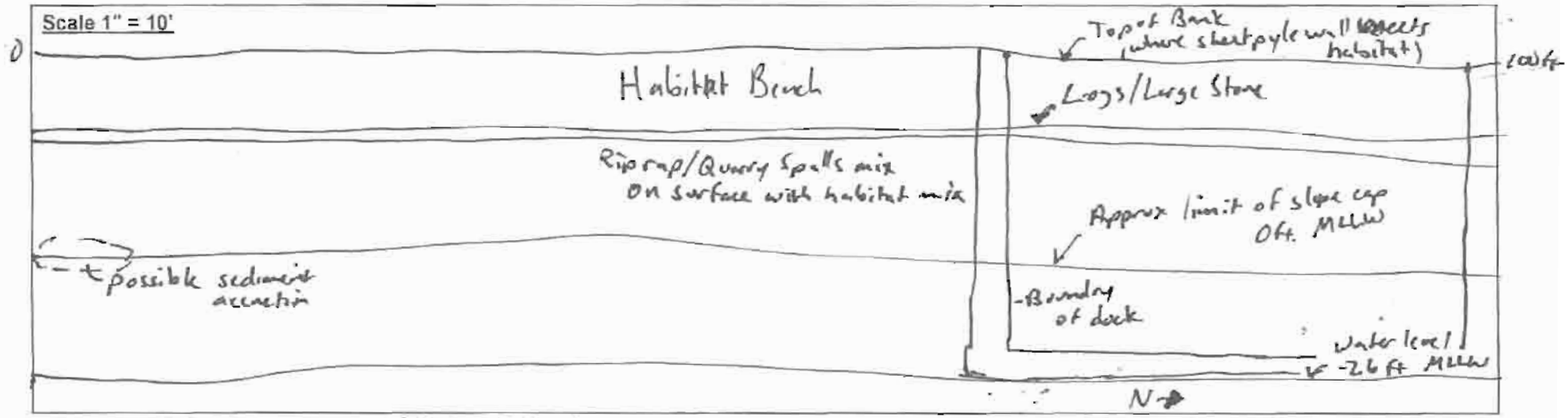
Date: 7-10-06

Field Personnel: T. Chantokalsky

Monitoring Interval: RA19A-5

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



⊕ photopoint approx 10 ft. South of Interval Start

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: possible sediment accretion along lower slope

P0001398 7/10/2006 11:42:50 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

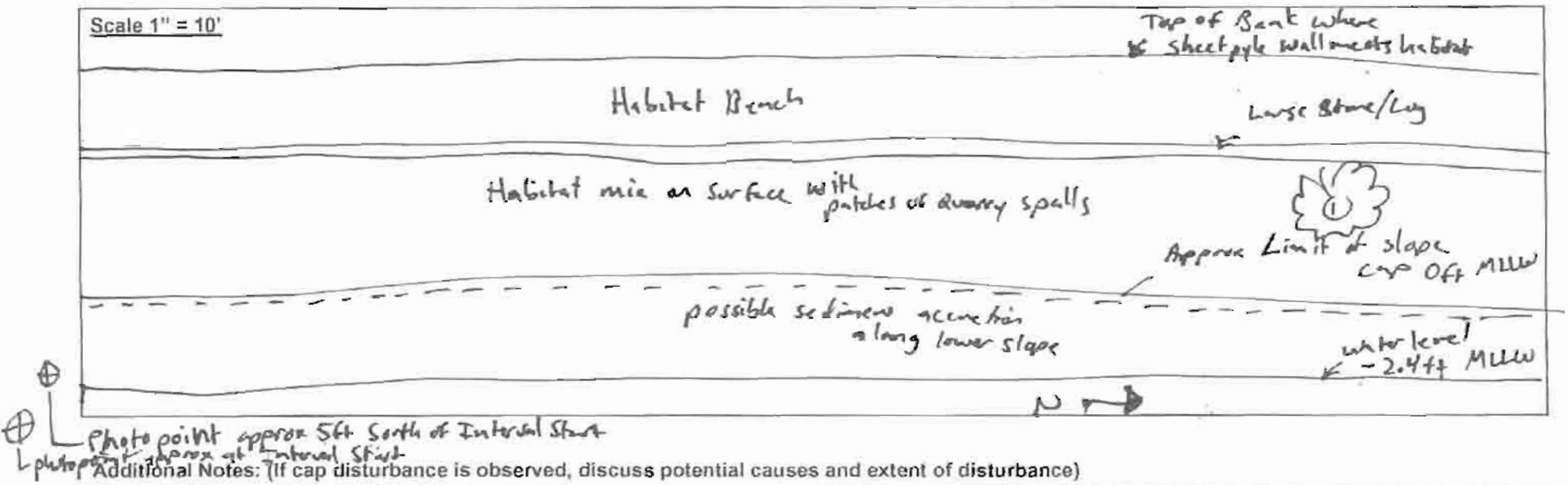
Date: 7-10-06

Field Personnel: T. Chmielowski

Monitoring Interval: RA19A-6

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Log root embedded in upper slope

P0001399 7/10/2006 11:53:48 AM

P0001400 7/10/2006 11:56:20 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

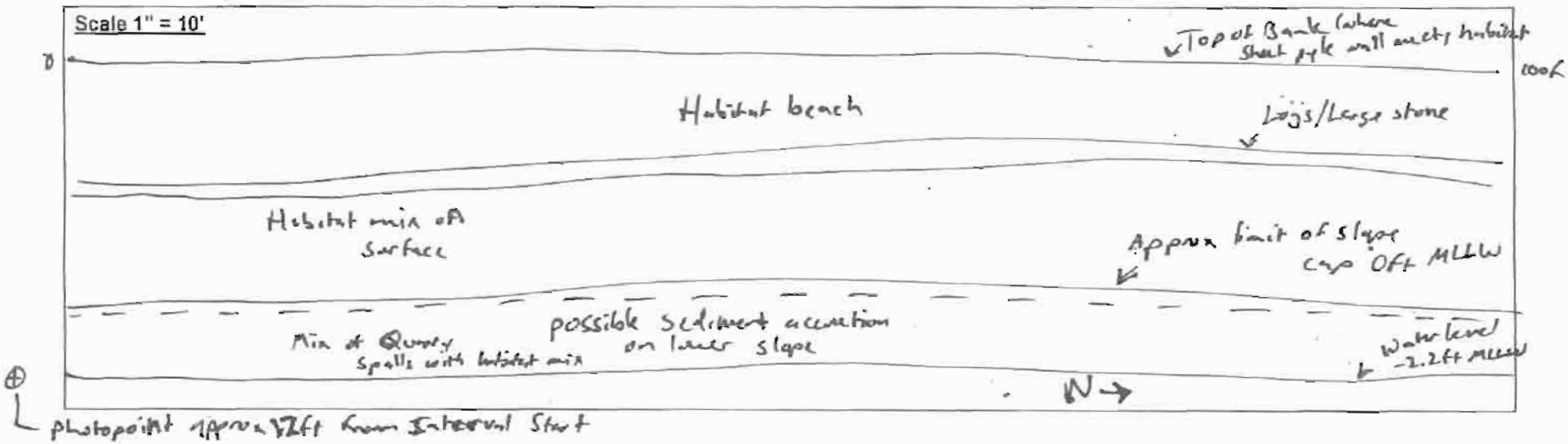
Date: 7-10-06

Field Personnel: T. Chouteau/Sky

Monitoring Interval: RA19A-7

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: Mix of finer sand in upper slope, Outside of marine float: sandy beach

P0001401 7/10/2006 12:02:34 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

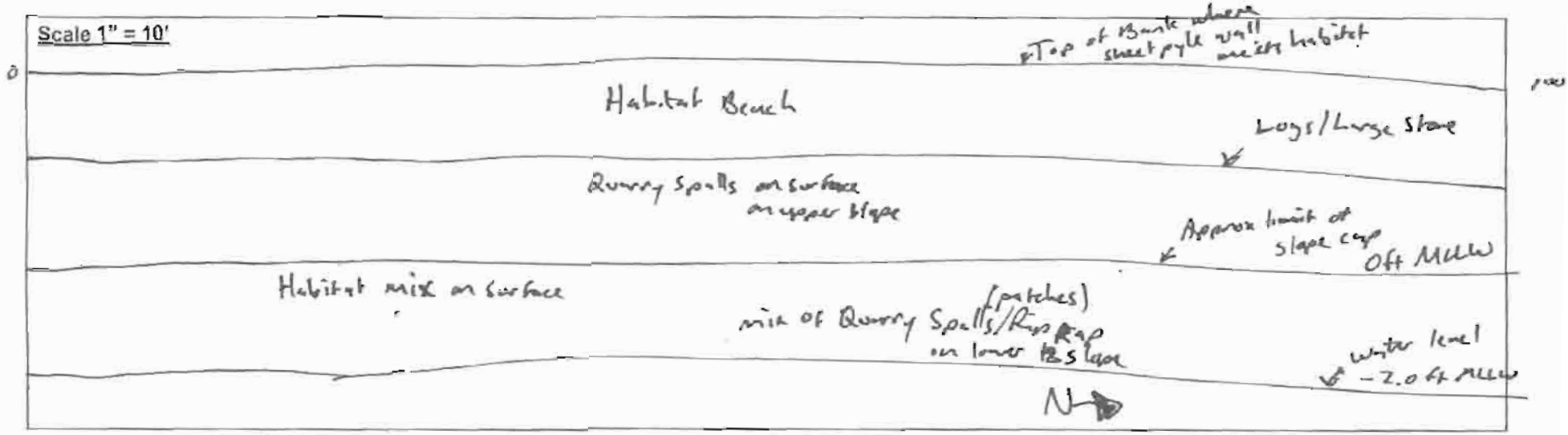
Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-10-06
Field Personnel: T. Chontofalsky
Monitoring Interval: RA19A-8

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Photopoint approx 10ft South of Interval Start.

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note: No observed transition between slope cap and existing habitat

P0001402 7/10/2006 12:09:14 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

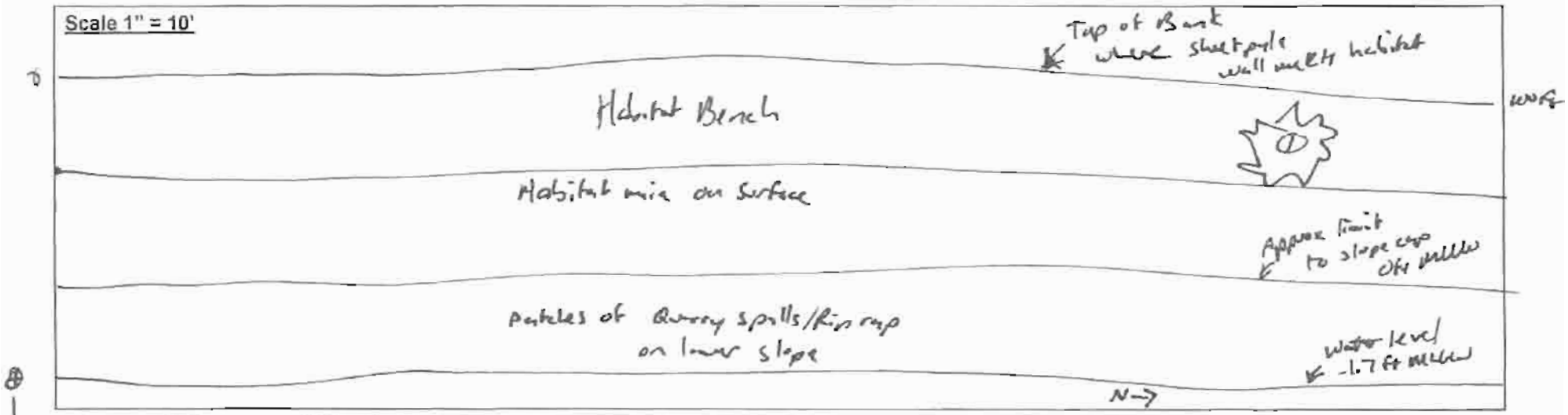
Date: 7-10-06

Field Personnel: T. Chontofalsky

Monitoring Interval: RA17A-1

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



photopoint approx 10 ft South of Interval start

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Log root embedded in slope (upper)

P0001403 7/10/2006 12:15:34 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

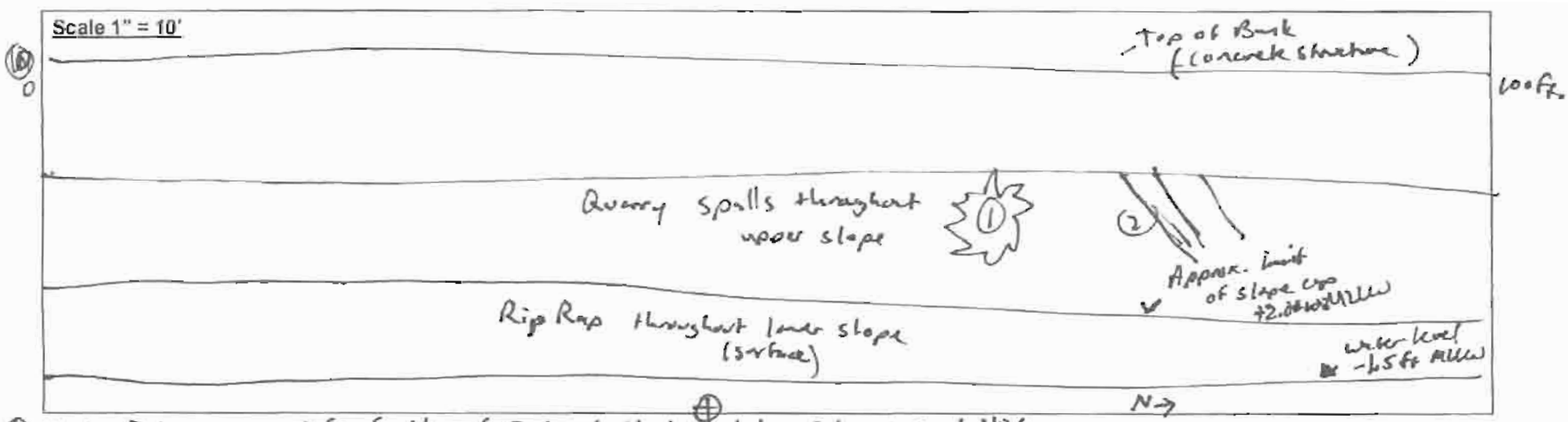
Date: 7-10-06

Field Personnel: T. Chmotolsky

Monitoring Interval: RA19A-10

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1) Log root embedded in Slope
2) Logs on surface of upper slope

P0001404 7/10/2006 12:24:36 PM

P0001405 7/10/2006 12:24:58 PM

P0001406 7/10/2006 12:28:10 PM

LOW-TIDE SLOPE CAP INSPECTION FORM

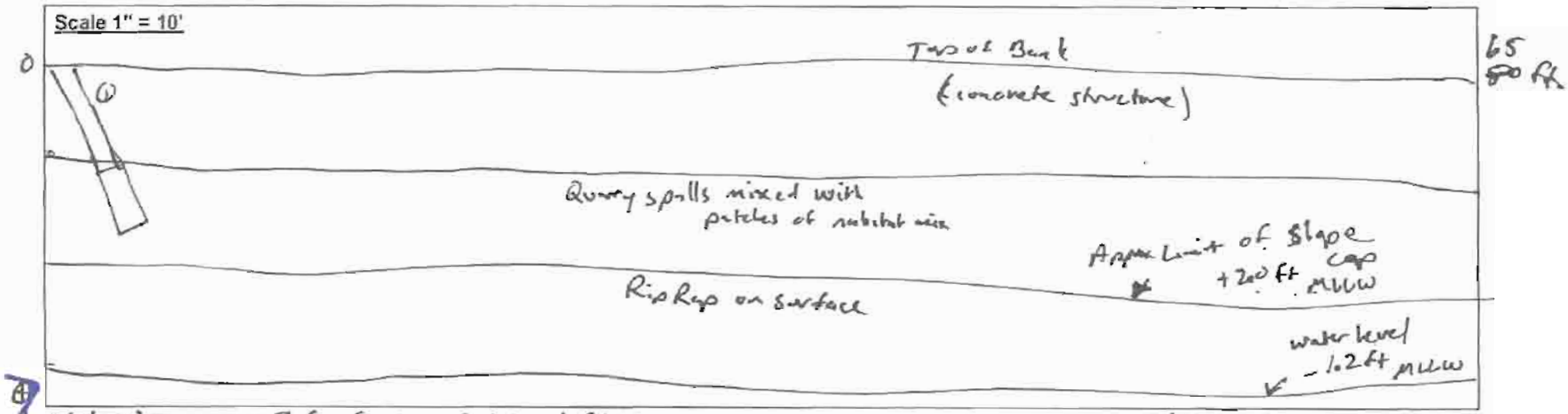
Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-10-06
Field Personnel: T. Chontofalsky
Monitoring Interval: RA17A-11

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Log at start of interval

Note: Interval is 65 ft in length

P0001407 7/10/2006 12:31:16 PM

Remedial Area 19B

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/10/06

Remedial Area: 19B (PAGE 1 OF 1)

Weather: CLOUDY ~ 65°F

Datum (Horiz/Vert): NAD 83 (STATE PLANE WA SOUTH)/MLLW

Field Personnel: M. WOLTMAN

Benchmark(s) Used for Location Control: #214 & #216

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting) START	FINISH	Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
RA19B-1	100	702779/1160426	702879/1160409	9:05	-.4'	Rip Rap / Quarry Spalls (w) Habitat mix
RA19B-2	100	702879/1160409	702969/1160373	9:20	-0.8'	"
RA19B-3	100	702969/1160373	703063/1160344	9:30	-1.3'	"
RA19B-4	100	703063/1160344	703104/1160329	9:40	-1.7'	"
RA19B-5	100	703104/1160329	703257/1160311	9:52	-2.0'	RIP RAP / QUARRY SPALLS (W) HABITAT MIX
RA19B-6	100	703257/1160311	703357/1160279	10:02	-2.2'	PREDOMINANT RIP RAP (W) HABITAT MIX
RA19B-7	100	703357/1160279	703448/1160268	10:15	-2.5'	"
RA19B-8	100	703448/1160268	703547/1160257	10:23	-2.7'	RIP RAP / MINOR QUARRY SPALL (W) HABITAT MIX

Monitoring Interval	CHECK ALL THAT APPLY: Sediment Accretion	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
RA19B-1	☐	☐	☐	☐	☐	☐	☐	☐	No apparent disruptions
RA19B-2	☐	☐	☐	☐	☐	☐	☐	☐	"
RA19B-3	☐	☐	☐	☐	☐	☐	☐	☐	"
RA19B-4	☒	☐	☐	☐	☐	☐	☐	☐	NO APPARENT DISRUPTIONS / GOOD UNDER PIER COVERAGE.
RA19B-5	☒	☐	☐	☐	☐	☐	☐	☐	GOOD UNDER-PIER COVERAGE / CAP APPEARS INTACT
RA19B-6	☒	☐	☐	☐	☐	☐	☐	☐	STEEP THREE SLOPE CAP APPEARS INTACT
RA19B-7	☒	☐	☐	☐	☐	☐	☐	☐	" MINOR ACCRETION (SED) @ WATERLINE
RA19B-8	☒	☐	☐	☐	☐	☐	☐	☐	" MINOR SEDIMENT ACCRETION @ WATERLINE.

NOTE: TRANSITION OF RA19B / RA19A BOUNDARY REFINED @ NORTH WESTERN CORNER OF NORTHERN-MOST MARINA FLOAT.

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

PHOTO DOCUMENTATION

Date: 7/10/2006

Weather: Cloudy ~58°F

Remedial Area: RA-19B

Field Personnel: Bill Essmeier, Tom Chomko Falsky, CG

Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes
RA19B-1	1381 /1	~10 South	N	702763.21/1160453.55	0905	1st Photo of Interval rope
"	1382 /2	~40	N	702815 / 1160437	0910	2nd Half of Interval rope
RA-19B-2	1383 /3	~10 South	N	702868 / 1160416	0922	Complete interval
RA-19B-3	1384 /4	~10 South	N	702967 / 1160383	0930	Complete interval
RA-19B-4	1385 /5	~10 South	N	703052/1160353	0939	Most of interval, Some is hidden
"	1386 /6	~40 on Dock	NW	703113 / 1160373	0949	2nd Half of Interval
RA-19B-5	1387 /7	~20 South	NW	703143/1160365	0952	Complete interval. from dock.
RA19B-6	1388 /8	~15 South	NW	703236/1160337	1003	1st half interval from dock.
"	1389 /9	~10	NW	703262/1160336	1007	2nd half interval from Gangway.
RA-19B-7	1390 /10	~10 South	NW	703352/1160325	1017	1st half interval from dock.
"	1391 /11	~40	NW	703396/1160317	1020	2nd half interval from dock.
RA19B-8	1392 /12	30 South	NW	703430/1160313	1023	Complete interval from dock.

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

Interval Rope is 100' with Red ball at each end, Yellow ball at 50', Yellow bumber at 25', 75'
RA-19B-4 (1386) taken from dock. RA-19B-5 (1387) from dock. (1388) 15 south on dock.

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

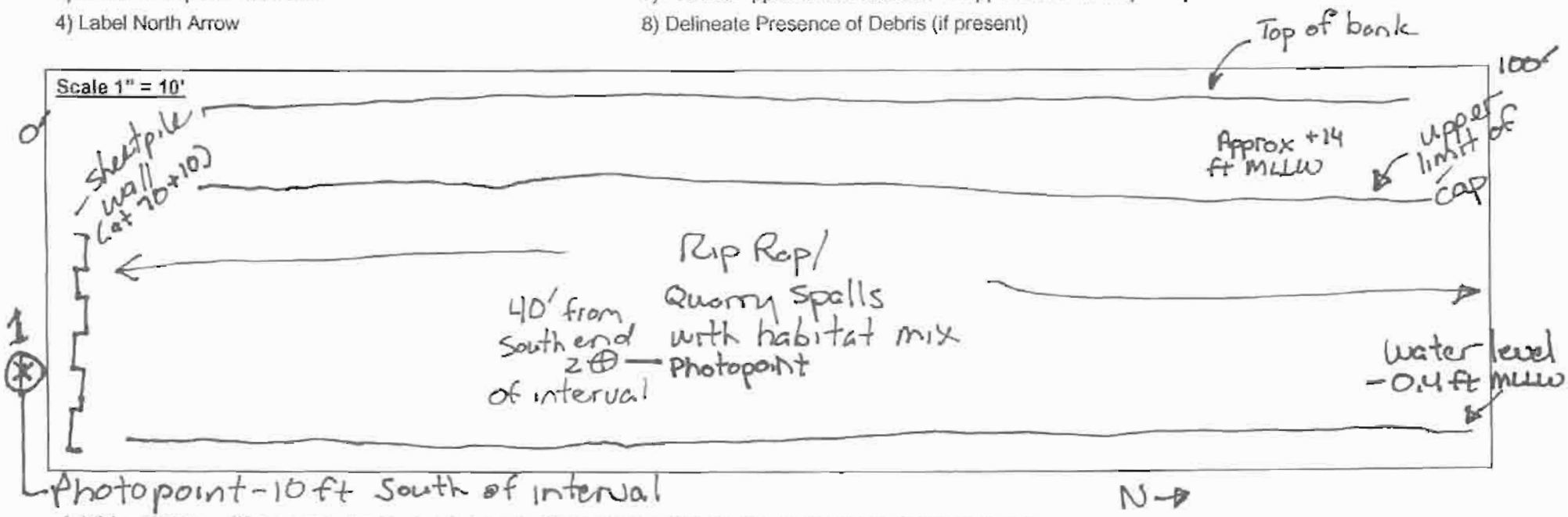
Date: 7/10/06

Field Personnel: Iain Wingard

Monitoring Interval: RAMB-1

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (if cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001381 7/10/2006 9:05:56 AM

P0001382 7/10/2006 9:10:54 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

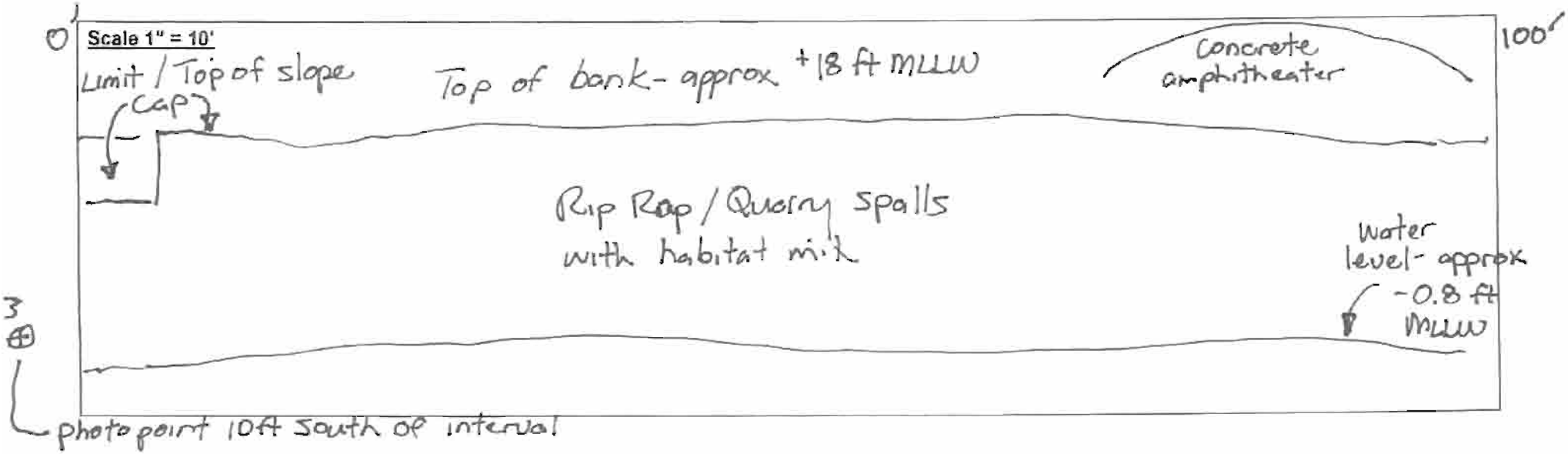
Date: 7/10/06

Field Personnel: Jain Wingard

Monitoring Interval: RA19B-2

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001383 7/10/2006 9:22:02 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

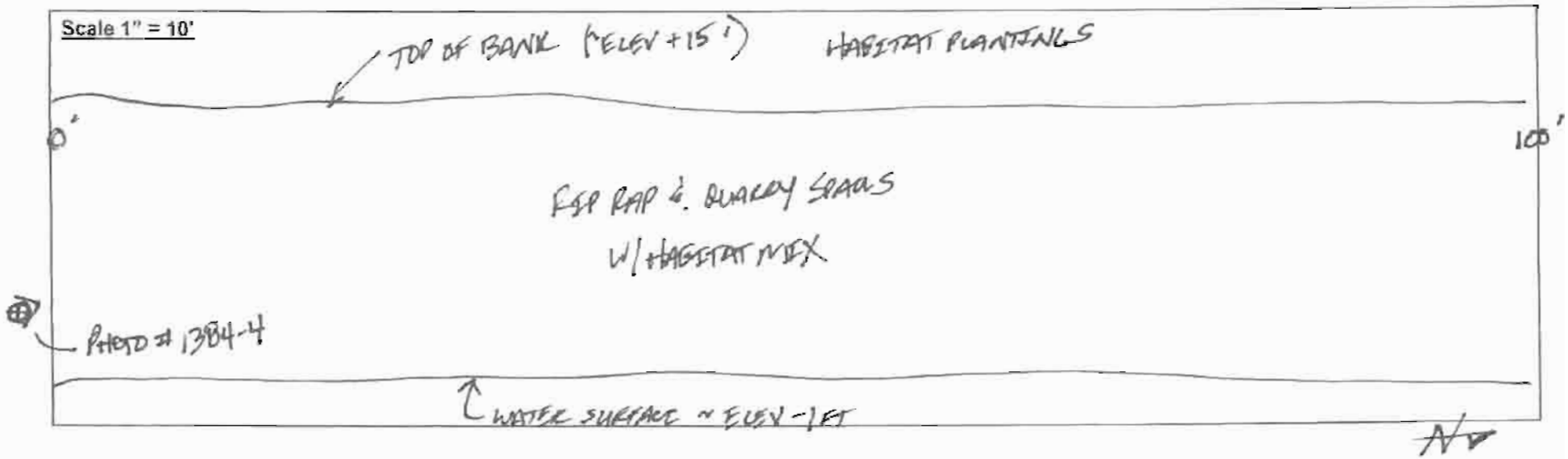
Date: 7/10/06

Field Personnel: Matt Woltman

Monitoring Interval: RA96-3

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001384 7/10/2006 9:30:24 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

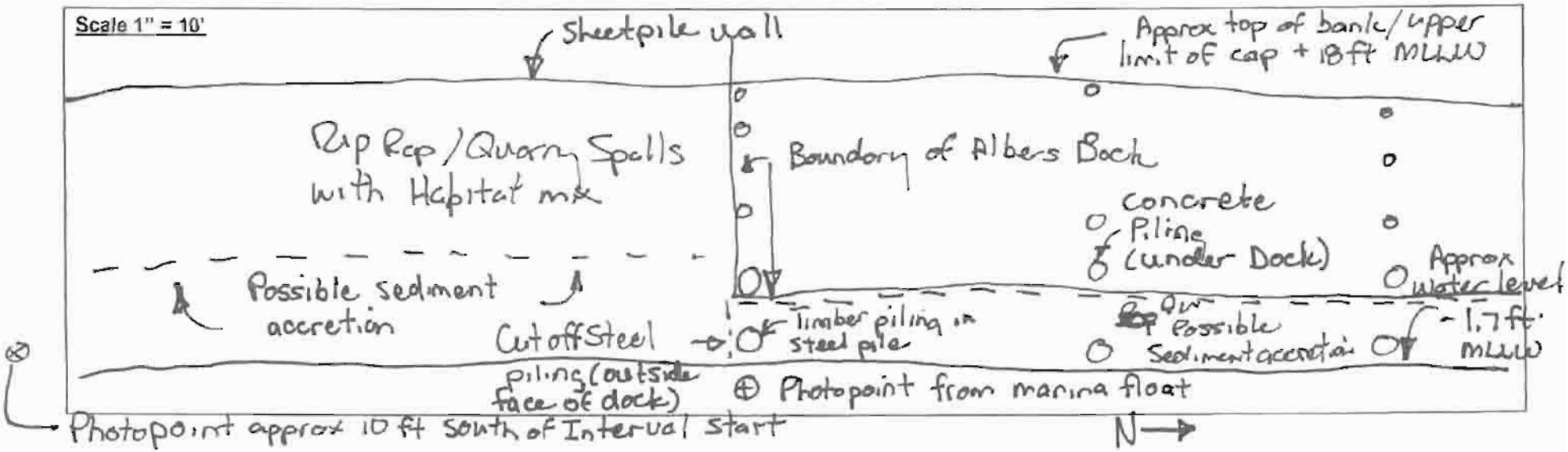
Date: 7/10/06

Field Personnel: Ian Wingard

Monitoring Interval: 2019B-4

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001385 7/10/2006 9:39:50 AM

P0001386 7/10/2006 9:49:48 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

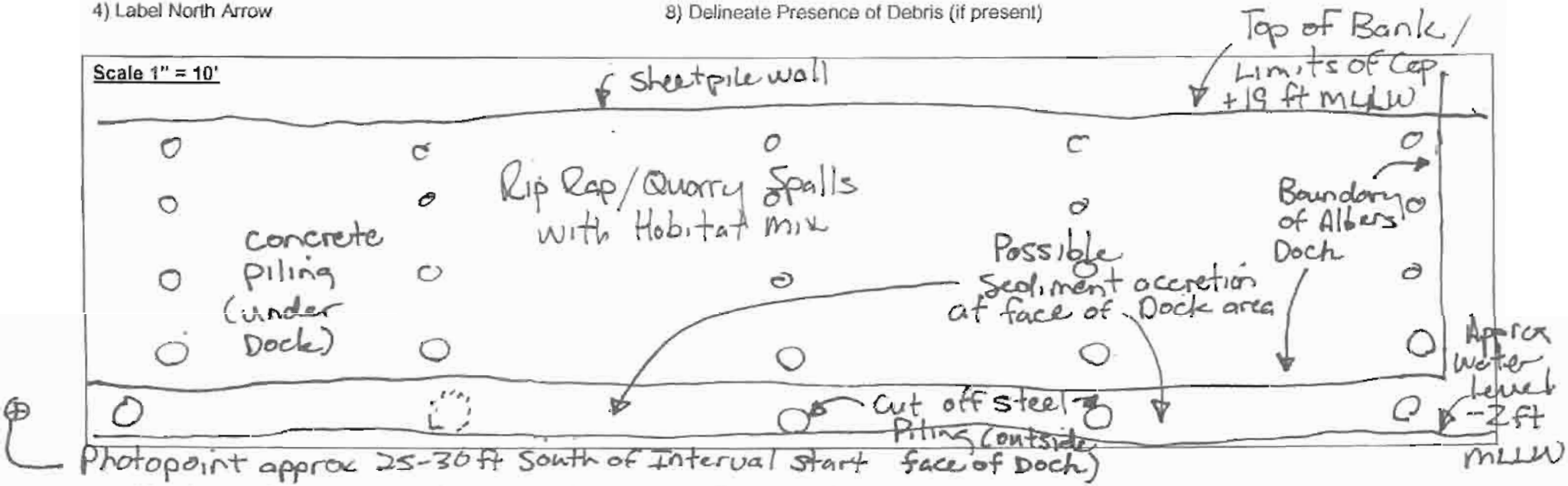
MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7/10/06
Field Personnel: Ian Wingard
Monitoring Interval: RA19B-5

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001387 7/10/2006 9:52:50 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

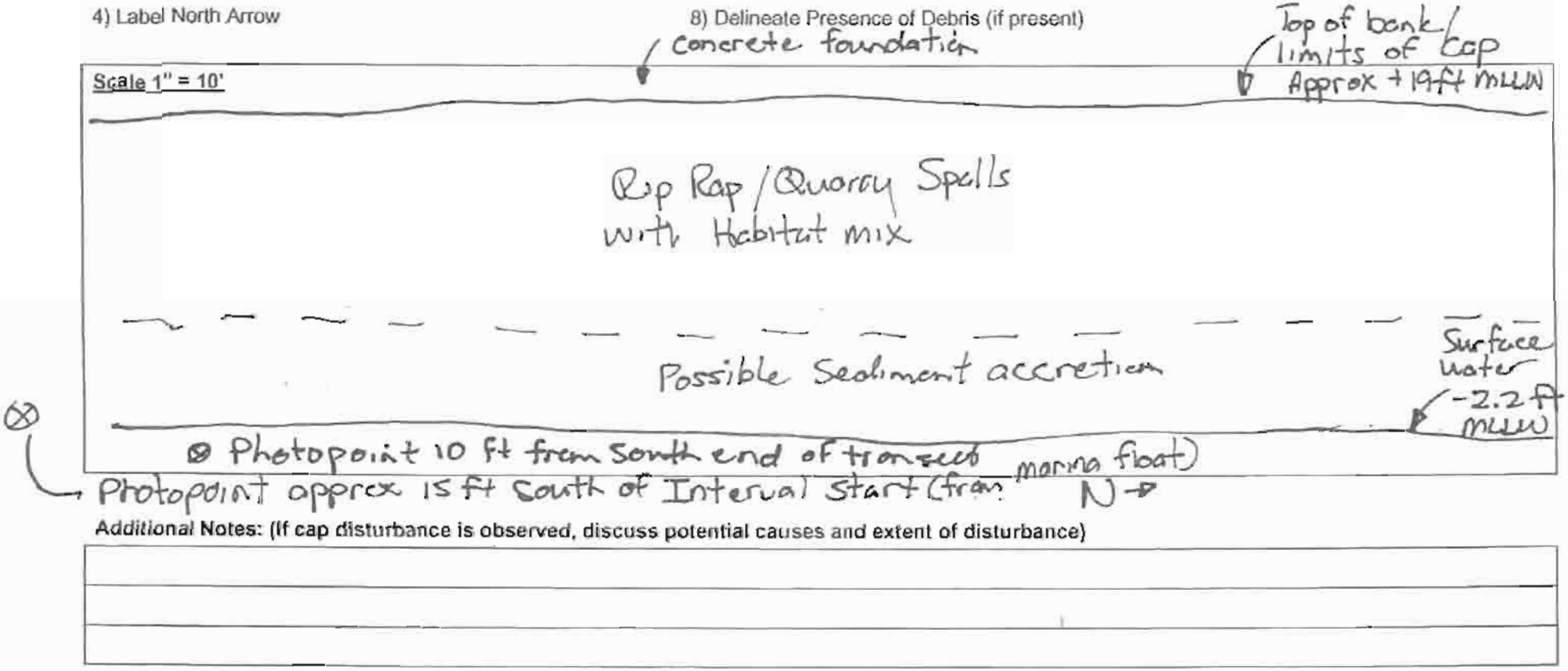
Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7/10/06
Field Personnel: Iain Wingard
Monitoring Interval: RA19B-6

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001388 7/10/2006 10:04:04 AM

P0001389 7/10/2006 10:08:10 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

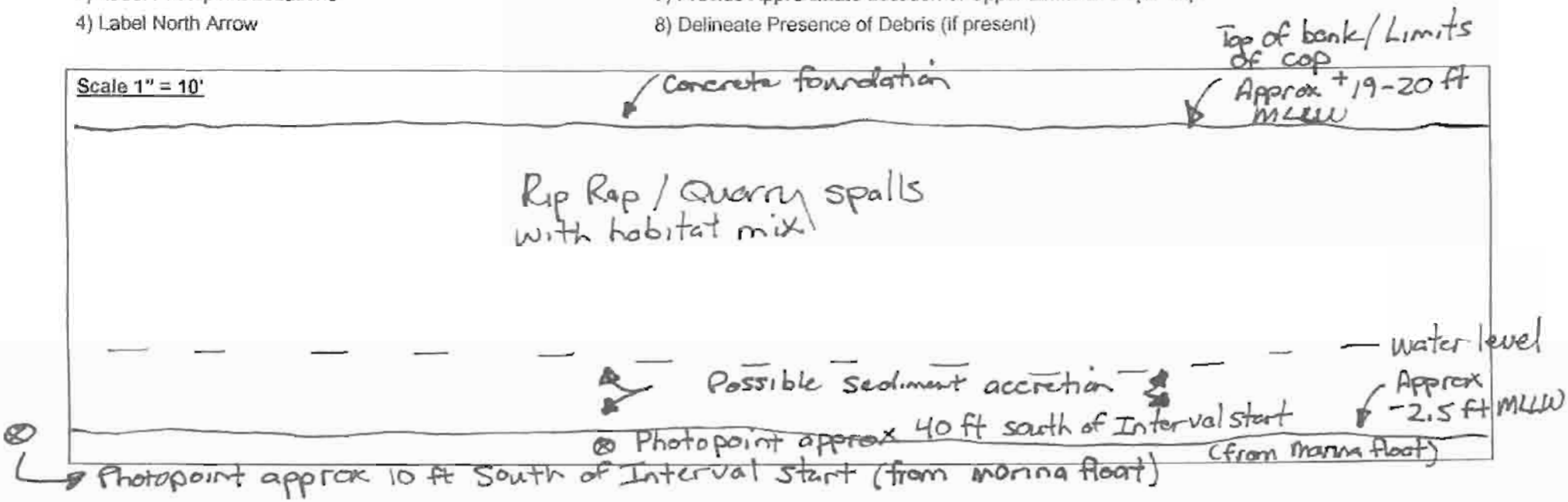
Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7/10/06
Field Personnel: Iain Wingard
Monitoring Interval: RA19B-7

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001390 7/10/2006 10:18:12 AM

P0001391 7/10/2006 10:21:20 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

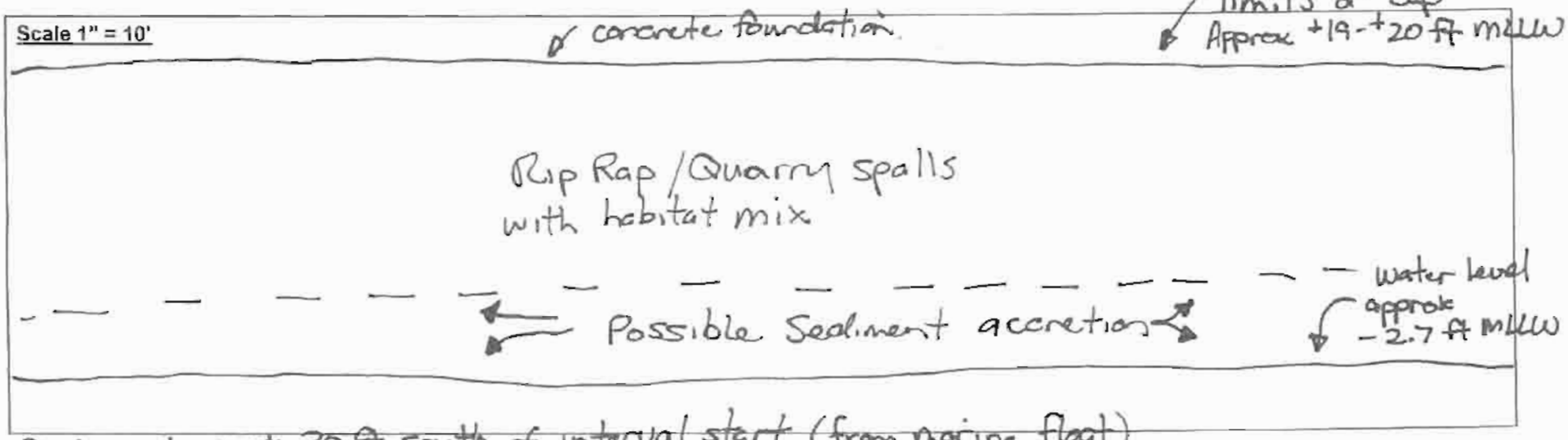
Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7/10/06
Field Personnel: Ian Wingard
Monitoring Interval: RA19B-B

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Photopoint approx 30 ft south of interval start (from moring float)

Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001392 7/10/2006 10:24:12 AM

Remedial Area 20

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/11/2006

Remedial Area: RA 20 (PAGE 1 OF 2)

Weather: Sunny ~ 60° F

Datum (Horiz/Vert): WA STATE PLANE SOUTH (NAD 83/91) / MLLW

Field Personnel: M. WOLTMAN

Benchmark(s) Used for Location Control: #214 & #215

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting) START	FINISH	Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
RA 20-1	100	702800/1160732	702904/1160724	0935	0.0'	RIP RAP W/HABITAT MIX (THIN SILT @ LOWER ELEVS)
RA 20-2	100	702904/1160724	703001/1160726	0940	-0.1'	RIP RAP W/HAB. MIX (THIN SILT & ALGAE @ LOWER ELEVS)
RA 20-3	100	703001/1160726	703079/1160737	0947	-0.4'	(0-25') RIP RAP W/HAB. MIX. SAND & GRAVEL (TO 100')
RA 20-4	100	703079/1160737	703138/1160811	1007	-1.2'	SAND & GRAVEL W/GRASS RIP RAP TO ~35'. RIP RAP & HAB MIX TO 100'
RA 20-5	100	703138/1160811	703212/1160860	1018	-1.6'	QUARRY SPALL & RIP RAP AGAINST SHEET PILE WALL
RA 20-6	100	703212/1160860	703242/1160731	1029	-2.0'	RIP RAP W/HABITAT MIX
RA 20-7	100	703242/1160731	703362/1160731	1042	-2.4'	RIP RAP W/HABITAT MIX
RA 20-8	100	703362/1160731	703390/1160781	1056	-2.8'	RIP RAP W/HABITAT MIX

Monitoring Interval	CHECK ALL THAT APPLY: Sediment Accretion *	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
RA 20-1	☒ *	☐	☐	☐	☐	☐	☐	☐	HABITAT MIX COVERAGE BEGINS @ ~ STA 70+10 (NORTH 20FT)
RA 20-2	☒ *	☐	☐	☐	☐	☐	☐	☐	HAB. MIX COVERAGE FROM ~ EL +5' & DOWN. SLOPE APPEARS STABLE.
RA 20-3	☒ *	☐	☐	☐	☐	☐	☐	☐	HABITAT AREA STARTS @ ~ 25' ON TRANSECT & WRAPS AROUND CORNER.
RA 20-4	☒ *	☐	☐	☐	☐	☐	☐	☐	HABITAT AREA ENDS @ ~ 35' ON TRANSECT. SLOPE CAP APPEARS INTACT.
RA 20-5	☐	☐	☐	☐	☐	☐	☐	☐	EAST FACE SHEET PILE WALL ADJ TO JOHNNY'S DOCK.
RA 20-6	☒ *	☐	☐	☐	☐	☐	☐	☐	SLOPE CAP APPEARS INTACT. TRANSECT TO FRONT OF JOHNNY'S RESTAURANT.
RA 20-7	☒ *	☐	☐	☐	☐	☐	☐	☐	HABITAT MIX TO TOP OF SLOPE & UNDER RESTAURANT.
RA 20-8	☒ *	☐	☐	☐	☐	☐	☐	☐	HABITAT MIX EXTENDS TO TOP OF SLOPE THROUGHOUT TRANSECT.

* VERY THIN LAYER SILT ACCRETION OBSERVED @ WATERLINE (BELOW ELEV ~+5 FT)

NOTE: GPS LOCATIONS FOR RA 20-5 MAY HAVE SOME ERROR DUE TO LOCATION ADJ. TO SHEET PILE WALL.

1160784

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7/11/2006

Remedial Area: RA 20 (PAGE 2 OF 2)

Weather: SUNNY ~ 70°F

Datum (Horiz/Vert): WA STATE PLANE SOUTH (NAD 83/91) / MLLW

Field Personnel: M. WORTMAN

Benchmark(s) Used for Location Control: #214 & #215

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting) START	FINISH	Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
RA 20-9	100	703390/1160781	703500/1160774	1106	-2.9	RIP RAP & QUARRY SPALLS W/SOME HAB. MIX
RA 20-10	40	703500/1160774	703539/1160773	1115	-3.0	RIP RAP & QUARRY SPALLS W/SOME HAB. MIX

Monitoring Interval	CHECK ALL THAT APPLY: Sediment Accretion	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
RA 20-9	* ☒	☐	☐	☐	☐	☐	☐	☐	PRIMARILY RIP RAP @ SURFACE W/HAB. MIX IN INTERSTICES OF RR.
RA 20-10	* ☒	☐	☐	☐	☐	☐	☐	☐	MAINLY RIP RAP W/HAB MIX IN INTERSTICES
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	

* VERY MINOR ACCRETION @ WATERLINE

NOTE: RA ENDS INTO NO ACTION AREA THAT BENDS AROUND NORTH FACE OF SHEET PILE WALL.
RA 15 BEGINS @ WEST SLOPE WHERE SHEET PILE WALL ENDS.

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

PHOTO DOCUMENTATION

Date: 7/11/2006

Weather: Part Cloudy, clear

Remedial Area: RA-20

Field Personnel: Bill Essmaier

Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes
RA20 - 1	1416	12	E	702813 / 1160 701	0923	1st 25' of Interval, on dock.
"	1417	18	NE	702817 / 1160 686	0930	2nd 25' of Int from dock
"	1418	45	NE	702839 / 1160 689	0935	Last 50' of Int from dock
RA20 - 2	1419	~~20~~ 12 South	NE	702886 / 1160 684	0940	1st 50' of Int from dock
"	1420	35	NE	702937 / 1160 685	0944	2nd 50' Int from dock.
RA20 - 3	1421	-10 South	NE	702984 / 1160 678	0949	1st 50' Int from dock.
RA20 - 3	1422	45	NE	703036 / 1160 675	0955	50 - 75' of Int from dock.
"	1423	60	SE	703108 / 1160 660	1008	Last 40' of Int from dock.
RA20 - 4	1424	-20 West	SE	703114 / 1160 717	1012	1st 50' of Int from dock
"	1425	25	E	703121 / 1160 757	1015	2nd 50' of Int from dock
RA20 - 5	1426	60	SE	703168 / 1160 809	1022	1st 50' from dock
"	1427	40	NE	703170 / 1160 812	1025	2nd 50' from dock
RA20 - 6	1428	60	E	703200 / 1160 764	1031	1st 40' from dock
"	1429	40	NW	703199 / 1160 786	1034	40 - 75' from dock
"	1430	75	NW	703198 / 1160 746	1037	75 - 100' of Int from dock.
-22— Go to next page.						

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

PHOTO DOCUMENTATION

Date: 7/11/2006

Weather: Clear 70'

Remedial Area: RA-20

Field Personnel: Bill Estimaier

Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes
RA20-7	1431	0	NE	703223 / 1160710	1046	1st 50' at tal from dock
"	1432	60	E	703298 / 1160645	1050	2nd 50' at tal from dock.
RA20-8	1433	25	E	703369 / 1160645	1057	1st 50' from dock
"	1434	75	E	703403 / 1160646	1101	2nd 50' from dock.
RA20-9	1435	60	SE	703459 / 1160751	1107	1st 50' from dock.
"	1436	45	NE	703444 / 1160753	1109	2nd 50' from dock
RA20-16	1437	40	E	703539 / 1160742	1115	0-25' from dock

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

LOW-TIDE SLOPE CAP INSPECTION FORM

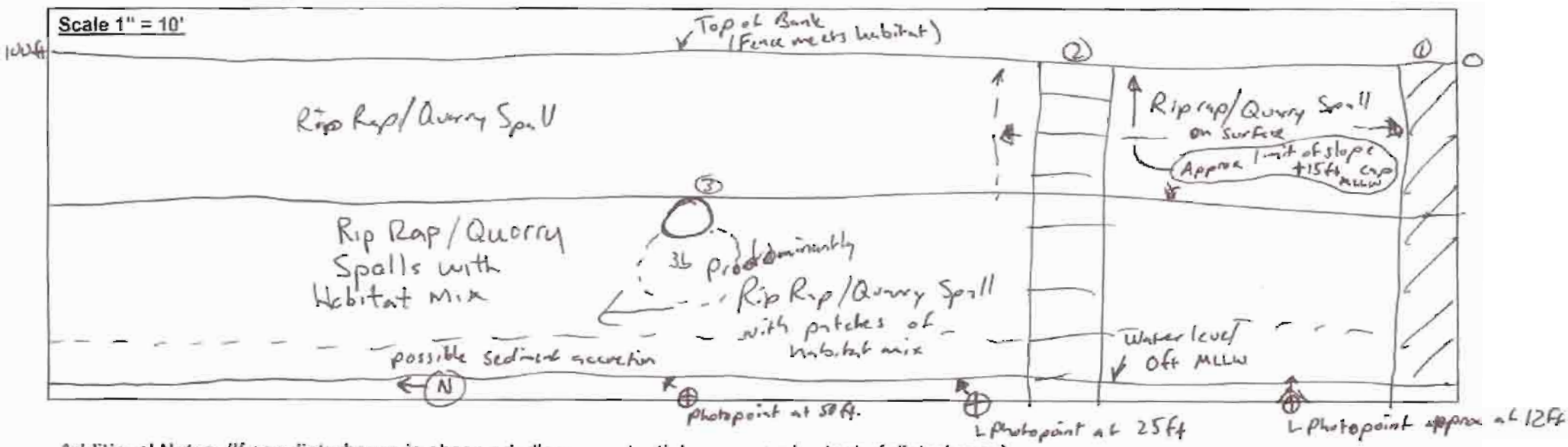
MONITORING INTERVAL TRANSECT DIAGRAM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7-11-06
Field Personnel: T. Chontofalsky
Monitoring Interval: RA20-1

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1. Boat Sling
2. Walkway for dock
3. Outfall structure (3b) depression around area of outfall structure

P0001416 7/11/2006 9:23:42 AM

P0001417 7/11/2006 9:30:46 AM

P0001418 7/11/2006 9:36:20 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

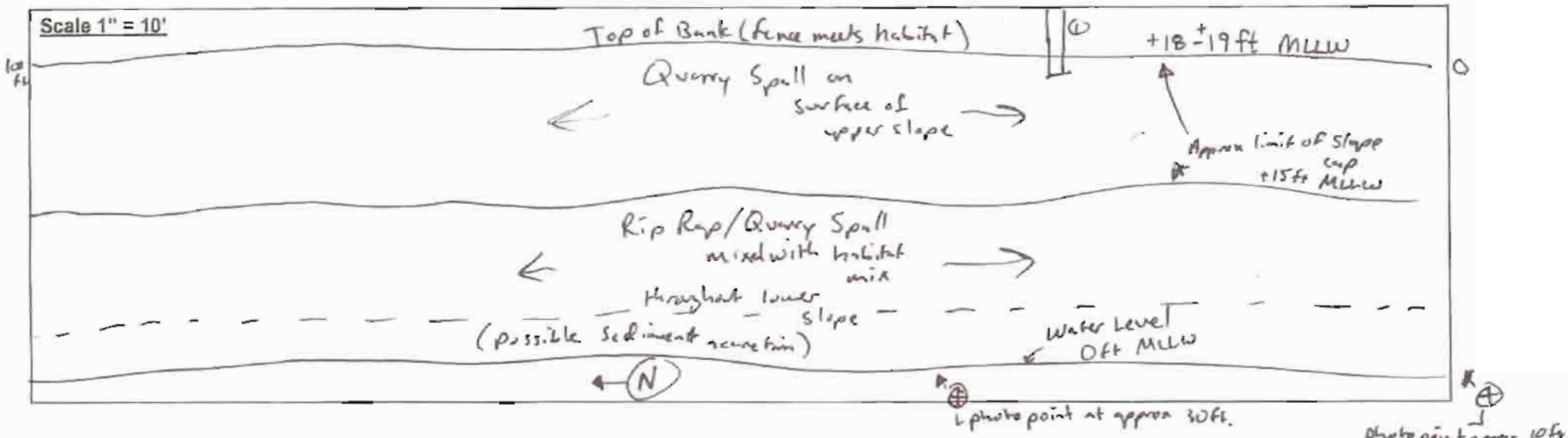
MONITORING INTERVAL TRANSECT DIAGRAM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7-11-06
Field Personnel: T. Chastofalsky
Monitoring Interval: RA20-2

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Light structure

P0001419 7/11/2006 9:41:00 AM

P0001420 7/11/2006 9:45:22 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

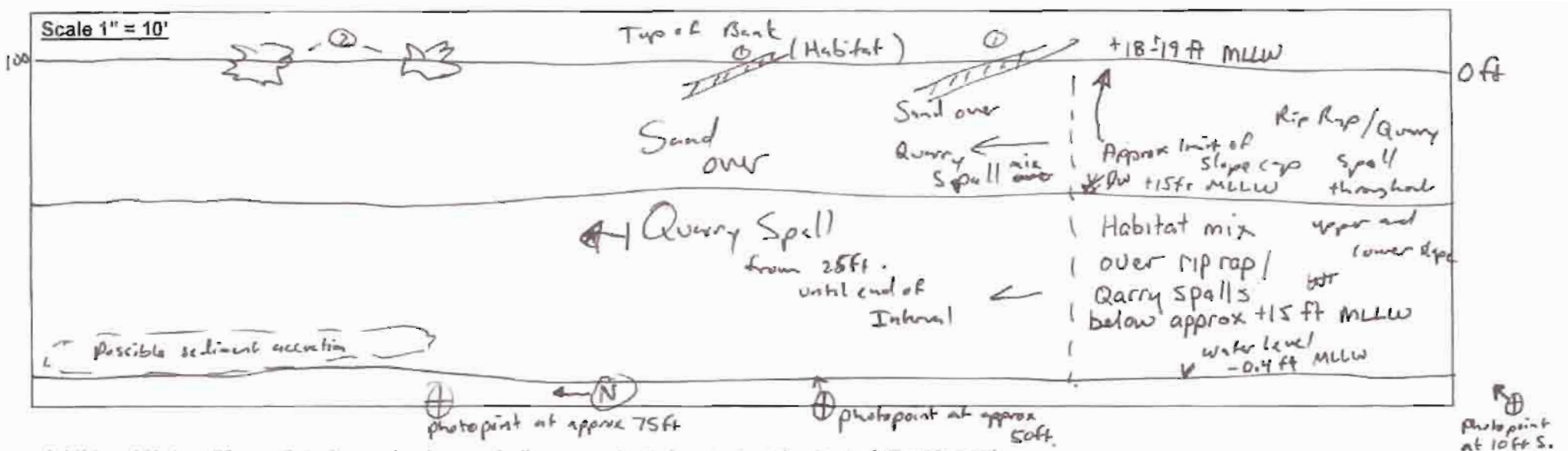
MONITORING INTERVAL TRANSECT DIAGRAM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7-11-06
Field Personnel: T. Chentofelsky
Monitoring Interval: RA20-3

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① 2 logs of top of slope
② Log roots embedded in habitat

P0001421 7/11/2006 9:50:10 AM

P0001422 7/11/2006 9:55:42 AM

P0001423 7/11/2006 10:09:04 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

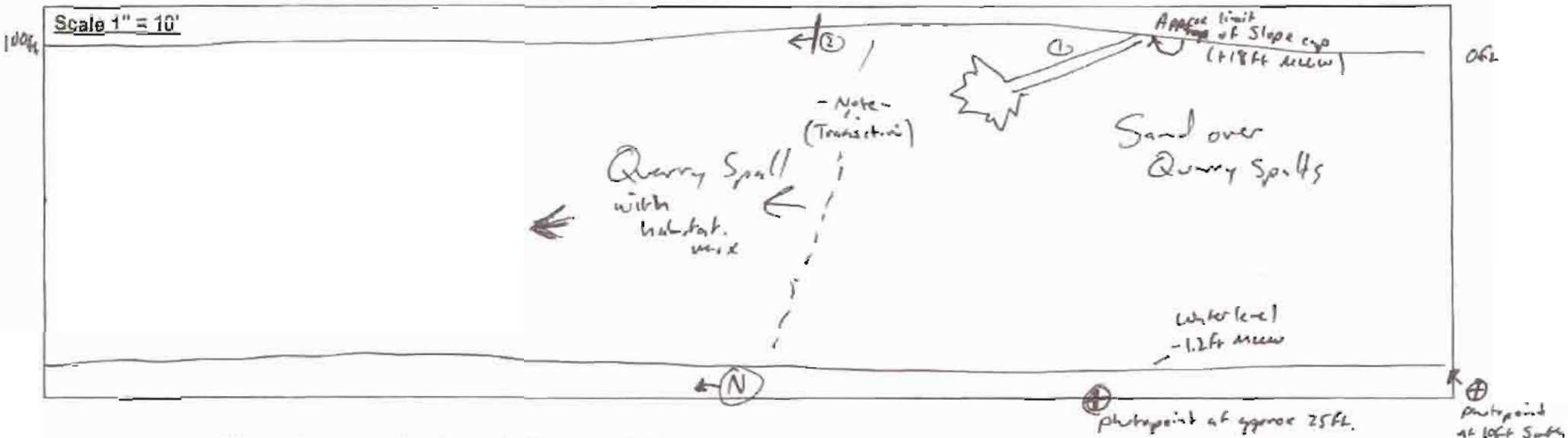
Date: 7-11-06

Field Personnel: T. Chontofalsky

Monitoring Interval: RA20-4

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① log on top of slope

② sheet pyle wall begins at approx 35ft until Interval End

Note: At 50ft transition from Sand/Quarry Spall to Quarry Spall with habitat mix cover.

P0001424 7/11/2006 10:12:58 AM

P0001425 7/11/2006 10:15:34 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

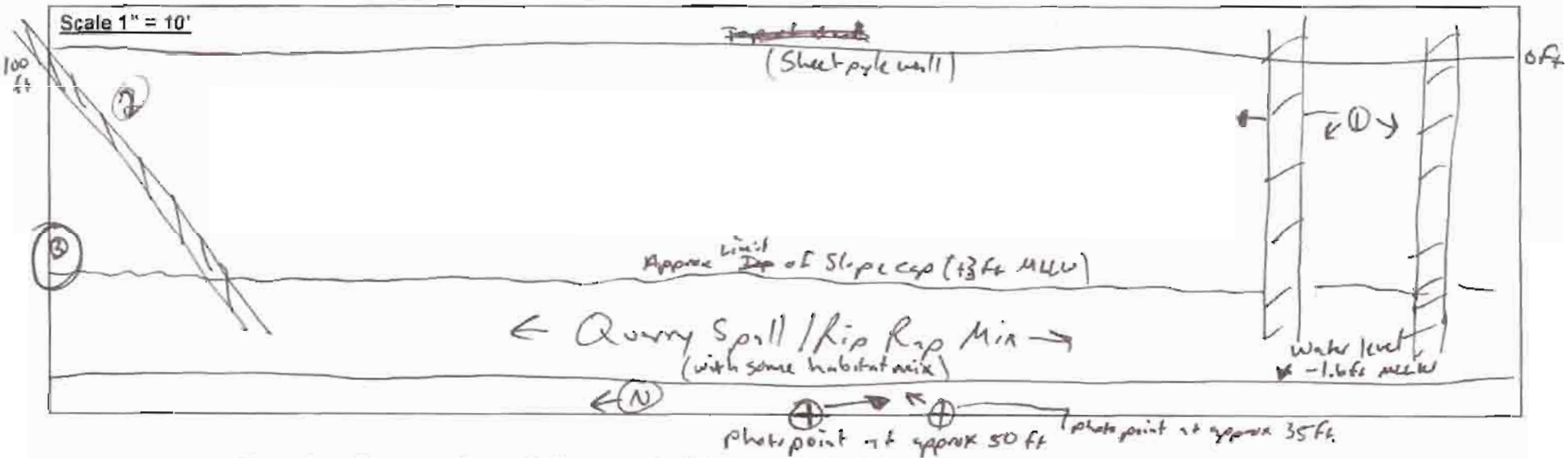
Date: 7-11-06

Field Personnel: T. Chonto Alsky

Monitoring Interval: RA20-5

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

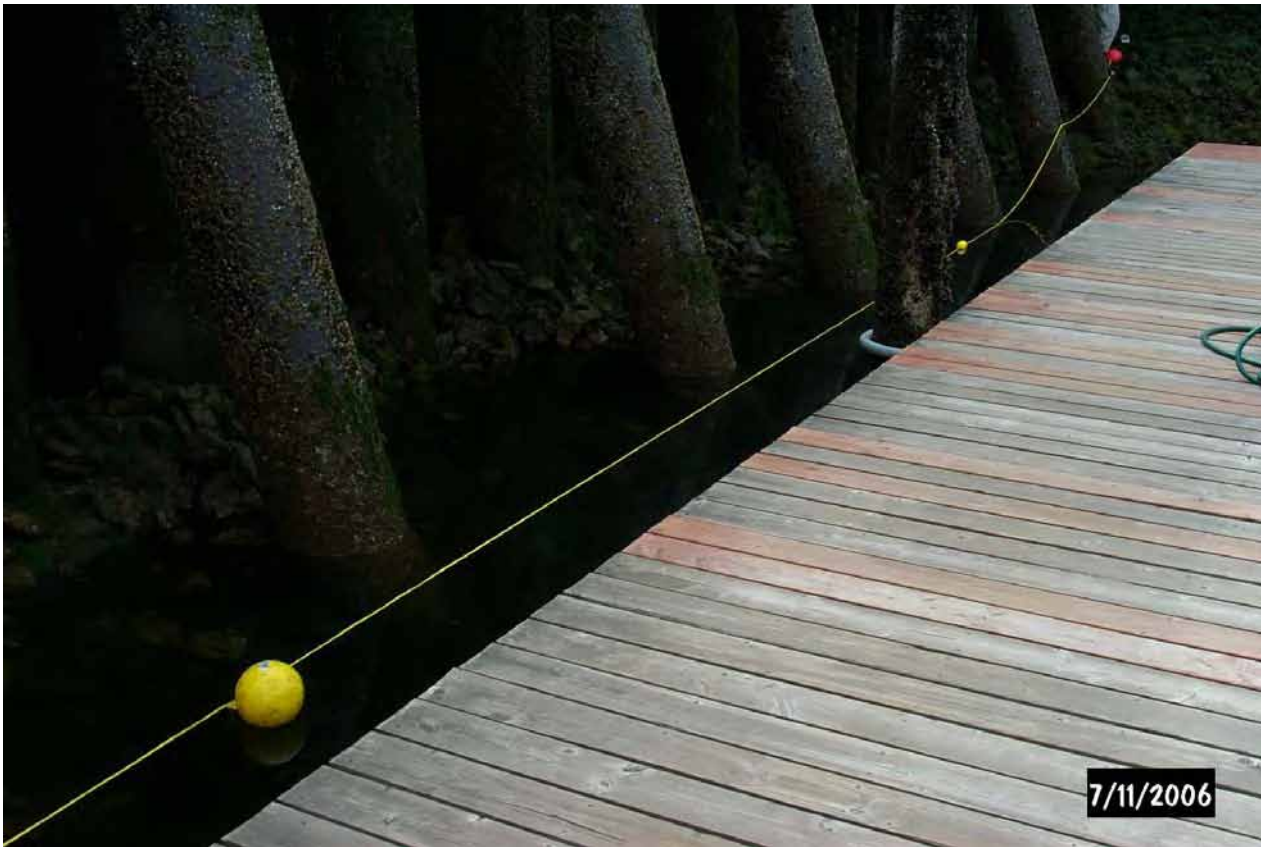


Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

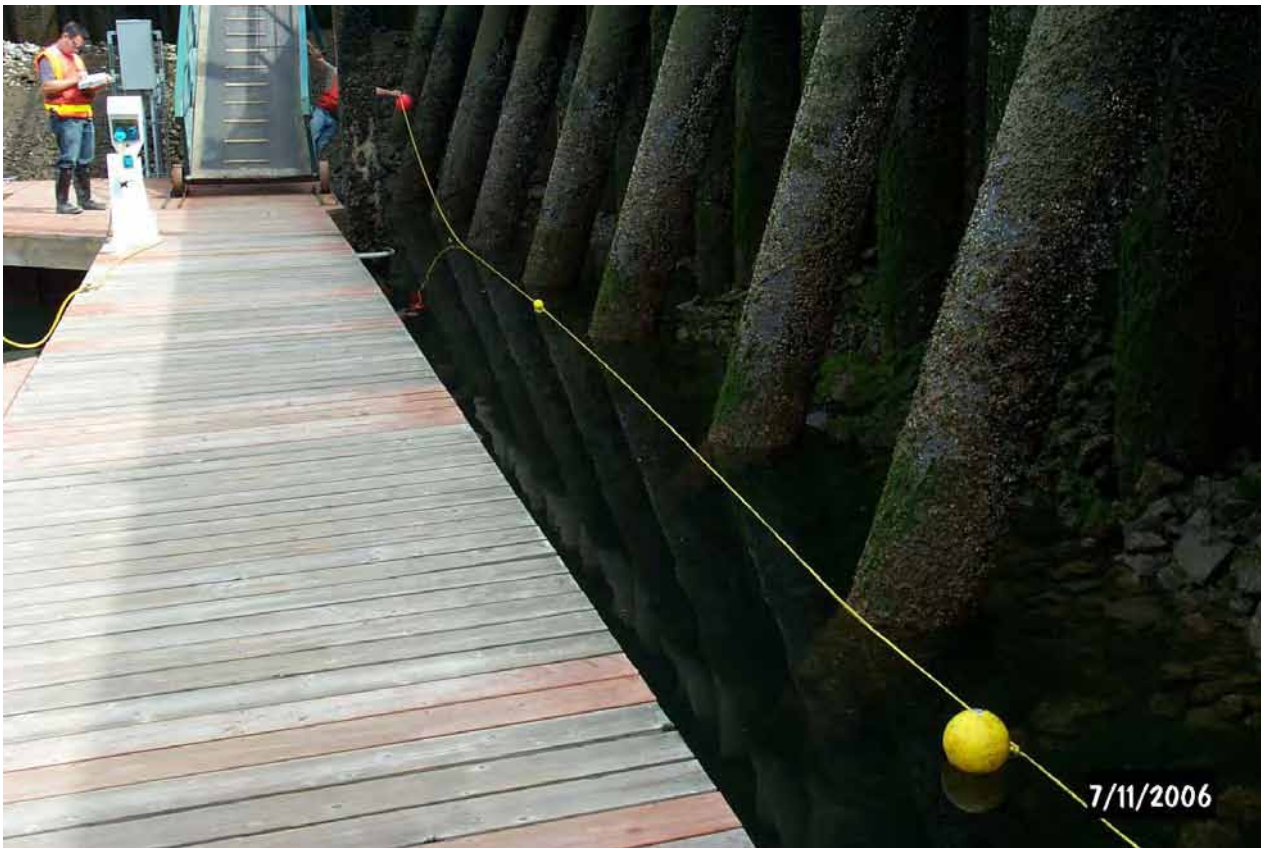
① Pilings throughout this interval

② walkway to animal float

③ Outfall 245 at approx 100 ft



P0001426 7/11/2006 10:22:56 AM



P0001427 7/11/2006 10:25:28 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

MONITORING INTERVAL TRANSECT DIAGRAM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 7-11-06

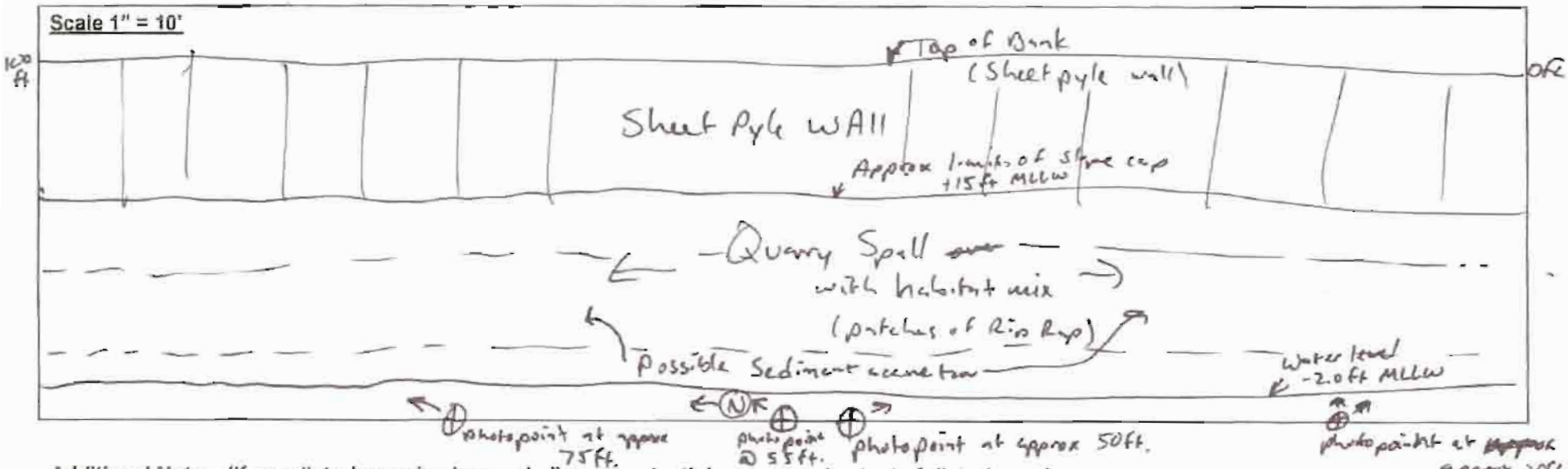
Field Personnel: T. Chowanfalsky

Monitoring Interval: RA 20-6

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

P0001428 7/11/2006 10:31:44 AM

P0001429 7/11/2006 10:34:48 AM

P0001430 7/11/2006 10:38:00 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

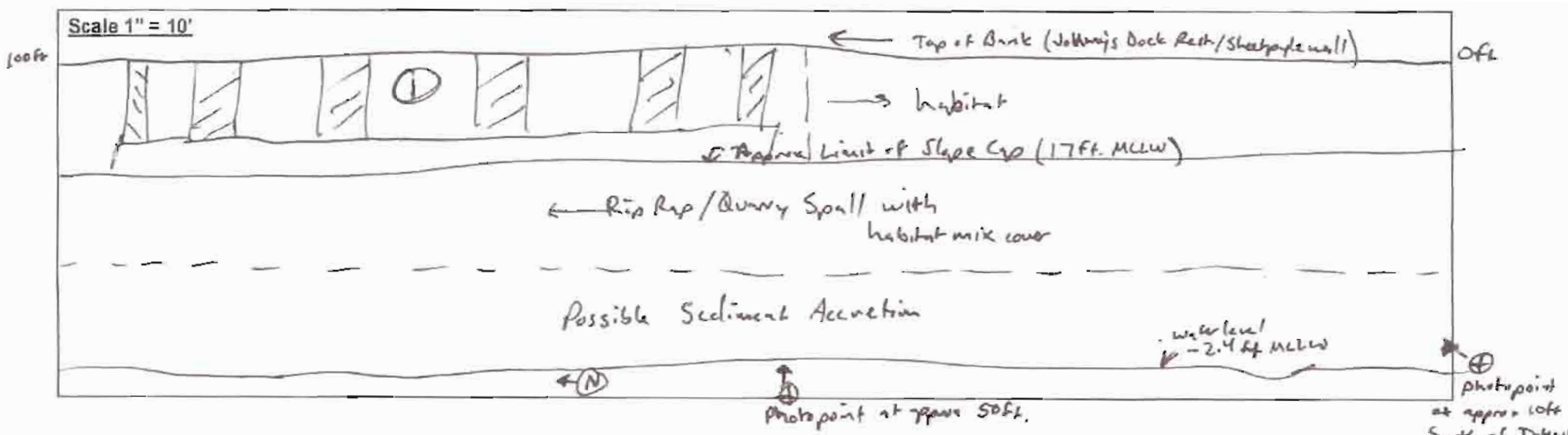
Date: 7-11-06

Field Personnel: T. Chontofalsky

Monitoring Interval: RA 20.7

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1 Pilings from restaurant

P0001431 7/11/2006 10:47:00 AM

P0001432 7/11/2006 10:51:06 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

MONITORING INTERVAL TRANSECT DIAGRAM

Thea Foss and Wheeler Osgood Waterways OMMP

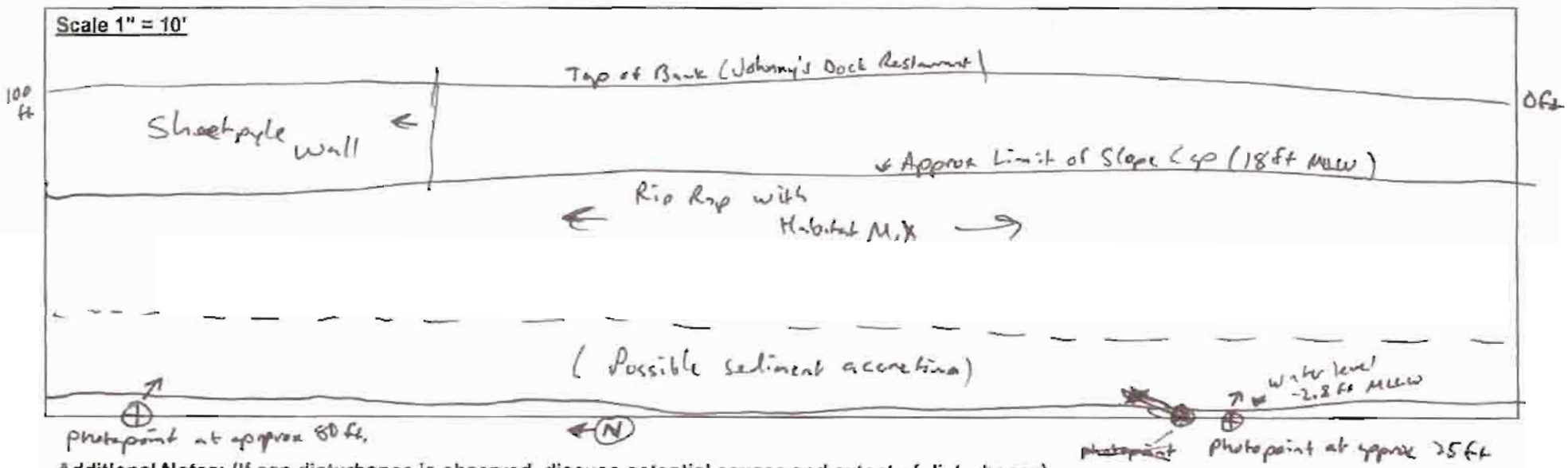
Date: 7-11-06

Field Personnel: T. Chamberlain/Kelsey

Monitoring Interval: RA20-8

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note! No observed transition in this interval. Habitat mix with Rip Rap

P0001433 7/11/2006 10:58:06 AM

P0001434 7/11/2006 11:01:28 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-11-06

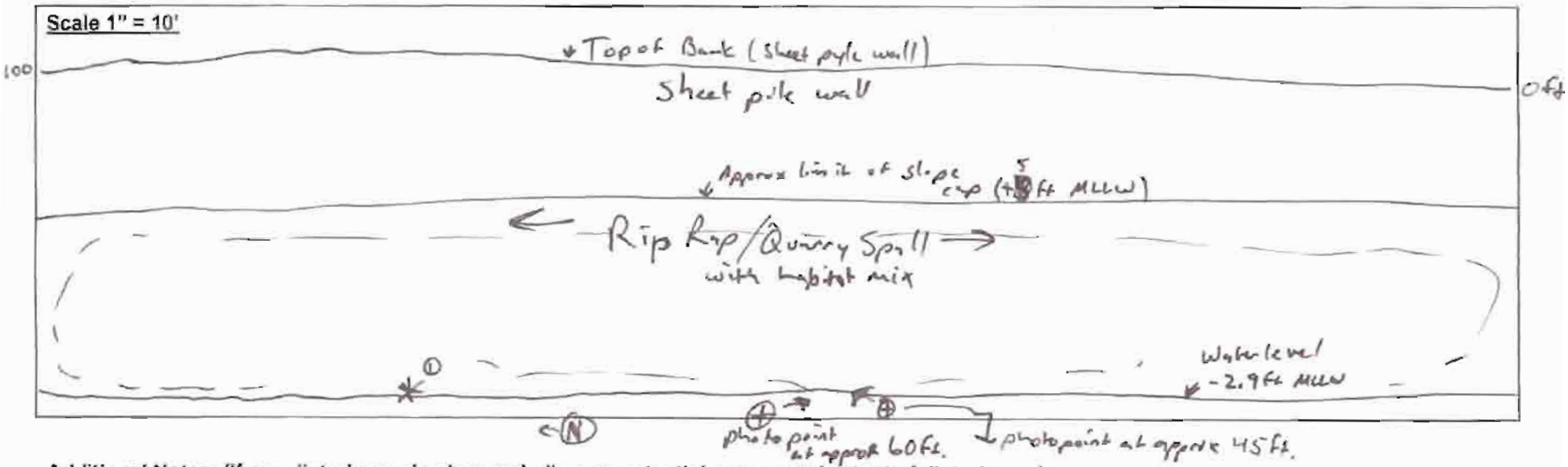
Field Personnel: T. Chartofalsky

Monitoring Interval: RA20-9

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

① Broken remains of ~~piling~~ old piling at water level (-2.9 ft MLLW)

Note: Sediment Accretion throughout lower slope

P0001435 7/11/2006 11:07:58 AM

P0001436 7/11/2006 11:10:02 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 7-11-06

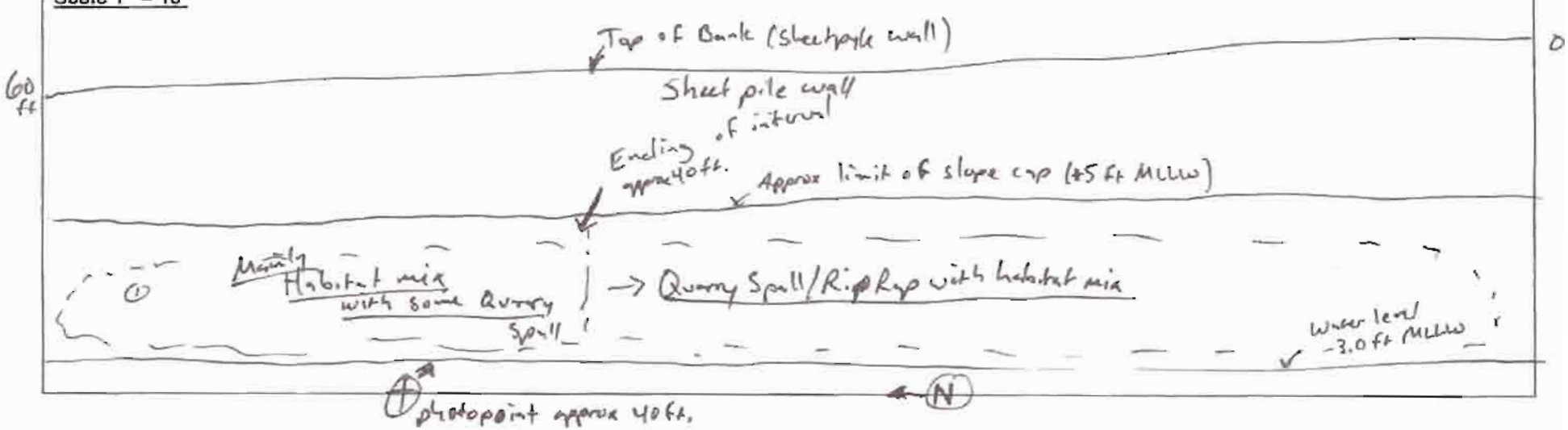
Field Personnel: T. Chontofalsky

Monitoring Interval: RA20-10

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

Note @ possible sediment accretion

↳ Transect is only 40 ft. (from 40 - 60 ft - "No Action Area")

P0001437 7/11/2006 11:15:42 AM

Sheen Source Removal Area

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

Date: 10/3/06

Remedial Area: Steep Source Removal Area

Weather: Overcast, wind calm, approx 60°F

Datum (Horiz/Vert):

Field Personnel: Jain Wingard

Benchmark(s) Used for Location Control:

Monitoring Interval	Monitoring Interval Length (in feet)	End Point Coordinates (Latitude/Longitude or Northing/Easting)		Time	Tide Elevation (MLLW)	Material at Surface of Slope Cap (Silt, Sand, Habitat Mix, Rip Rap, Quarry Spalls, Grout Mat, Other)
		START	FINISH			
Steep Source-1	65			7:45	0.0 ft	Sand/Silt

Monitoring Interval	CHECK ALL THAT APPLY								Other Observations (Include Potential Evidence of Recontamination; Sheen, Discoloration, Odor, Etc.)
	Sediment Accretion	Seepage	Underlying Sediment Exposed	Erosion (Cap Matl. Missing)	Debris	Downslope Movement	Grout Mat Exposed	Grout Mat Settlement or Cracking	
Steep Source-1	☒	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways UMMP

PHOTO DOCUMENTATION

Date: 10/3/06

Weather: Overcast, wind Calm, approx 60°F

Remedial Area: Seep Source Removal Area

Field Personnel: Iain Wingard

Monitoring Interval	Photograph Number	Location Along Transect (in feet)	Direction	Latitude/Longitude (Northing/Easting)	Time	Notes
Seep Source-1	1	approx 10ft E	SW		757	Photo taken 10ft E of East end of transect
	2	approx 10ft E	SSW		757	" " " " " " " "
	3	approx 10ft W	SSE		808	Photo taken 10ft W of west end of transect

Additional Notes: (For additional photo points, identify reason for taking additional photograph)

Additional notes for baseline photos above:

- Photos taken approx midway down shoreline slope north and adjacent to seep source area (i.e., slope is north and adjacent to Seep Source Removal Area).
- Photo #3 shows transect line with bouy strecthed out into waterway to identify width of transect (i.e., red bouy is out to south edge of sheen source area (Width is approx 20 ft)

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

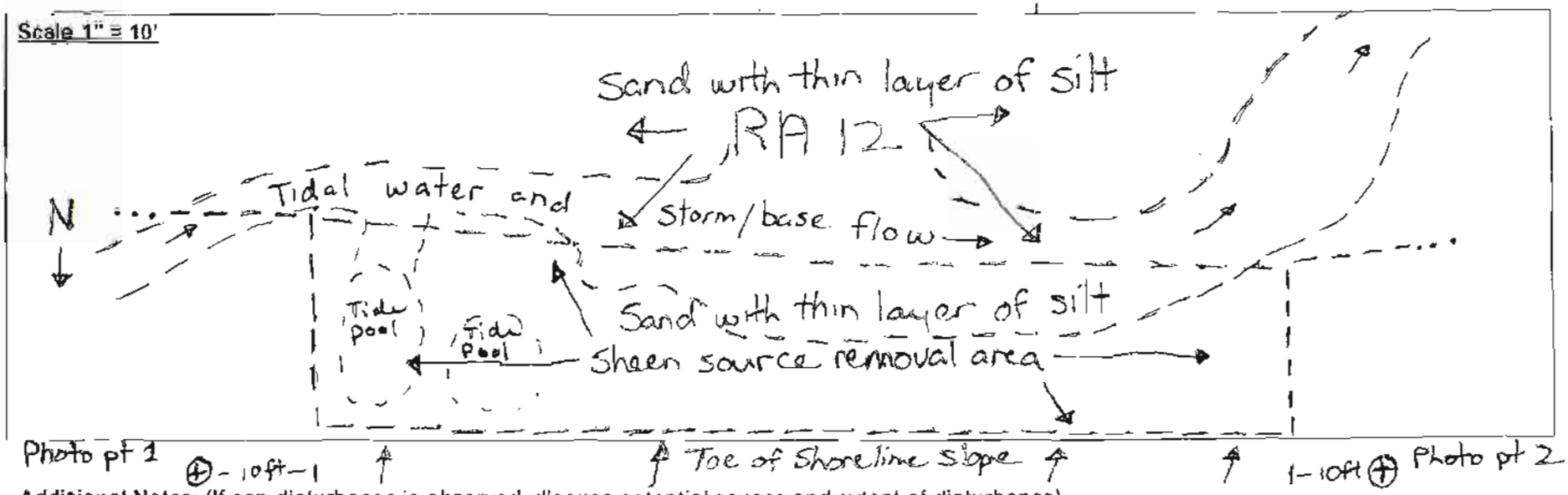
MONITORING INTERVAL TRANSECT DIAGRAM

Date: 10/3/06
Field Personnel: Iain Wingard
Monitoring Interval: Seep Source -1

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box (Transect is 65 ft)
6) Note Approximate Location of Water Surface & Top of Bank- water/tide is out
7) Provide Approximate Location of Upper Limits of Slope Cap Channel - Tide pools/ surface water present on cap surface
8) Delineate Presence of Debris (if present) - (Not present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

IMG_0253 10/3/2006 10:13:45 AM

IMG_0254 10/3/2006 10:13:46 AM

IMG_0255 10/3/2006 10:13:47 AM

Attachment B

Additional Photo Documentation

Remedial Area 3

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 8/9/2006

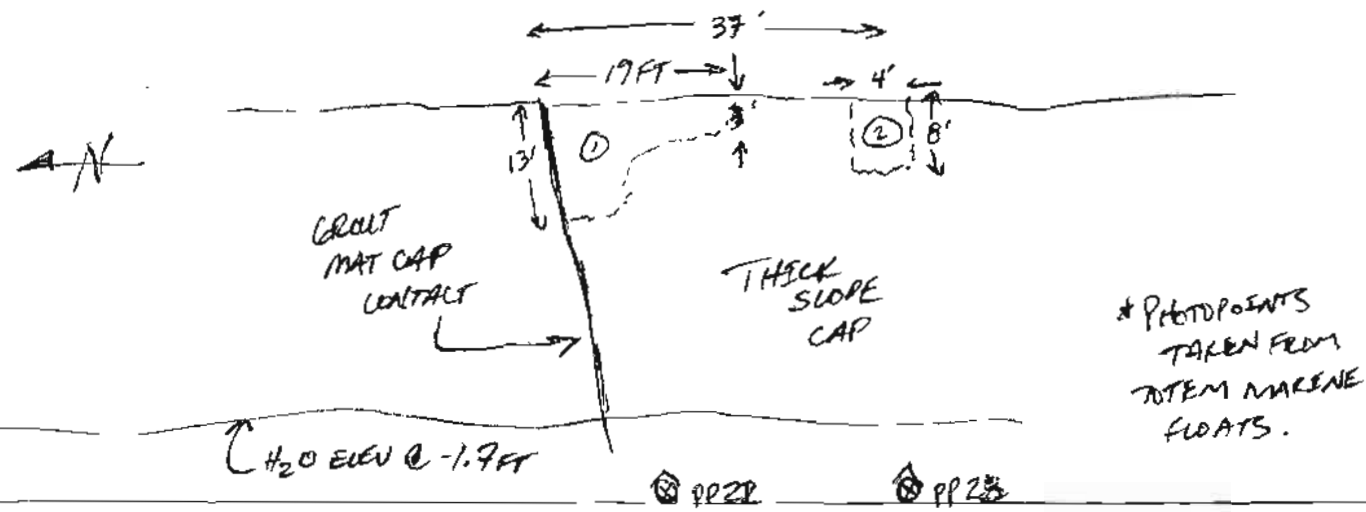
Field Personnel: M. WOLTMAN

Monitoring Interval: RA 3-1 & RA3-2

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1238 - TIDE @ ELEV -1.7FT. ① & ② TWO AREAS WHERE THICK SLOPE CAP HAS PUT DOWN THIN OR HAS MOVED TO EXPOSE UNDERLYING GEOTEXTILE FABRIC. SOME HABITAT MIX OBSERVED IN ROCK VOIDS. AREAS OF EXPOSED GEOTEXTILE AT APPROX ELEVATIONS +13-FT TO +16FT.

RA 3_Photopoint 22_102506 10/26/2006 10:00:17 AM

RA 3_Photopoint 23_102506 10/26/2006 10:00:17 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 8/9/2006

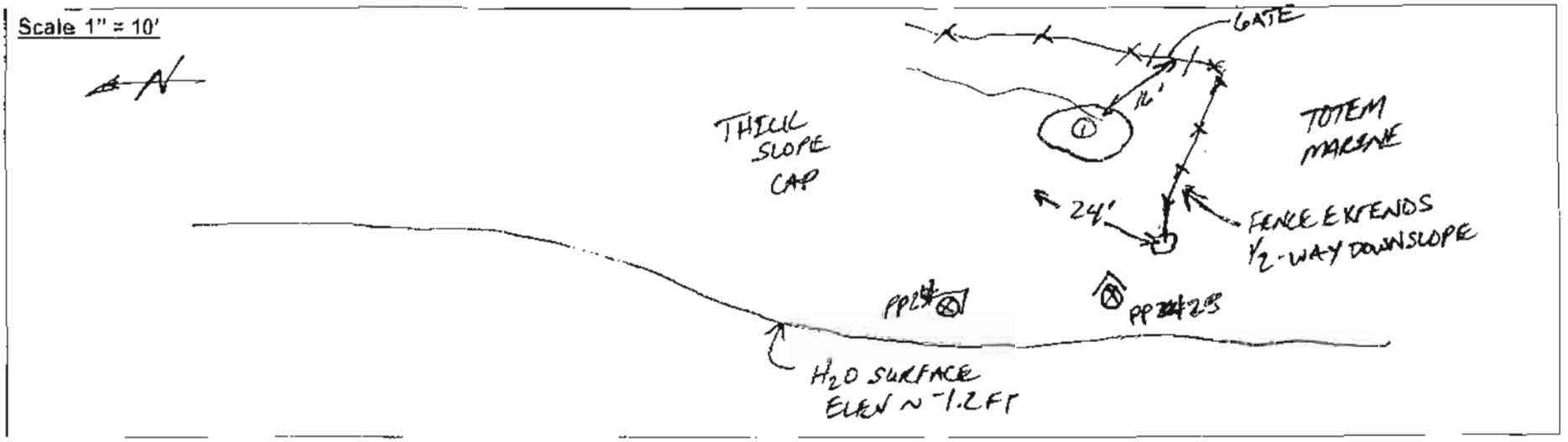
Field Personnel: M. WOLTMAN

Monitoring Interval: RA3-3

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1300 - TIDE ~ -1.2 FT. ① EXPOSED DEBRES MOUND APPROXIMATELY 10-FT DIAMETER LOCATED BETWEEN ELEVS +10 FT & +13 FT. MOUND RED-ISH COLOR W/ VISIBLE SMALL DEBRES PIECES IN SOLID MATRIX

LOW-T. _ SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

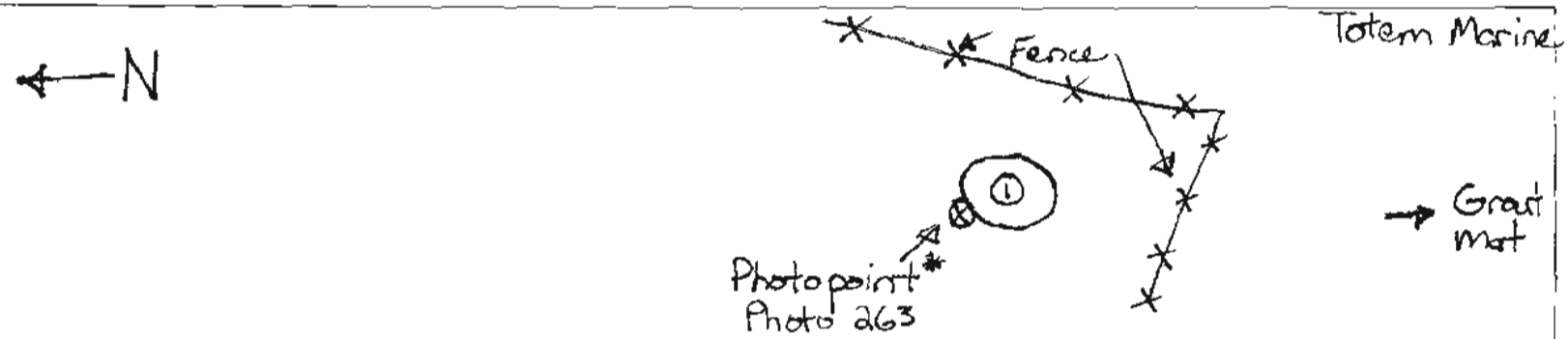
MONITORING INTERVAL TRANSECT DIAGRAM

Date: 10/13/06
Field Personnel: Iain Wingard
Monitoring Interval: RA3-3

Monitoring Interval Transect Notes:

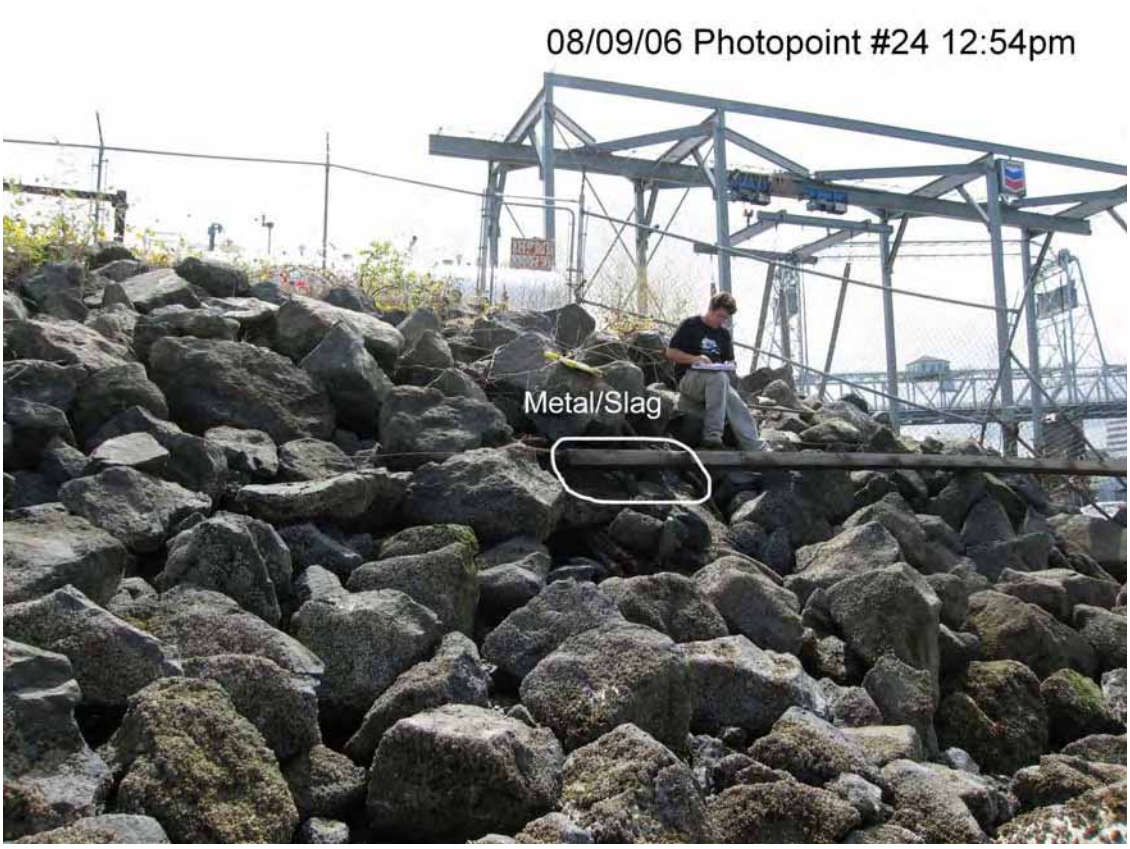
1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1 Mass of metal and slag - Solidified mass appears to be predominantly iron based (i.e., red/rust)
* Additional photo taken at close proximity to show nature of exposed Material



RA 3_Photopoint 24_102506 10/26/2006 10:00:17 AM

RA 3_Photopoint 25_102506 10/26/2006 10:01:17 AM

IMG_0263 10/13/2006 3:51:13 PM

Remedial Area 8

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

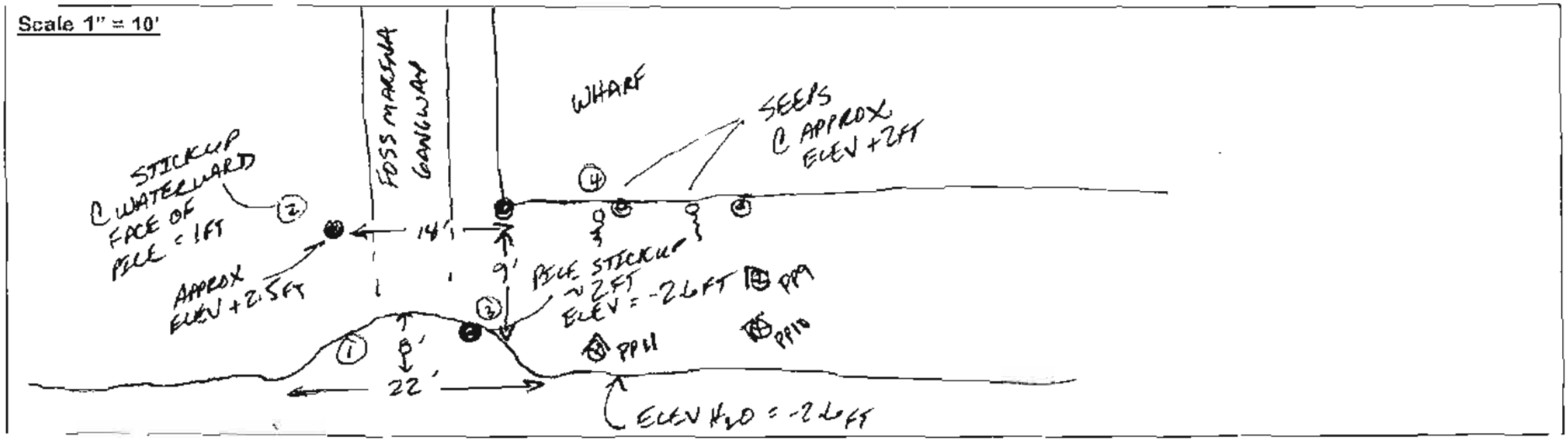
Date: 8/9/2006

Field Personnel: M. WOLTMAN

Monitoring Interval: RA B-14

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1107 - TIDE ELEV -2.6 FT. (1) CUT BACK INTO SLOPE TO ALLOW GANGWAY & PIER ACCESS. (2) & (3) TEMPER PILING.
(4) WATER SEEPS OBSERVED @ FACE OF FRONT OF WHARF PILING... MODERATE SEEPAGE OBSERVED. BOATS OBSERVED GROUNDING ON LAND-SIDE OF MARINA FLOATS

RA 8_Photopoint 9_102506 10/26/2006 10:01:17 AM

RA 8_Photopoint 10_102506 10/26/2006 10:01:17 AM

RA 8_Photopoint 11_102506 10/26/2006 10:01:13 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

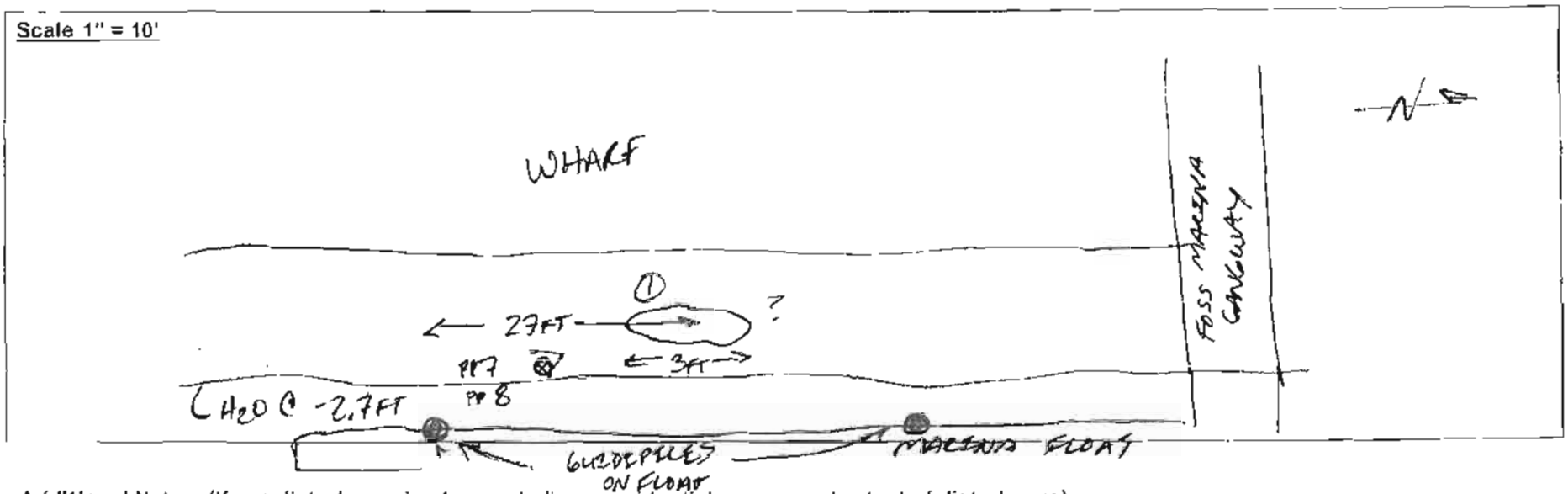
MONITORING INTERVAL TRANSECT DIAGRAM

Date: 8/09/06
Field Personnel: M. WATMAN
Monitoring Interval: RA B-116

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

H2O - TIDE ELEV. @ -2.7'. ① EXPOSED ORANGE MATERIAL, POSSIBLE DEBRIS BENEATH SLOPE CAP, EXPOSED AREA ~ 3FT LONG @ APPROX. ELEV +2FT. SLOPE CAP VERY STEEP HERE (LINERED W/ QUARRY SPALL & REPRP HAB. MIX).

RA 8_Photopoint 7_102506 10/26/2006 10:01:17 AM

RA 8_Photopoint 8 8/11/2006 9:33:11 AM

Remedial Area 19A

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

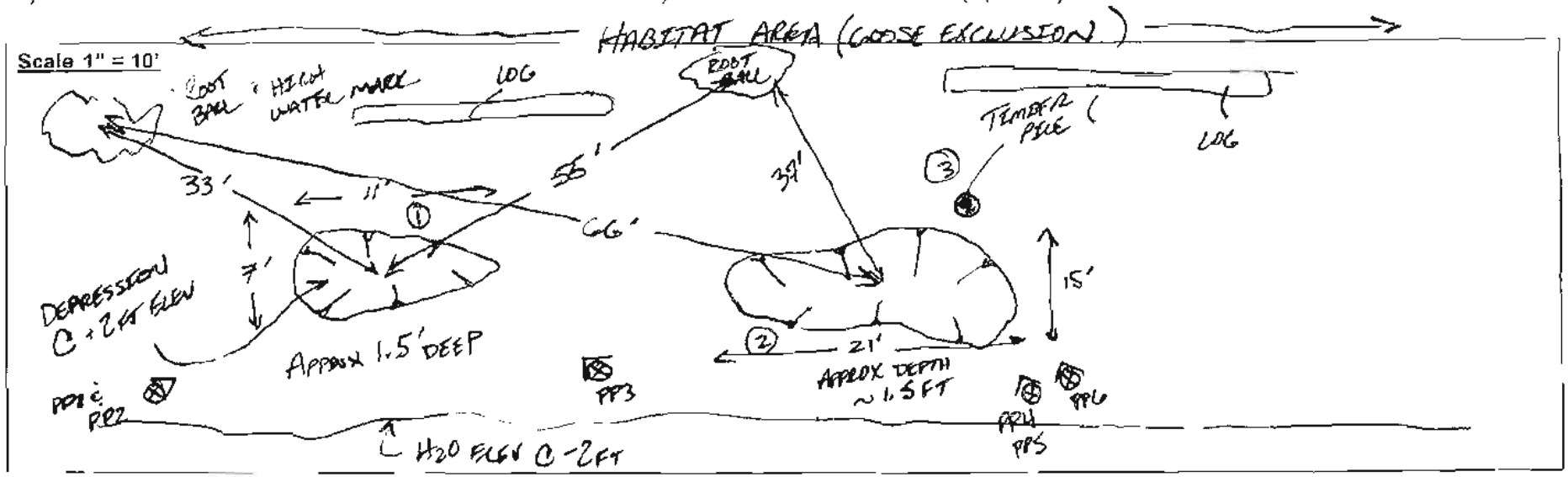
Date: 8/9/06

Field Personnel: M. WOLTMAN

Monitoring Interval: RA 19A - 3

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)



Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

1034 - TIDE @ -2 FT MLLW. TWO SHALLOW DEPRESSIONS (1) & (2) & ONE TIMBER PILE (3) ALONG TRANSECT. MEASUREMENTS FOR LOCATION TAKEN FROM ROOT BALL @ SOUTH END OF TRANSECT. BOTTOM OF (1) FILLED W/HABITAT MIX & QUARRY SPALLS. BOTTOM OF (2) FILLED W/HAB. MIX & FINE DARK SEDIMENT. PILE STICKS ABOVE MUDLINE APPROX 1.5 FT @ WATERWARD FACE OF PILE

RA19A_Photopoint 1_102506 10/26/2006 10:00:17 AM

RA19A_Photopoint 2 8/11/2006 9:20:58 AM

RA19A_Photopoint 3 8/11/2006 9:24:41 AM

RA19A_Photopoint 4 8/11/2006 9:26:27 AM

RA19A_Photopoint 5 8/11/2006 9:27:27 AM

RA19A_Photopoint 6 8/11/2006 9:28:19 AM

Remedial Area 20

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 8/1/2001

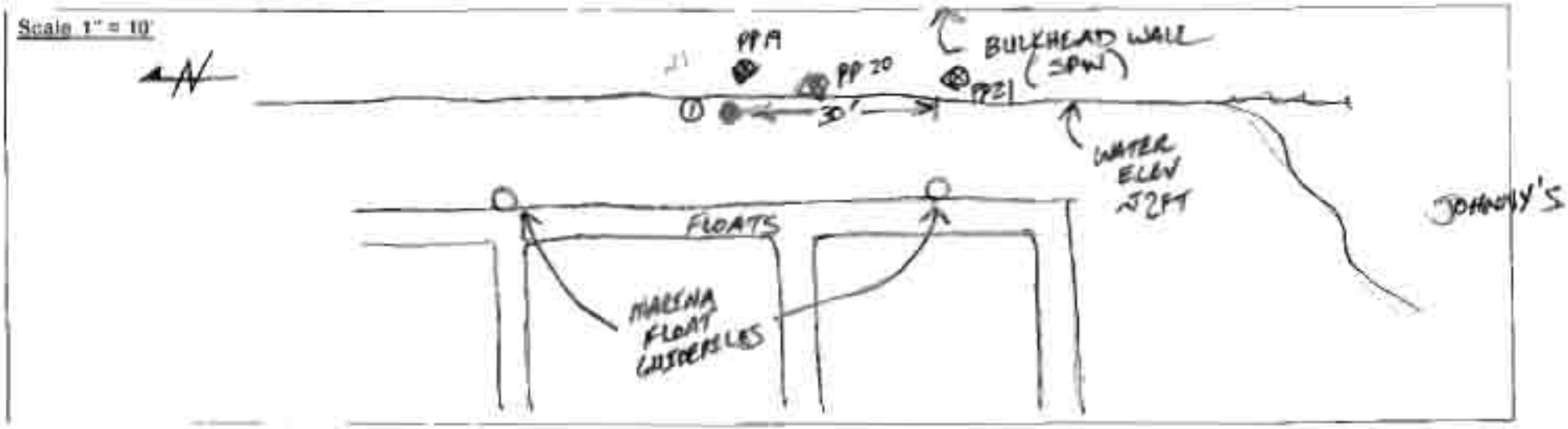
Field Personnel: M. Wolfrzadel

Monitoring Interval: PA 20-9

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'

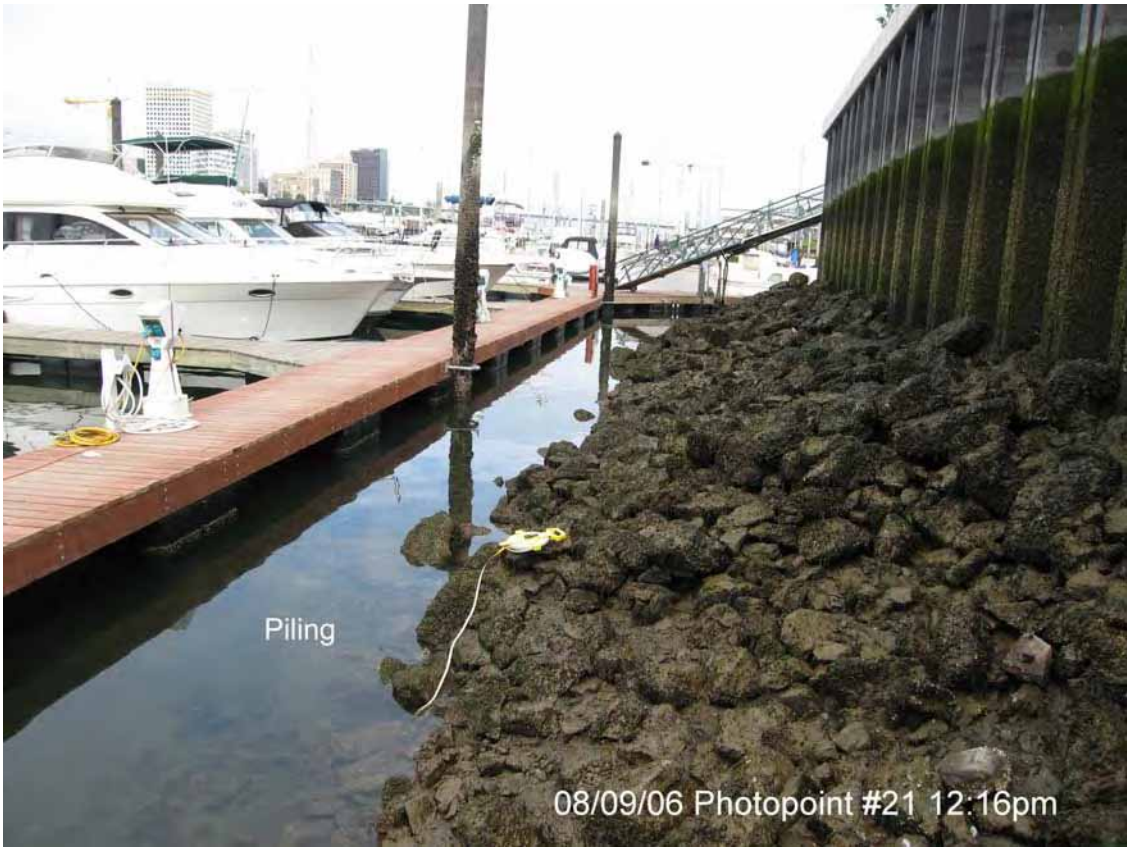


Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

R15 - TOE C ELEV -2FT. ① SUBMERGED LITTLE PILING PROTRUDING THROUGH PEA-GAP/HAB MIX CAP
PILE C APPROX. ELEV -2.5FT.

RA 20_Photopoint 19_102506 10/26/2006 10:01:13 AM

RA 20_Photopoint 20_102506 10/26/2006 10:01:13 AM



RA 20_Photopoint 21_102506 10/26/2006 10:01:13 AM

LOW-TIDE SLOPE CAP INSPECTION FORM

Thea Foss and Wheeler Osgood Waterways OMMP

MONITORING INTERVAL TRANSECT DIAGRAM

Date: 8/9/06

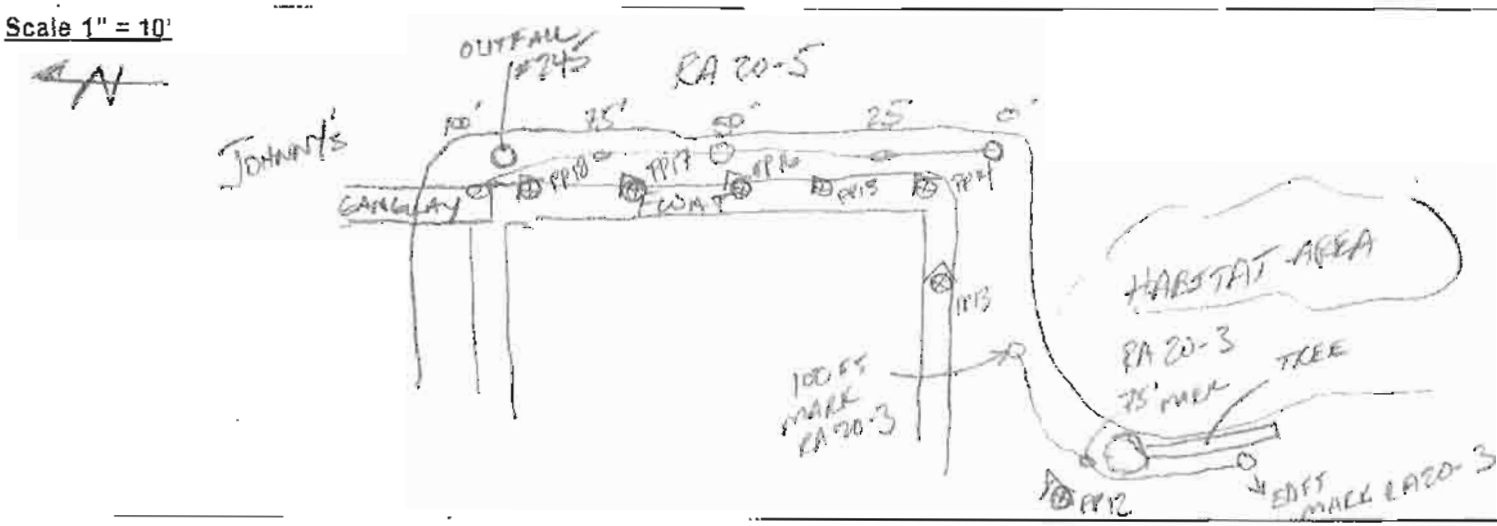
Field Personnel: M. WOOTMAN

Monitoring Interval: RA 20-3 & RA 20-5

Monitoring Interval Transect Notes:

1) Provide General Sketch of Observations Along Transect
2) Delineate Extent of Cap Integrity Issues (if present)
3) Label Photopoint Locations
4) Label North Arrow
5) Draw Diagram So That Monitoring Interval Fills Diagram Box (i.e., Monitoring Interval Endpoints are Shown at Sides of Diagram Box
6) Note Approximate Location of Water Surface & Top of Bank
7) Provide Approximate Location of Upper Limits of Slope Cap
8) Delineate Presence of Debris (if present)

Scale 1" = 10'



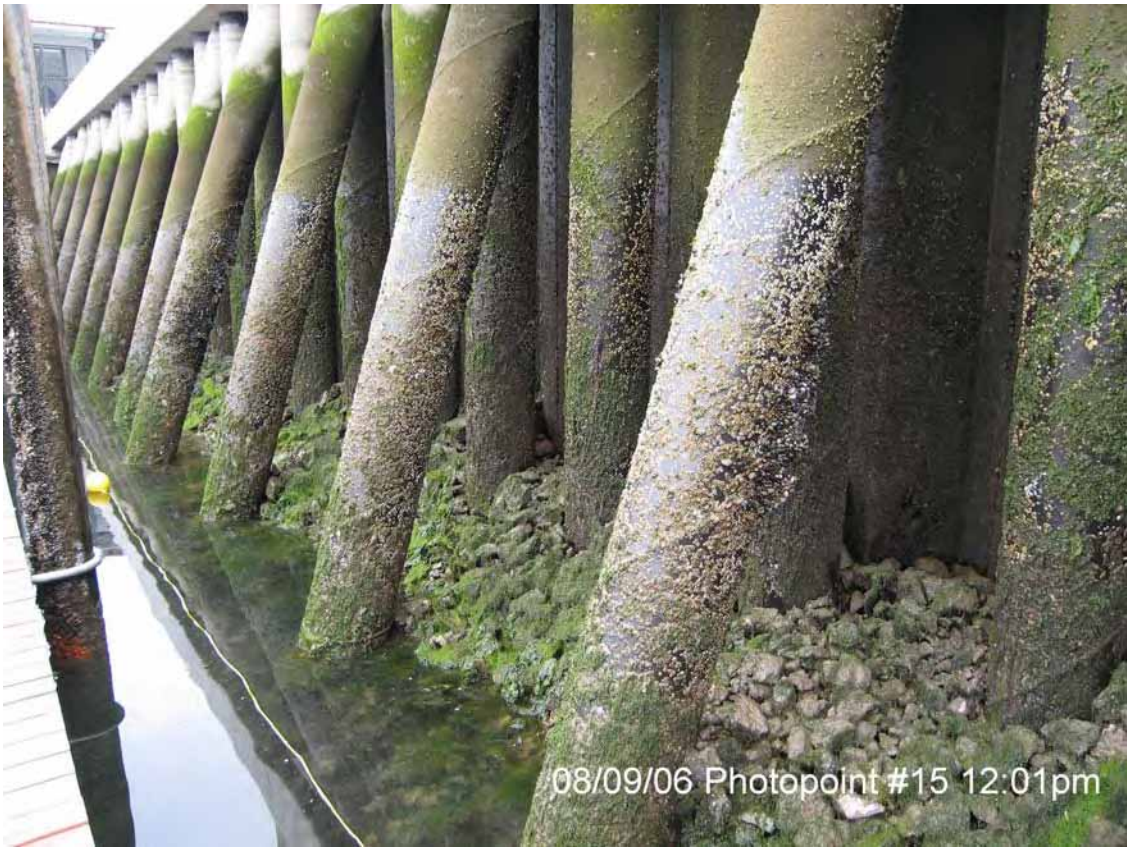
Additional Notes: (If cap disturbance is observed, discuss potential causes and extent of disturbance)

NEW PHOTOPOINTS FOR END OF RA 20-3 (PP12) & ALL OF RA 20-5 (PP13-PP18). PP18 ALSO CAPTURES PHOTO OF OUTFALL # 245

RA 20_Photopoint 12 8/11/2006 9:39:34 AM

RA 20_Photopoint 13 8/11/2006 9:41:15 AM

RA 20_Photopoint 14 8/11/2006 9:44:28 AM



RA 20_Photopoint 15 8/11/2006 9:45:47 AM

RA 20_Photopoint 16 8/11/2006 9:46:43 AM

RA 20_Photopoint 17 8/11/2006 9:47:34 AM

RA 20_Photopoint 18 8/11/2006 9:48:27 AM

Attachment A-2

Slope Area Maintenance Plan

THEA FOSS AND WHEELER-OSGOOD WATERWAYS
SLOPE AREA MAINTENANCE PLAN

INTRODUCTION

Remedial actions completed on shoreline slopes within the Thea Foss and Wheeler-Osgood Waterways include slope capping, slope rehabilitation, and habitat enhancement. The remedial actions performed in the Thea Foss and Wheeler-Osgood Waterways are shown on Figure 1. As part of the Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project, low tide inspections and subtidal hydrographic surveys of capped shoreline slope areas are performed to ensure the effectiveness of the remedial actions and to identify slope areas that may require maintenance.

The purpose of this Slope Area Maintenance Plan is to present the objectives and procedures for performing all maintenance of remedial actions constructed on shoreline slopes. Specific maintenance activities will be identified based on the results of inspections and surveys and documented in Preliminary Findings Memoranda and annual OMMP monitoring reports. Subsequent maintenance activities will be performed by the City of Tacoma (City) or a City contractor in accordance with the objectives and procedures described in this plan. The scope of this plan includes activities to maintain shoreline slope areas where remedial construction was performed as part of this project. The types of observed features on shoreline slopes that may require maintenance include, but are not limited to, the following:

- Remnant, treated piling protruding through an area of slope cap;
- Cap material sloughing that exposes underlying contaminated material;
- Contaminated debris protruding through an area of slope cap;
- Erosion or damage to stormwater outfall aprons and/or concrete splash pads; and
- Erosion or damage from waterway activities (i.e., marine, commercial, or industrial operations, construction, etc.).

The objectives of maintenance of shoreline slope areas include the following:

- Return the area requiring maintenance to post-remedial construction conditions;
- Maintain containment of underlying contaminated materials;
- Minimize the potential for transport of contamination to the water column or to the surface of adjacent areas through implementation of Best Management Practices (BMPs) during completion of maintenance activities;
- Minimize the potential for down-slope movement of slope materials during completion of maintenance activities; and
- Reuse existing slope area materials (i.e., filter material, rip rap, quarry spalls, etc.) to the extent practicable.

The objectives identified above are the basis for the procedures to be implemented during maintenance of shoreline slope areas.

SLOPE AREA REMEDIATION AND MONITORING

Remedial actions completed in slope areas of the Thea Foss and Wheeler-Osgood Waterways include slope capping, slope rehabilitation, and habitat enhancement. Slope areas are subject to monitoring through completion of low tide slope cap inspections and hydrographic surveys. The following sections summarize the design for remedial actions and describe the monitoring activities to be performed as part of OMMP for the Thea Foss and Wheeler-Osgood Waterways Remediation Project.

Slope Area Remedial Actions

Slope caps (thick slope caps, quarry spall caps, and grout mat caps) were constructed in specific slope areas of the Thea Foss and Wheeler-Osgood Waterways (Figure 1). Slope caps were constructed to contain contaminated sediment and debris; remnant, treated (i.e., creosote treated) piling; and to stabilize shoreline slopes. Thick slope and quarry spall cap components consist of the following design elements:

- 18-inches of slope cap filter material;
- Covered by 18-inches of armor material (riprap or quarry spalls);and
- Habitat mix placed at rates of 25 tons per 1,000 square feet or 15 tons per 1,000 square feet to fill in the voids of the riprap and quarry spalls, respectively.

The remedial design drawings for thick slope and quarry spall caps and specifications for cap materials are provided in Appendix A.

Grout mat caps were constructed in Remedial Area 3 (RA 3) , RA 19A, and 19B (Figure 1). The grout mat caps consist of one (i.e., RA 19A and RA 19B) or two (i.e., RA 3) approximately 6-inch thick layers of concrete placed in limited shoreline slope areas. Grout mat caps were constructed to reduce the required thickness of the cap and to preserve required berthing depths for vessels utilizing these areas in addition to containing contaminated materials and stabilizing shoreline slopes. The remedial design drawings for the grout mat caps constructed in RA 3, RA 19A, and RA 19B are provided in Appendix B.

The slope caps were constructed from the base or toe of the shoreline slope to varying elevations up the slope depending on specific features of a given slope area. In multiple remedial areas, slope caps were constructed from the base of the shoreline slope up to existing bulkheads or shoreline armoring, a previously constructed habitat enhancement area, or new sheet pile walls (i.e., RA 1, RA 8, RA 14, RA 19A, RA 19B, and RA 20). In two remedial areas, slope caps were constructed up to the waterward face of existing buildings and/or structures and quarry spalls and/or habitat mix was placed under the overwater portion of the structure to enhance the substrate (i.e., RA 8 and RA 20). Habitat enhancement was performed on top of or adjacent to the capped areas in several areas (RA 8 and RA 20). Slope caps were also constructed to the top of the slope bank in multiple remedial areas (i.e., RA 3, RA 8, RA 19B, and RA 20). The remedial design for a specific shoreline slope area will be reviewed when determining the scope of maintenance activities for a given area to ensure that they meet the intent of the designed elements and return the shoreline slope to post-construction conditions.

Slope Area Monitoring

Slope area monitoring is performed through completion of low tide slope cap inspections and subtidal hydrographic surveys. Data collected during these monitoring events are evaluated and used to identify specific slope areas that may require maintenance.

Low Tide Slope Cap Inspections

The OMMP specifies that low tide slope cap inspections be performed to verify the physical integrity of the intertidal portion of slope caps and containment of underlying contaminated sediment. Low tide slope cap inspections are performed on the exposed shoreline portion of slope caps (including grout mat caps) constructed in RA 1, RA 3, RA 8, RA 14, RA 19A, RA 19B, and RA 20, as well as the Sheen Source Removal Area in the Wheeler-Osgood Waterway, when tidal elevations are at or below 0 feet Mean Lower Lower Water (MLLW). Inspections of the slope caps include documentation of the following:

- Slope cap coverage;
- Areas of exposed sediment due to erosion or sloughing;
- Apparent down-slope movement of cap materials; and
- Presence of debris at the cap surface.

A baseline low tide slope cap inspection was completed in 2006 and subsequent monitoring events will be completed in Year 2 (2008), Year 4 (2010), Year 7 (2013), and Year 10 (2016) according to the schedule presented in the OMMP. Additional slope cap inspections may be completed after any event that could cause a slope failure, such as an earthquake or storm surge.

The results of low tide slope cap inspections are presented in Preliminary Findings Memoranda and annual OMMP monitoring reports. Results of monitoring events will be used as the basis for identifying maintenance activities that may be required in slope areas.

Hydrographic Surveys

The OMMP specifies that hydrographic surveys be completed in slope cap areas to monitor cap integrity of subtidal slope cap areas. Hydrographic surveys are to be performed in subtidal slope cap areas in RA 1, RA 3, RA 5, RA 8, RA 14, RA 19A, RA 19B, and RA 20 to provide survey coverage of slopes below elevation 0 feet MLLW. Results of hydrographic surveys in slope areas will be used to identify subtidal shoreline slope features that may require maintenance.

Baseline hydrographic surveys of remedial actions that were completed in the Thea Foss and Wheeler-Osgood Waterways were performed in 2003 (i.e., RA 1 and RA 3), 2005, and 2006. The post-construction hydrographic survey results performed in 2003, 2005, and 2006 are presented in the Remedial Action Construction Reports (RACRs) prepared for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2003 and 2006) and will be used as the baseline bathymetric conditions for slope cap areas. Subsequent hydrographic surveys will be completed in Years 2, 4, 7, and 10, according to the schedule presented in the OMMP. Additionally, hydrographic surveys may be completed after any event that could cause a slope failure, such as an earthquake or storm surge.

Results of future hydrographic survey monitoring events will be compiled and presented in Preliminary Findings Memoranda and annual OMMP monitoring reports. The results will also be used as the basis for identifying maintenance activities that may be required in specific slope areas.

SLOPE AREA MAINTENANCE

All slope area maintenance activities will be completed to satisfy the objectives described in this plan. Construction activities for the purpose of maintenance will be designed and executed in a manner that protects the environment by minimizing the potential transport of contamination to adjacent areas and ultimately containing contaminated material. Maintenance activities will be completed to restore shoreline slope areas to post-remedial construction conditions.

Slope Features Requiring Maintenance

Results of slope monitoring events will be used to identify slope features that may require maintenance. The slope features that may require maintenance include, but are not limited to, the following:

- **Exposed Piling and Debris.** Remnant, treated piling, or contaminated debris that protrudes through an area of slope cap may expose contaminated material and provide a pathway for underlying contamination to migrate to adjacent areas.
- **Cap Material Sloughing.** Sloughing of cap material may expose underlying contaminated sediment, debris, and piling, and provide a pathway for the underlying contamination to migrate to adjacent areas.
- **Outfall Apron/Splash Pad Damage.** Erosion or damage to stormwater outfall aprons or concrete splash pads may promote erosion of slope area material and expose underlying contaminated sediment, debris, and piling.
- **Waterway Activity Damage.** Waterway activities such as commercial or recreational vessel movement, industrial operations, and upland or in-water construction activities may result in damage to slope areas that could affect containment of underlying contaminated material.
- **Other Slope Features.** Unexpected events such as earthquakes or sudden storm surges may generate additional slope features that require slope maintenance.

EPA will be notified of the identification of issues that may require maintenance in Preliminary Findings Memoranda and annual OMMP monitoring reports. The information presented in these reports will be used to identify slope features requiring maintenance and facilitate contracting for maintenance activities.

Objectives of Maintenance Activities

The objectives of slope area maintenance activities include the following:

- **Return Shoreline Slope Areas to Post-Remedial Construction Conditions.** The RACRs present the post-remedial construction conditions for slope areas in the Thea Foss and Wheeler-Osgood Waterways that were performed in accordance with the remedial design. Maintenance activities will be designed to re-establish the post-

remedial construction conditions at all slope areas requiring maintenance identified during slope cap inspections or hydrographic surveys.

- **Provide Containment of Underlying Contaminated Materials.** At a minimum, a three-foot thick slope cap must be present over contaminated materials within the slope areas. Contaminated materials include contaminated sediment and debris and creosote-treated piling. Maintenance activities will be designed to ensure that the minimum cap material thickness is restored upon completion of specific maintenance activities.
- **Minimize the Potential Transport of Contamination.** Best Management Practices (BMP) will be implemented during all maintenance activities to minimize the potential transport of contamination to adjacent areas. The BMPs that will be performed during slope area maintenance are discussed in the BMPs section of this plan.
- **Minimize the Potential for Down-Slope Transport of Slope Material.** Maintenance activities will be performed in a manner that minimizes down-slope movement of slope cap material during construction so that existing water depths required for harbor area and channel use (i.e., vessel navigation and berthing) are not affected.
- **Reuse Existing Slope Cap Materials.** Slope cap filter material and slope armoring will be reused to the extent practicable during completion of maintenance activities.

Maintenance Activities

Maintenance of shoreline slope areas will include one or more of the following construction activities:

- **Capping of Exposed Contaminated Materials.** In areas where contaminated sediment, debris, or remnant treated piling are exposed due to sloughing or otherwise protrude above the surface of a slope cap, maintenance activities will be designed to cap over the contaminated material or protrusion with a minimum thickness of three feet of cap material (i.e., slope cap filter material, armoring, and habitat mix). The area of cap repair will be constructed as described in the remedial design to return the area to post-remedial construction conditions.
- **Remove Contaminated Material.** If capping of contaminated material protruding through a capped area is not feasible or stable slopes cannot be maintained, a portion of the protrusion (i.e., treated piling or debris) may be removed to allow for placement and maintenance of the required thickness of cap material necessary to ensure containment.
- **Contaminated Material Disposal.** Contaminated material removed from shoreline slope areas will be transported to an approved landfill facility for disposal as part of maintenance construction activities.
- **Stabilize Areas of Erosion or Sloughing.** Shoreline slope areas that are identified to have significant erosion or sloughing will be stabilized by placement of additional cap and/or armor material within the slope area to enhance existing slope stability and prevent future erosion or sloughing. If significant erosion is observed at an outfall apron and/or splash pad, additional armor material will be placed to disperse erosive forces associated with high flow events at the outfall.
- **Implement Best Management Practices (BMPs).** BMPs will be implemented during all maintenance activities as described in the BMP section of this plan in order to protect

adjacent remedial areas and prevent transport of contamination as a result of maintenance work.

Methods of Maintenance

Slope area maintenance activities will generally be performed using upland/shoreside equipment (i.e., backhoe/track hoe, crane, vactor truck, etc.) or over-water equipment (i.e., derrick barge, material barge, backhoe/track hoe, etc.) staged adjacent to a specific slope area, depending on site access and construction equipment constraints.

The general approach to performing maintenance of identified slope features (i.e., protruding piling or debris, cap material sloughing, and damaged outfall aprons or splash pads) will involve the following procedures:

- Stage construction equipment and materials in the uplands adjacent to the slope area feature requiring maintenance or on the water if access by water-based equipment facilitates maintenance activities.
- Temporarily relocate armor material as necessary around the slope feature to expose protruding piling or debris, stabilize areas of sloughing, or facilitate access to a damaged stormwater outfall apron or splash pad.
- For slope features where containment is not feasible because treated piling or debris would protrude through the cap surface and direct placement of slope cap materials would not produce a stable slope or would affect site facilities (i.e., marina floats, etc.), remove a portion of the feature so that placement of filter material and slope armoring can be achieved and a stable slope can be constructed.
- Cover remaining piling, debris, or exposed sediment in areas of sloughing with a minimum of 18 inches of filter material. Use sediment stakes or surveying techniques to confirm placement of the 18 inches of filter material. For damaged outfall apron or splash pad slope features, place 18 inches of filter material only in areas where underlying contaminated sediment is exposed at the slope surface.
- Place a minimum of 18 inches of armor material over the filter material so that a stable slope is constructed. Placement of armor material may include reuse of existing armor material temporarily relocated at the slope feature. For damaged outfall apron or splash pad slope features, place additional armor material in a configuration that provides added protection from erosional forces during high flow events at the outfall.
- Verify completed cap thickness meets the previously constructed conditions using sediment stakes or surveying techniques.
- Place habitat mix over the area of slope cap maintenance at the appropriate rate based on the type of armoring material present.

Alternate methods of construction may also be required to complete slope area maintenance activities where equipment access has significant restrictions. These methods may include, but are not limited to, the following;

- Removal of piling or debris from the uplands using crane-based equipment to reach over wharf structures or access slope areas that cannot accommodate upland or water-based excavation equipment;

- Manual removal of piling or debris during low tide periods using shovels, chainsaws, pick axes, etc.;
- Repair of underwater slope cap sloughing features through placement of additional filter and armor material using conventional derrick-barge equipment such as over-water cranes and cable arm material placement buckets; and
- Reforming and construction of new outfall aprons or splash pads to prevent future erosion of slope areas during high flow events at the outfall.

BEST MANAGEMENT PRACTICES

The following Best BMPs will be implemented during slope area maintenance:

- **Work in the Dry.** To the extent possible, maintenance activities will be completed in the dry during periods of low tide to avoid potential impacts to surface water and the potential for transport of contaminated materials.
- **Debris Containment and Sorbent Booms.** Continuous debris containment and/or sorbent booms will be deployed around slope areas undergoing maintenance. When all components of slope maintenance work at a specific location can be performed in the dry in one tidal cycle, continuous sorbent booms will be deployed around the work area at a minimum to contain possible petroleum releases (i.e., creosote from piling, etc.) to surface water. For work that is completed in the dry over multiple tide cycles or is entirely in-water work, slope surfaces undergoing maintenance will be fully enclosed with continuous debris containment and sorbent booms.

  Debris containment booms will be constructed with silt curtains five to six feet in depth attached to contain debris and suspended sediment. Sorbent booms will be continuous within but adjacent to the debris containment boom and will contain petroleum sheens or spills. Booms will be maintained throughout the duration of maintenance activities. Additionally, floating debris will be removed from within all boom areas on a regular basis or as needed, so that debris does not escape containment.
- **Visual Water Quality Monitoring.** Visual water quality monitoring will be performed during all maintenance work to be performed on slope areas to ensure that construction activities do not impact adjacent surface water. Visual water quality monitoring will include the following:

  - Observations of the condition of debris containment and/or sorbent booms;
  - Observations of the presence of debris inside and outside containment boom areas;
  - Observations of persistent turbidity within or outside of a boomed area;
  - Observations of petroleum sheen within or outside of a boomed area; and
  - Observations of the presence of fish or wildlife within the boomed area.

  The following actions will be taken if persistent turbidity or petroleum sheen emanating from the project area is observed outside of the boomed area or fish and wildlife are observed within the boomed area:

  - Maintenance activities will cease;
  - Appropriate measures will be taken to correct the problem or situation; and
  - The EPA project manager will be notified of the occurrence and the measures taken to correct the situation.

Visual water quality observations and any necessary corrective actions will be documented on the water quality monitoring form provided in Appendix C.

- **Fish Window.** All work in slope areas will be completed within agency-defined fish windows to minimize potential impacts to aquatic life.

Additional BMPs may be implemented during maintenance activities, as necessary, to avoid potential impacts to surface water, potential for transport of contaminated materials, and impact on fish and wildlife.

CONSTRUCTION MANAGEMENT

Oversight and inspection of maintenance activities will be performed by a representative of the City of Tacoma. The inspector will be present during all maintenance activities to perform the following activities:

- Document construction progress;
- Verify that construction activities are being performed according to design and that the slope area is returned to post-remedial construction conditions; and
- Ensure that BMPs have been implemented and are performed in accordance with this Slope Area Maintenance Plan.

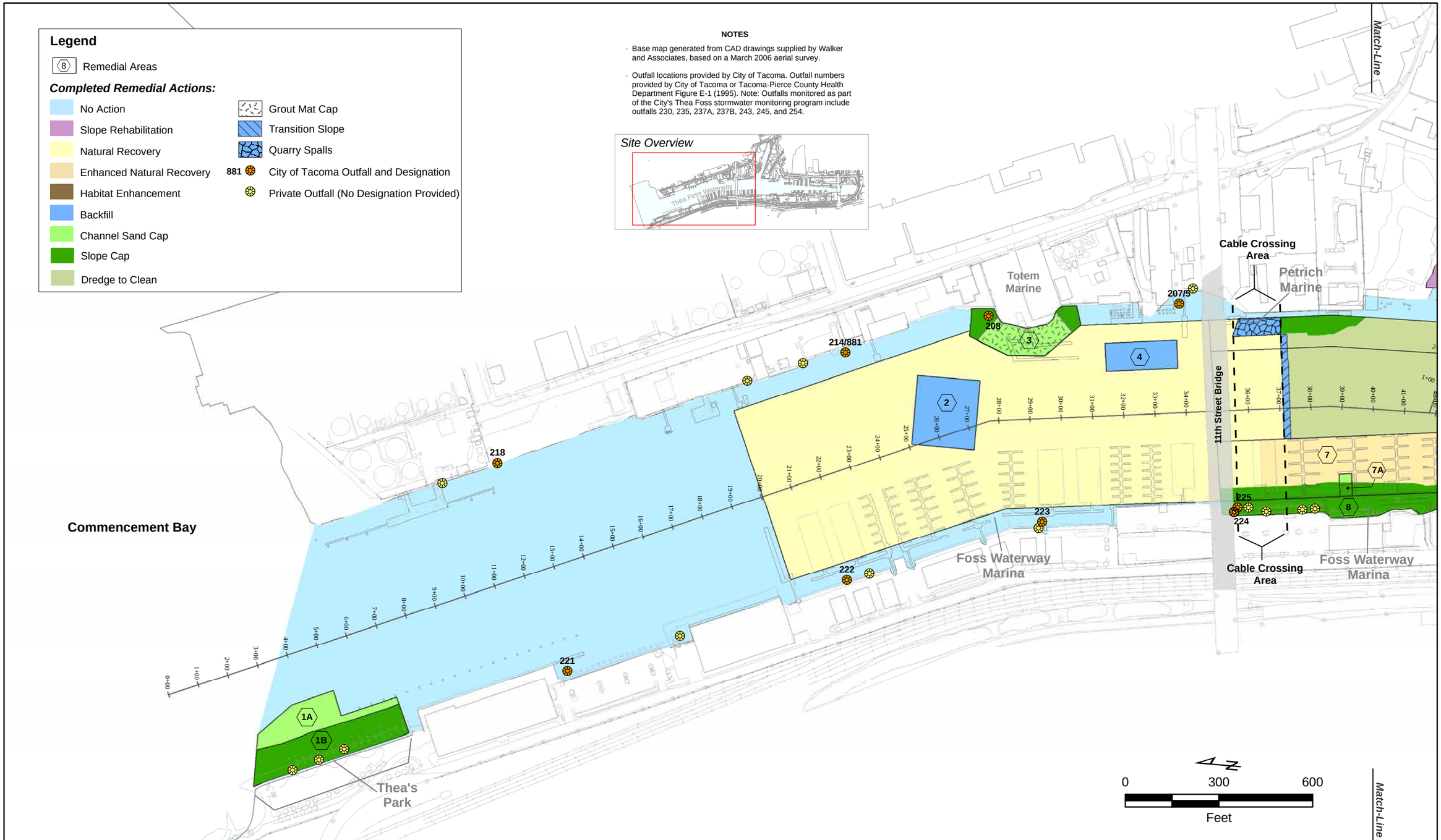
Construction progress will be documented with photographs and preparation of a daily inspection log.

PEFORMANCE OF WORK

EPA and any affected property owners will be notified 30 days prior to performance of maintenance activities. After completion of construction activities, a memorandum will be prepared and submitted to EPA to document the work performed in each slope area. The memorandum will also be incorporated into the subsequent year's annual OMMP monitoring report. Slope area monitoring will be resumed in accordance with the OMMP to ensure that areas of maintenance are effectively containing contaminated materials.

FIGURES

Figure 1 – Completed Remedial Actions



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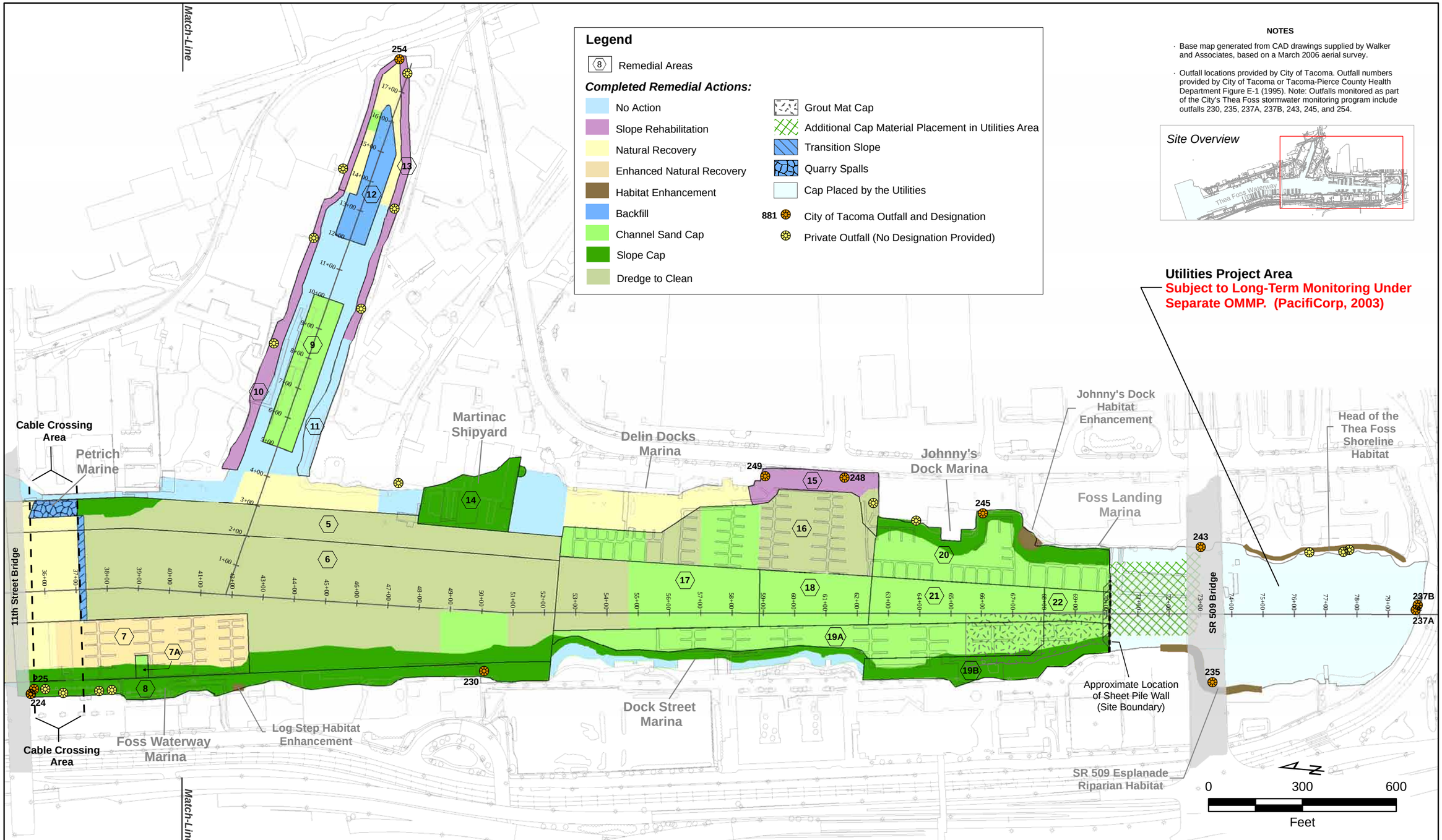
Thea Foss and Wheeler-Osgood Waterways
Slope Area Maintenance Plan

Figure 1 (Page 1 of 2)
Completed Remedial Actions

DATE: 2/21/2007 2:51:25 PM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\Baseline Report Figures\Slope Area Maintenance Plan Figures\Figure 1 Completed Remedial Actions (1of2) 022107.mxd



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Thea Foss and Wheeler-Osgood Waterways Slope Area Maintenance Plan

Figure 1 (Page 2 of 2) Completed Remedial Actions

DATE: 2/21/2007 2:53:54 PM
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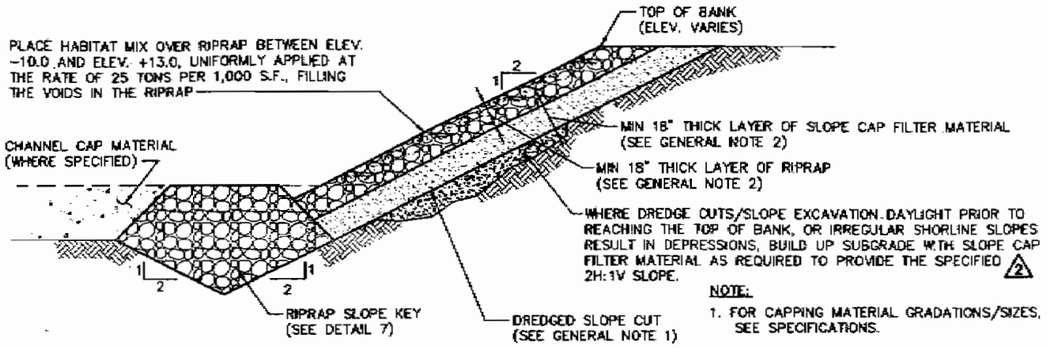
Appendix A

Thick Slope and Quarry Spall Cap Plans and Material Specifications



NOTE:

1. FOR CAPPING MATERIAL GRADATIONS/SIZES, SEE SPECIFICATIONS.
2. SEE THE GENERAL NOTES FOR DREDGING AND CAPPING TOLERANCES.

1 SECTION – THICK SLOPE CAP
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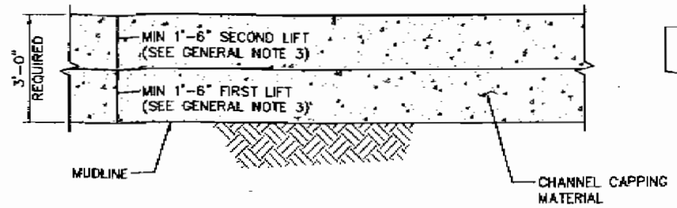
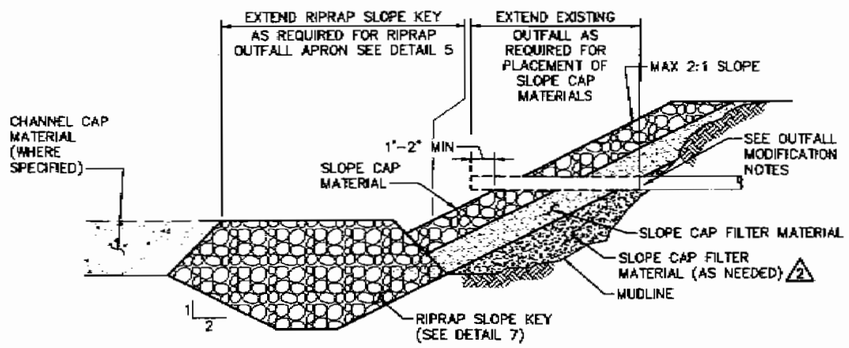


2 SECTION – THICK CHANNEL CAP
SCALE: N.T.S.

3 SECTION – THIN CAP
SCALE: N.T.S



4 DETAIL – OUTFALL MODIFCATION
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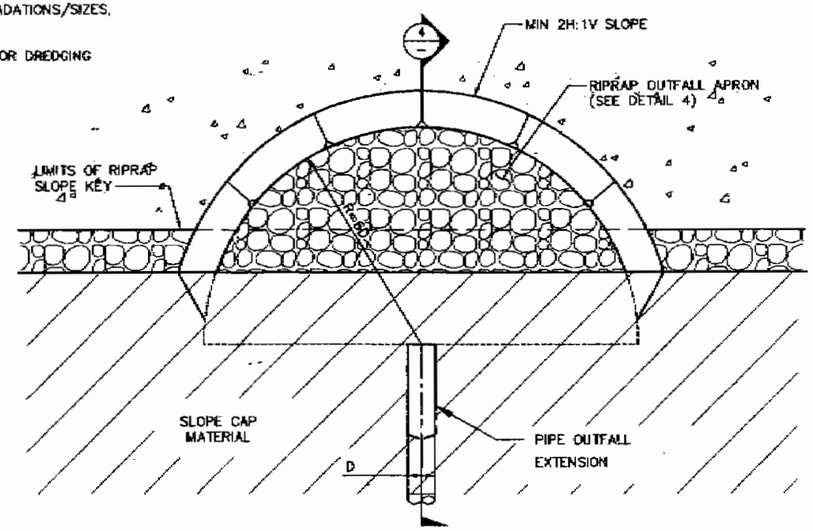
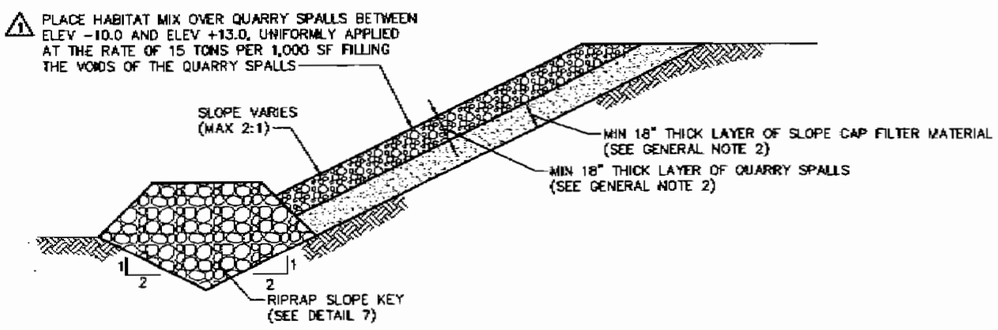


6 DETAIL – RIPRAP OUTFALL APRON
SCALE: N.T.S



5 DETAIL – QUARRY SPALL CAP
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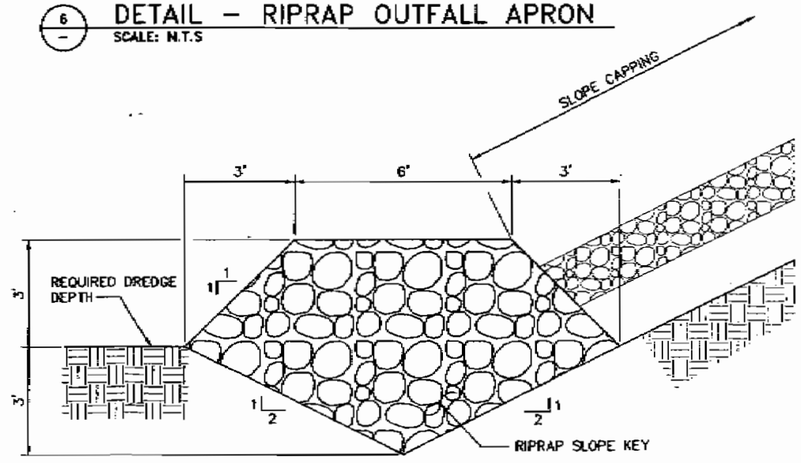

7 DETAIL – RIPRAP SLOPE KEY
SCALE: N.T.S

GENERAL NOTES:

1. DREDGING TOLERANCE: DREDGING DEPTHS SHOWN ON THE PLANS ARE MINIMUM DEPTHS. SLOPE AND CHANNEL DREDGING SHALL BE ACCOMPLISHED WITHIN A TOLERANCE OF +12 INCHES.
2. SLOPE CAPPING TOLERANCE: THE LAYER THICKNESS SHOWN ON THE PLANS FOR FILTER MATERIAL AND RIPRAP SLOPE CAPPING MATERIALS IS A MINIMUM THICKNESS. SLOPE CAPPING MATERIALS SHALL BE PLACED WITHIN A TOLERANCE OF +6 INCHES.
3. CHANNEL CAPPING TOLERANCE: THE LIFT THICKNESS SHOWN ON THE PLANS FOR CHANNEL CAPPING MATERIAL IS A MINIMUM THICKNESS. EACH LIFT OF THICK AND THIN CHANNEL CAP SHALL BE CONSTRUCTED WITH A PLACEMENT TOLERANCE OF +6 INCHES

OUTFALL MODIFICATION NOTES:

1. THE CONTRACTOR SHALL NOTIFY THE CITY OF ALL MODIFICATIONS TO EXISTING OUTFALLS OR DRAINS PRIOR TO CONSTRUCTION AND PREPARE A PLAN SHOWING THE PROPOSED MODIFICATION. REMOVE ANY SEDIMENT AND DEBRIS FROM THE END OF THE OUTFALL PIPE PRIOR TO PIPE EXTENSION.
2. PIPE EXTENSIONS SHALL BE CONSTRUCTED OF MATERIALS MATCHING THE EXISTING OUTFALL PIPE.
3. OUTFALL EXTENSIONS SHALL HAVE A MINIMUM PIPE LENGTH OF 3 FEET. REMOVE A PORTION OF THE EXISTING OUTFALL PIPE IF NECESSARY TO INSTALL THE MINIMUM LENGTH EXTENSION.
4. CONNECT EXTENSION PIPE TO THE EXISTING OUTFALL PIPE USING A FLEXIBLE PIPE COUPLING OR OTHER CITY APPROVED CONNECTION DEVICE.
5. REMOVE ANY BACKFLOW PREVENTION DEVICES FOUND ON EXISTING OUTFALL PIPES AND REINSTALL ON PIPE EXTENSIONS.
6. PLACE SLOPE CAP MATERIALS AROUND PIPE EXTENSIONS AS REQUIRED TO SUPPORT THE PIPE EXTENSION, ALLOW DRAINAGE AND PROVIDE THE MINIMUM SPECIFIED CAPPING THICKNESS.
7. AN OUTFALL APRON WILL NOT BE REQUIRED WHERE:
   - A. OUTFALL PIPES ARE SMALLER THAN 8" INCHES IN DIAMETER.
   - B. THE DISTANCE BETWEEN THE END OF THE PIPE OUTFALL EXTENSION AND THE TOE OF THE SLOPE EXCEEDS 6D.
   - C. IF THE TOE OF SLOPE IS AT ELEV -10.0 OR LOWER.

ISSUED FOR CONSTRUCTION

THEA FOSS WATERWAY
BERGER/ABAM ENGINEERS INC.
33301 9TH AVENUE SOUTH
FEDERAL WAY, WASHINGTON
98003-2600
VOICE: (206)431-2300
FAX: (206)431-2250
HARTCROWSER
Hart Crowser, Inc.
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Seattle, Washington 98102-3699
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GARY R. HORVAT
STATE OF WASHINGTON
EXPIRES OCTOBER 3, 2003
5/16/03

APPROVED			DATE
MDB	5/16/03	SJC	5/16/03
DRAWN BY	DATE	CHECK BY	DATE
PTL	5/16/03	GEH	5/16/03
DESIGN BY	DATE	PROJ ENGR	DATE

MARK	REVISION	BY	APP.	DATE
1	ADDENDUM #2 REV	BA	HC	3/14/03
2	ADDENDUM #4 REV	BA	HC	4/2/03

THEA FOSS AND WHEELER-OSGOOD WATERWAYS REMEDIATION PROJECT

MISCELLANEOUS WATERWAY REMEDIATION DETAILS

DRAWING NO. C-12.1
WORK ORDER DC 2001
SHEET NO. 25 OF 97

Last Saved on Fri May 16 2003 at 07:00AM by BoBiger File Name: G:\2001\F451-03-045\CADD\dgn\C-12_R.dwg Scale: 1

GENERAL

1.01 DESCRIPTION OF WORK

The work described in this specification includes identification, characterization, and approval of materials used for maintenance of slope areas in the Thea Foss and Wheeler-Osgood Waterways. Materials to be used for slope maintenance activities may include the following:

- Slope cap filter material;
- Rip Rap;
- Quarry spalls; and
- Habitat mix.

1.02 QUALITY ASSURANCE

Sampling, testing, and inspection for compliance with this specification shall be in accordance with the requirements specified herein.

1.03 STANDARD SPECIFICATIONS

The Standard Specifications for the work described in this section shall be the Standard Specifications for Road, Bridge, and Municipal Construction as prepared by the Washington Department of Transportation (WSDOT) and the American Public Works Association (APWA), Washington State Chapter, 2006 Edition.

1.04 SUBMITTALS

The following submittals shall be provided for slope maintenance materials:

A. Source Identification (per Paragraph 2.02-A).

B. Material Source Characterization (per Paragraph 2.02).

C. Shipping Receipts and Material Volumes for slope maintenance materials (per Paragraph 3.01).

Test reports shall be provided by a laboratory that is independent of the supplier.

PART 2 - PRODUCTS

2.01 GENERAL

Materials shall be of the quality, size, shape, and gradation or equal to that specified herein. Material sources shall be selected well in advance of the time when the material will be required in the work. Suitable representative samples and test reports, as described below, must be submitted to and approved by the Engineer prior to delivery of materials to the jobsite.

2.02 MATERIAL SOURCE CHARACTERIZATION

Material source characterization shall be performed as specified below to assure that materials used for slope maintenance are natural, native, virgin materials, free of unwanted materials including debris or recycled materials, and meet the requirements of these specifications. Any material that has been determined to be substandard by the City of Tacoma for any reason will be rejected. In the event that a material is rejected, it shall be removed from the site.

Slope cap filter material, rip rap, quarry spalls and habitat mix were placed on shoreline slopes within the Thea Foss and Wheeler-Osgood Waterways as part of Thea Foss and Wheeler-Osgood Waterways Remediation Project. Slope maintenance activities will use materials that meet the specifications for these materials approved for use by the United States Environmental Protection Agency (EPA) as part of the Thea Foss and Wheeler-Osgood Waterways Remediation Project.

Each material source shall be approved by EPA, in accordance with these specifications, prior to materials being bought to the area requiring maintenance. Specific sources used to supply these materials as part of the Thea Foss and Wheeler-Osgood Waterway Remediation Project have already been approved by EPA. Where a previously approved borrow source is identified as the source for materials to be used for slope maintenance, the Material Source Characterization will consist of Source Identification (2.02 A), Source Inspection (2.02 B), and Grain Size Distribution (2.02 C. 1). The Material Source Characterization for sources not previously approved by EPA shall include all of the requirements specified below. The Contractor shall submit a characterization of any and all imported material prior to any on-site placement.

A. Source Identification

Prior to material source sampling, documentation of the origin of each type of maintenance material including the names, addresses, and source identification numbers and maps identifying specific location(s) of material source(s).

B. Source Inspection

All material sources shall be inspected at the source by a representative of the City of Tacoma and the supplier(s) of the material. The witnessing of the inspection by a representative of the City shall in no way release the supplier(s) from complying with the Specifications and in no way shall be construed as approval of any particular source of material.

C. Testing, Reporting, and Certification

Samples of the source material comprising slope cap filter material and habitat mix shall undergo all of the following tests. Rip rap and quarry spalls will meet the requirements of 2.03 and 2.04.

1. Grain Size Distribution (ASTM D 422-63).
2. Particle Specific Gravity (ASTM D 854).
3. Weight per unit volume of uncompacted materials.

4. Priority Pollutant Metals (EPA SW 846 6010B/6020/ 7000 Series).
5. Volatile Organic Compounds (EPA SW 846 8260B).
6. Semi-volatile Organic Compounds (EPA SW 846 8270C).
7. Chlorinated Pesticides (EPA Method 8081).
8. Polychlorinated Biphenyls (EPA Method 8082).
9. Total Organic Carbon (EPA Method 9060).

The results of such tests shall be provided at least two weeks before delivery of the materials to the jobsite. The results of each test shall be provided in a report that clearly identifies the following:

1. Source of samples.
2. Sampling dates.
3. Chain of custody.
4. Sampling locations.
5. Supplier's certification that the samples tested and the results provided are representative of materials that shall be delivered to the site.

The supplier shall ensure the chemical nature of the material used for slope maintenance in the Thea Foss and Wheeler-Osgood Waterways does not pose a risk to human health or the environment. As such, imported slope maintenance materials shall be, at a minimum, less than the Sediment Quality Objective (SQO) concentrations for Commencement Bay (EPA 1989) and the Explanation of Significant Differences (EPA 2000).

D. Inspection of Materials at the Jobsite

Slope maintenance materials shall be visually inspected upon delivery. Materials shall be inspected for presence of foreign, recycled, or reprocessed material. Material may be rejected due to identification of any such material or as a result of substandard test results. Materials may be segregated for testing based on appearance or odor. Segregated material may be tested according to procedures at the City of Tacoma's discretion.

2.03 SLOPE CAP FILTER MATERIAL

Slope cap filter material shall be clean, free-draining sand and gravel from a recognized and established borrow site. Individual particles shall be free from all objectionable coating. The material shall contain no organic matter or soft friable particles in quantities considered objectionable. Slope cap filter material shall meet the following gradation requirements:

U.S. Standard Sieve Size	Percent Passing (by weight)
6 inch	100
4 inch	90 to 100
3/4 inch	50 to 90
No. 4	35 to 65
No. 10	15 to 45
No. 40	2 to 10
No. 200	0 to 2 (wet screen)

2.04 RIPRAP

Riprap shall consist of broken stone from an approved source that is hard, sound, dense, and durable. It shall be free from seams, cracks, and other defects tending to destroy its resistance to weather and seawater. Dry unit weight shall not be less than 160 pounds per solid cubic foot. Riprap shall meet the degradation, wear, and specific gravity requirements of Section 9-13 of the Standard Specifications. Rock for Riprap shall be angular, each piece having its greatest dimension not greater than three times its least dimension, and shall meet the following gradation requirements:

Light Riprap:

Light Riprap shall be large rock, 12 to 15 inches in size with up to 25 percent by weight smaller than 12 inches. The portion smaller than 12 inches shall be crushed rock that is greater than the U.S. No. 4 Standard Sieve size.

Heavy Riprap:

Weight In Pounds	Percent Lighter (by weight)
1,000	100
400	55 to 90
50	20 to 50
2	5 to 15

2.05 QUARRY SPALLS

Quarry spalls shall consist of broken stone from an approved source, free from segregation, seams, cracks or other defects and shall conform with the requirements for quality and gradation in Section 9-13.6, QUARRY SPALLS of the Standard Specifications.

2.06 HABITAT MIX

Habitat mix shall consist of 2-inch minus pit-run, rounded material from an approved source, uniform in quality and substantially free from wood, roots, bark and other extraneous materials. The individual particles shall be free from all objectionable coating and shall contain no organic matter or soft friable particles in quantities considered objectionable by the City of Tacoma. The material shall conform to the following gradation:

U.S. Standard Sieve Size	Percent Passing (by weight)
2 inch	100
1/1/2 inch	80 to 95
3/4 inch	60 to 80
No. 4	40 to 60
No.10	30 to 50
No. 40	10 to 20
No. 200	0 to 5 max. (wet screen)

PART 3 - EXECUTION

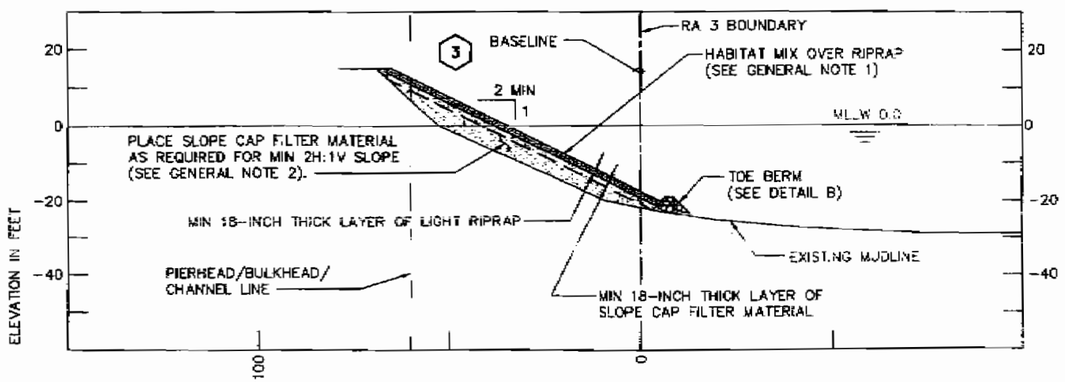
3.01 GENERAL

Slope maintenance materials shall be provided from a source approved by EPA. The supplier shall provide daily reports of the quantities of slope maintenance materials used. The reports shall include tabulated summaries of volumes placed for each material. Shipping receipts for all materials delivered to the site shall also be submitted on a daily basis.

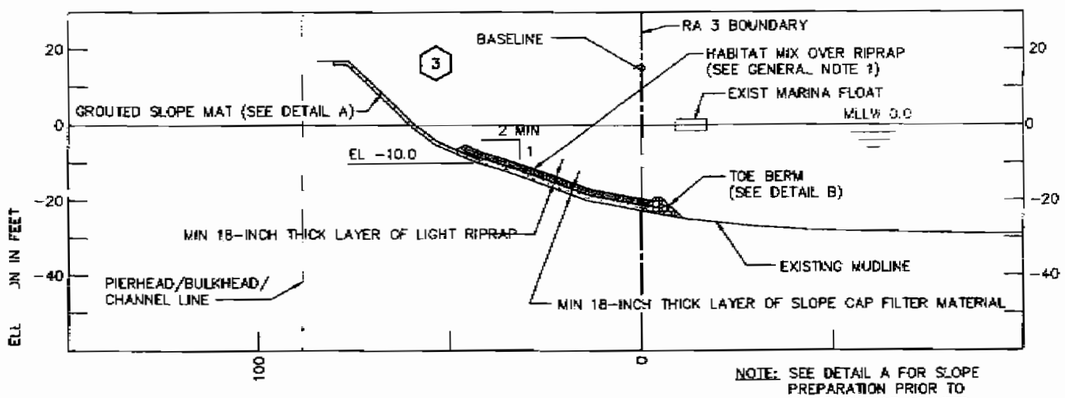
END OF SECTION

Appendix B

Grout Mat Cap Plans

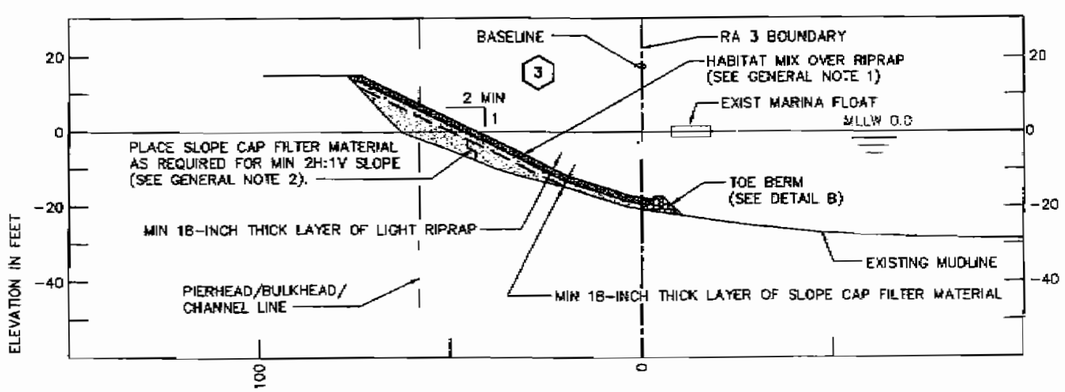


1 SECTION

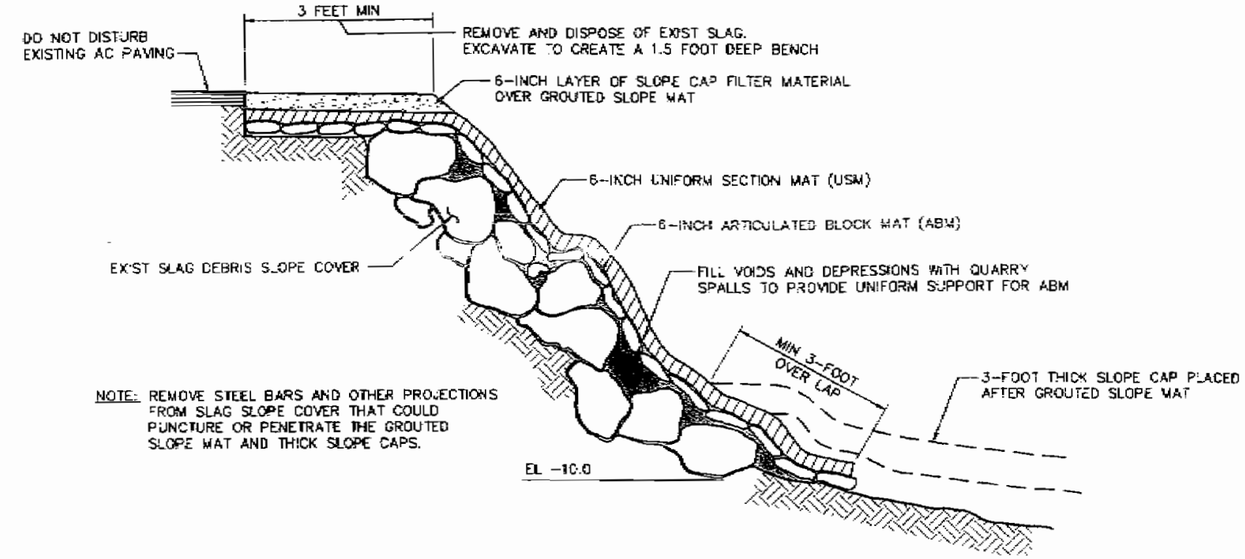


NOTE: SEE DETAIL A FOR SLOPE PREPARATION PRIOR TO PLACEMENT OF GROUTED SLOPE MAT.

2 SECTION



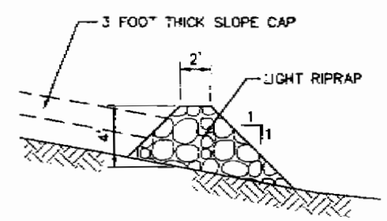
3 SECTION



NOTE: REMOVE STEEL BARS AND OTHER PROJECTIONS FROM SLAG SLOPE COVER THAT COULD PUNCTURE OR PENETRATE THE GROUTED SLOPE MAT AND THICK SLOPE CAPS.

A DETAIL – GROUTED SLOPE MAT

N.T.S.



B DETAIL – TOE BERM

N.T.S.

LEGEND

- (X) REMEDIAL ACTION AREA NUMBER (SEE DWG. C-1)
- LIGHT RIPRAP
- SLOPE CAP FILTER MATERIAL
- GROUTED SLOPE MAT

GENERAL NOTES:

1. PLACE HABITAT MIX OVER RIPRAP SLOPE CAP BETWEEN ELEV. -10.0 AND ELEV. +13.0, UNIFORMLY APPLIED AT THE RATE OF 25 TONS PER 1,000 S.F. FILLING THE VOIDS OF THE RIPRAP.
2. WHERE IRREGULAR SHORELINE SLOPES ARE STEEPER THAN 2H:1V, BUILD UP THE SUBGRADE WITH SLOPE CAP FILTER MATERIAL AS REQUIRED TO CREATE A SLOPE NO STEEPER THAN 2H:1V.

CONSTRUCTION SEQUENCE NOTES:

1. COMPLETE DEMOLITION WORK.
2. FILL VOIDS AND DEPRESSIONS OF EXISTING SLAG DEBRIS SLOPE COVER PRIOR TO PLACEMENT OF GROUTED SLOPE MAT.
3. CONSTRUCT GROUTED SLOPE MAT IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS.
4. CONSTRUCT TOE BERM PRIOR TO PLACEMENT OF THICK SLOPE CAPPING MATERIALS.
5. PLACE SLOPE CAP FILTER MATERIAL AS REQUIRED TO OBTAIN THE MINIMUM 2H:1V SLOPES DESIGNATED ON THE PLANS, AND PROVIDE A MIN 18-INCH THICK FILTER LAYER FOR RIPRAP. SEE THE PROJECT SPECIFICATIONS FOR LIMITATIONS REGARDING PLACEMENT OF SLOPE CAP MATERIALS.
6. AFTER CITY INSPECTION AND APPROVAL OF FILTER MATERIAL PLACEMENT, PLACE RIPRAP ARMORING.
7. AFTER CITY INSPECTION AND APPROVAL OF RIPRAP PLACEMENT, PLACE HABITAT MIX OVER RIPRAP.
8. PERFORM DIVER SURVEY OF GROUTED SLOPE MAT AND PROVIDE REPORT TO THE CITY. REPORT SHALL INCLUDED REPRESENTATIVE PHOTOGRAPHS.
9. COMPLETE FINAL SURVEYING AND CAP BOUNDARY VERIFICATION SAMPLING IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS.

1"=20' 20 0 20 40 scale feet

ISSUED FOR CONSTRUCTION

BERGER/ABAM ENGINEERS INC.
33301 9TH AVENUE SOUTH
FEDERAL WAY, WASHINGTON 98003-2600
(206)431-2300 FAX: (206)431-2250

HARTCROWSER
Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699
Fax 206.328.5581
206.324.9530

HARRY E. HORSLEY STATE OF WASHINGTON 23611 REGISTERED PROFESSIONAL ENGINEER
EXPIRES OCTOBER 3, 2003

APPROVED _____ DATE _____

MDB DRAWN BY	10-8-02 DATE	RDD CHECK BY	10-8-02 DATE
RTK DESIGN BY	10-8-02 DATE	AR PROJ ENGR	10-8-02 DATE

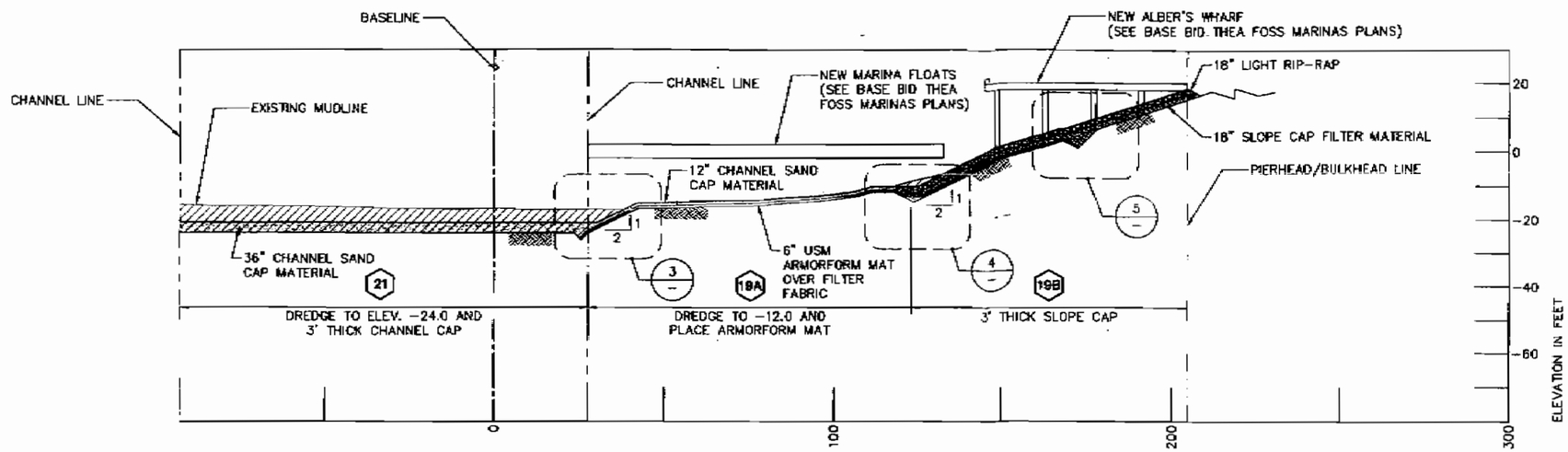
MARK	REVISION	BY	APP.	DATE

THEA FOSS AND WHEELER-OSGOOD WATERWAYS REMEDIATION/2002 CONSTRUCTION PROJECT

RA 3 TOTEM MARINE DETAILS & SECTIONS

DRAWING NO. C-7
WORK ORDER DC 2001
SHEET NO. 9 OF 16

Last Saved on Mon Nov 18 2002 at 12:20PM by Bellinger File Name: Q:\1999\49-0233\502\dwgs\C-07.dwg Scale: 20



SECTION – GENERIC CAPPING WITH USM ARMORFORM MAT – STATION 66+50

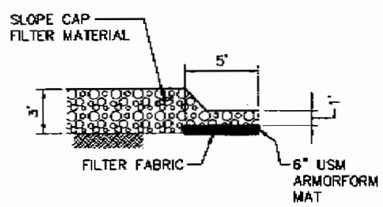
SCALE: 1"=40'

LEGEND

- REMEDIAL ACTION AREA NUMBER (SEE DWG. C-1.1)
- DREDGING
- SLOPE FILTER CAP
- CHANNEL SAND CAP

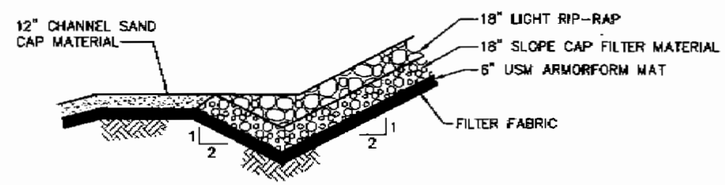
NOTES:

1. FOR CHANNEL AND SLOPE CAPPING DETAILS, SEE DWG. C-12.1.
2. FILTER FABRIC SHALL BE MIRAFI 600X OR APPROVED EQUAL. SEE SPECIFICATIONS.



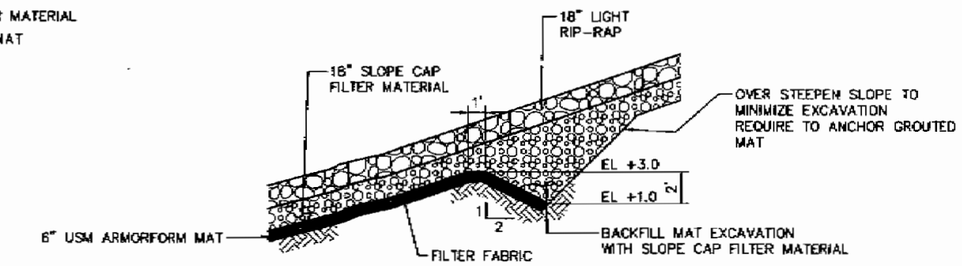
SECTION @ ENDS

SCALE: NTS



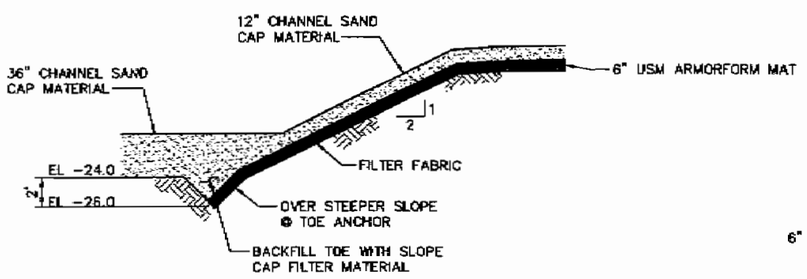
DETAIL – TOE KEY

SCALE: NTS



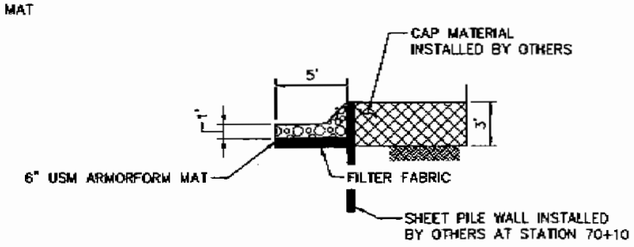
DETAIL – TOP OF MAT ANCHORING

SCALE: NTS



DETAIL – TOE OF MAT ANCHORING

SCALE: NTS



SECTION @ ENDS

SCALE: NTS

40 0 40 80
scale feet

1

ISSUED FOR CONSTRUCTION

BERGER/ABAM ENGINEERS INC.
33301 9TH AVENUE SOUTH
FEDERAL WAY, WASHINGTON
98003-2600
VOICE: (206)431-2300
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Seattle, Washington 98102-3699
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HARRY E. HORYZA STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER
EXPIRES OCTOBER 3, 2003

APPROVED _____ DATE _____

MDB DRAWN BY	5/16/03 DATE	BJC CHECK BY	5/16/03 DATE	1	ADDENDUM #4 NEW SHEET	BA	HC	6/1/03
MJM DESIGN BY	5/16/03 DATE	GEH PROJ ENGR	5/16/03 DATE	MARK	REVISION	BY	APP.	DATE

THEA FOSS AND WHEELER-OSGOOD WATERWAYS REMEDIATION PROJECT
ALBERS MILL WHARF & MARINA
GROUTED SLOPE MAT SECTIONS & DETAILS

DRAWING NO. C-23.3
WORK ORDER DC 2001
SHEET NO. 43 OF 97

Appendix C

Visual Water Quality Monitoring Form

Visual Water Quality Monitoring Form	Date	
Location:	Time	
	From	To
Personnel:		

Construction Activity / Equipment

Containment/Sorbent Boom Checklist		
Type of boom(s) deployed:	☐ **Debris Containment**	☐ **Sorbent**
Was the work area fully enclosed by the boom(s)?	☐ **Yes**	☐ **No**

Visual Water Quality Monitoring Checklist	N/A	Yes	No
Was visual water quality monitoring performed during construction or work activity?	☐	☐	☐
Were all debris and/or petroleum releases contained within the boom(s)?	☐	☐	☐
Was debris removed regularly so that it did not escape containment?	☐	☐	☐
Was surface water free of a persistent turbidity plume that extended away from the work zone?	☐	☐	☐
Were fish observed within the work area?	☐	☐	☐
Did overall surface water quality appear to be acceptable?	☐	☐	☐

Describe any observed water quality problems (as applicable):

Describe additional environmental controls implemented during construction (as applicable):

Describe any corrective action taken to solve problems described above (as applicable):

Print Name	Signature	Date
Reviewed by	Signature	Date

Attachment A-3

Supplemental Slope Inspection at Outfall 230

Outfall 230 on July 10, 2006 during Low Tide Slope Cap Inspection

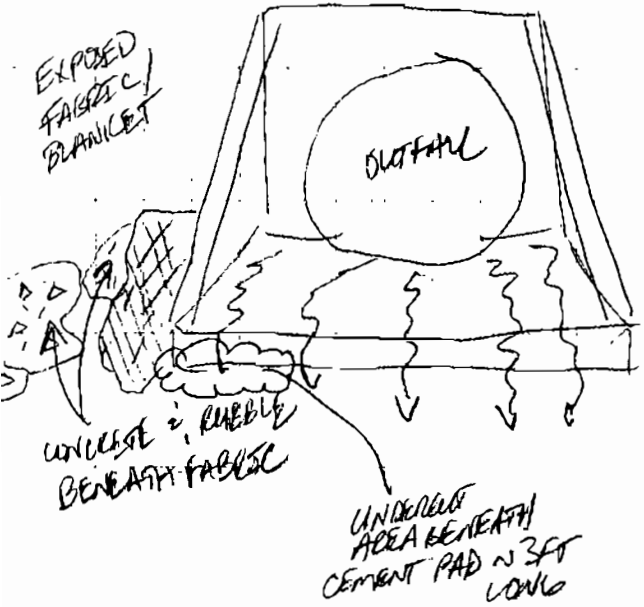
Outfall 230 on January 17, 2007 during Supplemental Low Tide Inspection

(2)

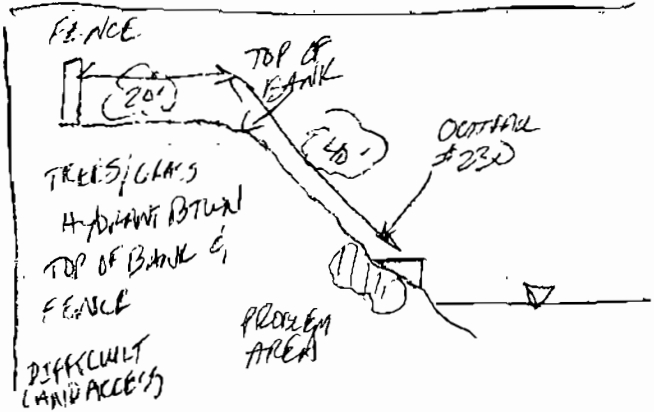
* BLD BEAM @ BASE OUTFALL (FROM H2O) ACROSS BASE, COVER PROBLEM AREA, HAB NEX.

OUTFALL #230 - NEW SITE FROM LOW TIDE OUTFALL INSPECTION

GOOD H2O ACCESS



- CONCRETE RUBBLE ~1/4 UP EDGE OUT OUTFALL
- EXTENDS ~12FT FROM EDGE OF OUTFALL
- NO EVIDENCE IN POST-WALST PHOTOS
- BLANKET SEEN IN PRE-LOW PHOTOS



Appendix B

Sediment and Cap Performance Monitoring

Attachment B-1

Supplemental Natural Recovery Area Preliminary Findings Memorandum

(on enclosed CD)

THEA FOSS AND WHEELER-OSGOOD WATERWAYS REMEDIATION PROJECT

YEAR 0 BASELINE MONITORING

SUPPLEMENTAL BASELINE NATURAL RECOVERY MONITORING PRELIMINARY FINDINGS MEMORANDUM

FEBRUARY 1, 2007

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY

Prepared by:

CITY OF TACOMA
FLOYD|SNIDER

PRELIMINARY FINDINGS MEMORANDUM
SUPPLEMENTAL BASELINE NATURAL RECOVERY MONITORING

INTRODUCTION

This memorandum presents the findings from Year 0, supplemental baseline natural recovery monitoring performed in the Thea Foss and Wheeler-Osgood Waterways. Supplemental baseline natural recovery area monitoring is required as part of Natural Recovery and Enhanced Natural Recovery Performance Monitoring specified in the EPA-approved Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006). The OMMP requires that supplemental baseline natural recovery area monitoring be conducted during Year 0 and that long-term natural recovery monitoring be performed during Years 2, 4, 7, and 10, as necessary, to verify that surface sediments in natural recovery areas satisfy performance criteria within the allowed 10-year time frame.

As described in the OMMP, surface sediment samples (0 to 10 cm) were collected from areas designated for natural recovery and enhanced natural recovery in the Thea Foss and Wheeler-Osgood Waterways. The baseline natural recovery area monitoring was performed in accordance with the OMMP. Provided with this memorandum are attachments that contain the field forms and photographs documenting observations during sample collection and the laboratory analytical report and data validation for sample analyses. The following sections summarize natural recovery area monitoring requirements and the results of supplemental baseline natural recovery area sampling and analysis performed.

SUMMARY OF NATURAL RECOVERY PERFORMANCE MONITORING REQUIREMENTS

The OMMP requires that surface sediment (0 to 10 cm) sampling and analysis be conducted in natural recovery and enhanced natural recovery areas to monitor the attenuation of chemical concentrations. The designated natural recovery and enhanced natural recovery areas to be monitored include the northern portions of Remedial Area (RA) 5 and RA 6, RA 7, most of the area north of the 11th Street Bridge to Station 20+00, the head of the Wheeler-Osgood Waterway located between RA 12 and RA 13, an area east of RA 16 and north of RA 15, and an area located east of RA 5 near the mouth of the Wheeler-Osgood Waterway extending from Station 41+50 to 46+50 (Figure 1). Additionally, slopes in the Wheeler-Osgood Waterway comprising RA 10, RA 11, and RA 13 were designated for natural recovery and slope rehabilitation during the Remedial Design phase of the project and will be monitored as part of the OMMP.

The OMMP specifies that natural recovery performance monitoring be conducted during Years 0 (baseline), 2, 4, 7, and 10, as necessary, to verify that surface sediments designated for natural recovery satisfy performance criteria within the allowed 10-year time frame. Year 0, or baseline monitoring, is comprised of a combination of the results of post-construction verification and supplemental surface samples.

Post-construction confirmation surface samples collected within the designated natural recovery areas adjacent to RA 2 and RA 4 and within the northern portions of RA 5, RA 6, and RA 7 are used to characterize natural recovery baseline conditions in these areas. The results of post-

construction confirmation surface samples used as baseline for natural recovery areas were presented in the Remedial Action Construction Report (RACR) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006) and will also be presented in the Baseline Year 0 Operations, Maintenance, and Monitoring Report. Supplemental baseline samples were required within designated natural recovery and enhanced natural recovery areas as part of Year 0 monitoring where there was insufficient existing post-construction data to complete the baseline characterization. Table 1 identifies the post-construction confirmation and supplemental samples that establish the baseline for natural recovery and enhanced natural recovery areas. Figure 1 identifies the baseline natural recovery and enhanced natural recovery area sample locations.

The results of Year 0 surface samples collected from natural recovery and enhanced natural recovery areas provide the baseline for evaluating the results of subsequent natural recovery monitoring. The results of subsequent natural recovery sampling and analysis will be compared to the baseline results to evaluate trends in chemical concentrations to identify if natural recovery and enhanced natural recovery areas will satisfy or have satisfied performance criteria within the allowed 10-year time frame.

SUMMARY OF FIELD ACTIVITIES AND OBSERVATIONS

Supplemental baseline natural recovery monitoring consisted of collection and analysis of surface samples (0 to 10 cm) from natural recovery and enhanced natural recovery areas in the Thea Foss and Wheeler-Osgood Waterways. A Van Veen sampler deployed from a boat was used to collect surface samples from the supplemental sampling locations in channel and harbor areas on October 23-24, 2006. Samples of shoreline areas in the Wheeler-Osgood Waterway were collected using a stainless steel spoon and bowl when the sample locations were exposed at a low tide on October 25, 2006. Sample collection forms and photographs documenting activities and observations were prepared during the field events and are presented in Attachment A.

The coordinates for sample locations in channel and harbor areas in the Thea Foss and Wheeler-Osgood Waterways were generated based on the locations identified on figures presented in the OMMP. During sample collection, the sampling vessel was maneuvered to the sample coordinates and a buoy was deployed to mark the sample location. Then the sampling vessel was maneuvered to the position of the buoy and the Van Veen sampler was deployed at the sample location. The actual sample coordinates where the sampler was deployed were collected at each location at the time of sample collection. The actual sample coordinates are provided on the field forms in Attachment A and actual sample locations are shown on Figure 1.

Samples collected from the shoreline of the Wheeler-Osgood Waterway are composites comprised of subsamples collected from three locations in each RA (i.e., RA 10, RA 11, and RA 13). The locations of the shoreline subsamples were established by installing stakes at each sample location prior to sample collection. Shoreline sample locations were established at the approximate mid-point of the slope at three evenly spaced locations within each RA (Figure 1). The approximate mid-point of the slope within each RA and at each sample location was identified from post-construction hydrographic surveys of the shoreline areas and locations identified on figures presented in the OMMP. Stakes were installed at the sample locations during low tides on October 18-19, 2006. Photographs of the shoreline sample location stakes within the Wheeler-Osgood Waterway are presented in Attachment A. The actual sample coordinates were collected at each location at the time of sample collection and are provided on the field forms in Attachment A. The actual sample locations are shown on Figure 1.

A quality control check was performed daily on the Global Positioning System (GPS) unit used to document sample location coordinates. The coordinates of known benchmarks were recorded from the GPS prior to initiation of sampling on each day. The coordinates of the benchmarks recorded by the GPS on the day of sampling were compared to the surveyed coordinates of the benchmarks. The recorded GPS readings were within 10 feet of the known benchmark coordinates as required in the OMMP.

Collection of supplemental baseline samples from channel and harbor areas within the Thea Foss and Wheeler-Osgood Waterways generally progressed from north to south. Samples were collected from sample locations NR-06, NR-07, NR-11, NR-16, NR-17, NR-19, and NR-20 on October 23, 2006, and from sample location NR-25 on October 24, 2006.

Samples collected in the natural recovery area north of the 11th Street Bridge (i.e., NR-06, NR-07, and NR-11) (Figure 1) consisted of a soft, olive to gray colored silt containing shells, worms, and worm tubes. Multiple casts were necessary to acquire sample material that was not over-penetrated by the sampler. No odor or sheen was detected in the samples collected from the area north of the 11th Street Bridge (Attachment A).

The sample collected from the enhanced natural recovery area in RA 7 (i.e., NR-16) consisted of approximately 1 cm of soft, olive to gray colored silt overlying the channel cap material placed during remedial actions in RA 7. No odor or sheen was detected in the sample collected from RA 7.

The sample collected from the natural recovery area located at the mouth of the Wheeler-Osgood Waterway (i.e., NR-17) consisted of olive to dark gray colored sand containing wood fibers and pieces. Worms were also observed in the sample. Additionally, a slight hydrogen sulfide odor and sheen spots were detected in the sample bowl after homogenization of the sample material.

The samples collected from the natural recovery area at the head of the Wheeler-Osgood Waterway, north and east of RA 12 (i.e., NR-19 and NR-20, respectively) consisted of olive to dark gray colored silt containing shells, mussels, barnacles, and worms. No sheen was observed in the samples collected from the head of the Wheeler-Osgood Waterway. A slight creosote odor was detected in the sample material collected from the area east of RA12 when the sample was homogenized in the sample bowl.

The sample collected from the natural recovery area west of RA 16 and north of RA 15 (i.e., NR-25) consisted of olive to dark gray colored silt containing shells and wood fibers and pieces. No sheen was observed in the sample collected from the area west of RA 16. A slight hydrogen sulfide odor was detected in the sample material.

Collection of supplemental baseline samples from shoreline areas in the Wheeler-Osgood Waterway generally progressed from sample locations with higher elevations to sample locations with lower elevations as the samples were collected as the tide receded. Samples were collected from three locations in RA-10 (i.e., SR-10-D1, SR-10-D2, and SR-10-D3), RA-11 (i.e., SR-11-D1, SR-11-D2, and SR-11-D3), and RA-13 (i.e., SR-13-D1, SR-13-D2, and SR-13-D3) and combined to comprise a composite for each RA. The samples were collected from shoreline areas in the Wheeler-Osgood Waterway on October 25, 2006 (Figure 1).

The samples collected from the natural recovery and slope rehabilitation areas on the shorelines of the Wheeler-Osgood Waterway consisted of an olive, dark gray, or brown colored sand with gravel or silt. Samples also contained wood pieces and shells. No odor or sheen was detected in the samples collected from the shorelines in the Wheeler-Osgood Waterway.

The following sections summarize the results and findings from the Year 0 baseline supplemental natural recovery monitoring.

SUMMARY OF ANALYTICAL RESULTS

The samples collected from natural recovery and enhanced natural recovery areas were analyzed by the City of Tacoma laboratory. The supplemental baseline natural recovery area samples were analyzed for conventionals, metals, semi-volatile organic compounds (SVOC), pesticides, and polychlorinated biphenyls (PCBs) in accordance with the OMMP (Table 2). The results of sample analysis are summarized in Table 3. The laboratory analytical report is provided in Attachment B.

Eleven samples from locations in natural recovery and enhanced natural recovery areas were analyzed to complete the baseline characterization of these areas. Additionally, three duplicate samples were collected, one on each day of sample collection activities, and analyzed for quality control. The detected chemical concentrations in the samples are compared to the Sediment Quality Objectives (SQOs) to identify the baseline conditions.

Detected chemical concentrations were less than the SQOs in the samples collected from the northeast and northwest portions of the natural recovery area north of the 11th Street Bridge (i.e., NR-06 and NR-07, respectively) (Table 3 and Figure 1). Only bis(2-ethylhexyl)phthalate (BEHP) was detected at concentrations greater than the SQOs in the remaining sample collected from the natural recovery area north of the 11th Street Bridge (i.e., NR-11). The detected concentration of BEHP was approximately 1.5 times the SQO. The detected concentrations of most chemicals in samples collected north of the 11th Street Bridge were less than one-half the SQO. Benzyl alcohol was qualified as not detected at a concentration that was greater than the SQO in two samples collected north of the 11th Street Bridge because benzyl alcohol was detected in the associated laboratory method blank sample.

Relatively few chemicals were detected in the sample collected from the enhanced natural recovery area located south of the 11th Street Bridge (i.e., NR-16). All of the detected chemicals were at concentrations that were substantially less than the SQOs.

One chemical was detected at a concentration greater than the SQO in the sample collected from the natural recovery area located at the mouth of the Wheeler-Osgood Waterway (i.e., NR-17). Pyrene was detected at approximately 1.25 times the SQO.

Three chemicals were detected at concentrations greater than the SQOs in the sample collected in the natural recovery area located in the head of the Wheeler-Osgood Waterway, north of RA-12 (i.e., NR-19). Benzo(a)anthracene, pyrene, and N-nitrosodiphenylamine were detected at concentrations that were at or below two times the SQOs.

A sample and sample duplicate were submitted for analysis from the natural recovery area located in the head of the Wheeler-Osgood Waterway, east of RA-12. Three chemicals were detected in both the parent sample and sample duplicate at concentrations exceeding the SQOs. BEHP, 1,2-dichlorobenzene, and PCBs were detected in both samples at similar

concentrations, concentrations less than two times the SQOs. Multiple polycyclic aromatic hydrocarbons (PAHs) were detected in the parent sample at concentrations exceeding the SQOs but were not detected in the sample duplicate at similar concentrations. PAH concentrations detected in the duplicate sample were generally less than one-half the SQOs. The similarity in chemical concentrations between the parent sample and sample duplicate, except for the concentrations of PAHs, indicates that the PAHs were likely present in a subcomponent of the sample, a piece of creosote treated wood for example, and not homogenous within the sediment matrix. Additionally, benzyl alcohol was qualified as not detected at a concentration that was greater than the SQO in the parent sample because benzyl alcohol was detected in the associated laboratory method blank sample.

A sample and sample duplicate were also submitted for analysis from the natural recovery area located east of RA-16 and north of RA-15. Mercury, PAHs, butylbenzyl phthalate, and BEHP were detected in both samples at concentrations exceeding the SQOs. The detected concentrations of mercury, PAHs, and butylbenzyl phthalate were at or below twice the SQOs for these chemicals. The detected concentration of BEHP was between two and three times the SQO.

Relatively few chemicals were detected in the samples collected from the slope rehabilitation natural recovery areas located along the shoreline within the Wheeler-Osgood Waterway (i.e., SR-10, SR-11, and SR-13). All of the detected chemical concentrations were substantially less than the SQOs.

The results for Year 0 supplemental natural recovery sample analysis presented above characterize the baseline for the areas sampled. The results of the baseline natural recovery monitoring will used as the basis for comparison to the results of subsequent natural recovery and enhanced natural recovery performance monitoring.

SUMMARY OF DATA QUALITY

Data validation was performed on the results of analyses on supplemental natural recovery area samples in accordance with the OMMP. The resulting data validation reports are presented in Attachment B. All data are considered valid and acceptable for use. All qualifiers resulting from data validation are presented in the summary of analytical results provided in Table 3.

Some deviations from performance goals were identified as a result of matrix interferences. As outlined in the OMMP, multiple re-analyses were performed on sample extracts in order to meet performance criteria. Additional cleanups were also performed in an effort to increase analytical accuracy. Deviations from performance goals are identified in the data validation reports and generally resulted in the data being qualified as an estimate (i.e., J qualifier).

SUMMARY OF PRELIMINARY FINDINGS

The following summarizes the results and preliminary findings for the Year 0, baseline supplemental natural recovery sampling and analysis performed in the Thea Foss and Wheeler-Osgood Waterways:

- No chemicals were detected at concentrations greater than the SQOs in the samples collected from the northeast and northwest portions of the natural recovery area north of the 11th Street Bridge (i.e., NR-06 and NR-07), from the enhanced natural recovery area

south of the 11th Street Bridge (i.e., NR-16), and from the slope rehabilitation natural recovery areas along the shorelines in the Wheeler-Osgood Waterway (i.e., SR-10, SR-11, and SR-13);

- Detected chemical concentrations that were greater than the SQO were predominantly at or below twice the SQO in samples collected from the remaining five sample locations; and
- The results of analyses of the sample and sample duplicate collected from the head of the Wheeler-Osgood Waterway east of RA-12 were similar except for PAHs that were detected in the parent sample at concentrations exceeding the SQOs but were not detected at concentrations exceeding the SQOs in the duplicate sample. The detected concentrations of PAHs in the parent sample were likely present in a subcomponent of the sample, a piece of creosote treated wood for example, and not homogenous within the sediment matrix.

The results of Year 0 supplemental natural recovery sampling and analysis characterize the baseline for the areas sampled. The results from Year 0 supplemental natural recovery monitoring will be combined with the results from construction verification sampling performed in natural recovery areas and presented in the Baseline Operations, Maintenance, and Monitoring Report to provide a comprehensive baseline for all natural recovery and enhanced natural recovery areas within the Thea Foss and Wheeler-Osgood Waterways. The results of baseline natural recovery monitoring will used as the basis for comparison to the results of subsequent natural recovery and enhanced natural recovery performance monitoring conducted in accordance with the OMMP.

Table 1
Post-Construction Verification and Supplemental Baseline Natural Recovery Samples

Area	Remedial Action	Post-Construction Verification Samples Used for Baseline	Supplemental Baseline Natural Recovery Samples	Supplemental Baseline Sample Collection Date
North of 11th Street Bridge	Natural Recovery	RA-02-004	NR-06	October 23, 2006
		RA-02-006		
		RA-02-007		
		RA-02-008		
		RA-02-009	NR-07	October 23, 2006
		RA-04-005		
		RA-04-006		
		RA-04-007		
		RA-04-008	NR-11	October 23, 2006
		RA-04-009		
		RA-04-010		
		RA-04-011		
		RA-04-012		
Northern Portion of RA5	Natural Recovery	RA-05-002	None	NA
		RA-05-009		
		RA-05-010		
Northern Portion of RA6	Natural Recovery	RA-06-001	None	NA
		RA-06-014		
		RA-06-015		
RA 7	Enhanced Natural Recovery	RA-07-001	NR-16	October 23, 2006
Mouth of the Wheeler-Osgood Waterway	Natural Recovery	None	NR-17	October 23, 2006
Shoreline of the Wheeler-Osgood Waterway	Slope Rehabilitation / Natural Recovery	None	SR-10	October 25, 2006
			SR-11	October 25, 2006
			SR-13	October 25, 2006
Head of the Wheeler-Osgood Waterway	Natural Recovery	None	NR-19	October 23, 2006
			NR-20	October 23, 2006
Harbor Area Adjacent to RA 15 and RA 16	Natural Recovery	None	NR-25	October 24, 2006

Table 2
Summary of Parameters for Sediment Sample Analysis

Parameters	Analyte	SQO	Analytical Method
Conventionals	Total Organic Carbon in %	NA	EPA Method 9060
	Total Solids in %	NA	PSEP 1997
Metals	Antimony	150 mg/kg	EPA Method 6010B
	Arsenic	57 mg/kg	
	Cadmium	5.1 mg/kg	
	Copper	390 mg/kg	
	Lead	450 mg/kg	
	Nickel	140 mg/kg	
	Silver	6.1 mg/kg	
	Zinc	410 mg/kg	
	Mercury	0.59 mg/kg	EPA Method 7471A
Semi-Volatile Organic Compounds	2-Methylnaphthalene	670 µg/kg	EPA Method 8270C
	Acenaphthene	500 µg/kg	
	Acenaphthylene	1,300 µg/kg	
	Anthracene	960 µg/kg	
	Fluorene	540 µg/kg	
	Naphthalene	2,100 µg/kg	
	Phenanthrene	1,500 µg/kg	
	Total LPAHs	5,200 µg/kg	
	Benzo(a)Anthracene	1,600 µg/kg	
	Benzo(a)Pyrene	1,600 µg/kg	
	Benzo(b)Fluoranthene	NA	
	Benzo(k)Fluoranthene	NA	
	Total Benzofluoranthenes	3,600 µg/kg	
	Benzo(g,h,i)Perylene	720 µg/kg	
	Chrysene	2,800 µg/kg	
	Dibenz(a,h)Anthracene	230 µg/kg	
	Fluoranthene	2,500 µg/kg	
	Indeno(1,2,3-c,d)Pyrene	690 µg/kg	
	Pyrene	3,300 µg/kg	
	Total HPAHs	17,000 µg/kg	
	Dimethylphthalate	160 µg/kg	
	Diethylphthalate	200 µg/kg	
	Di-n-butylphthalate	1,400 µg/kg	
	Butylbenzylphthalate	900 µg/kg	

Parameters	Analyte	SQO	Analytical Method
Semi-Volatile Organic Compounds	Bis(2-Ethylhexyl)Phthalate	1,300 µg/kg	EPA Method 8270C
	Di-n-octylphthalate	6,200 µg/kg	
	Phenol	420 µg/kg	
	2-Methylphenol	63 µg/kg	
	4-Methylphenol	670 µg/kg	
	2,4-Dimethylphenol	29 µg/kg	
	Pentachlorophenol	360 µg/kg	
	Benzyl alcohol	73 µg/kg	
	Benzoic acid	650 µg/kg	
	1,2-Dichlorobenzene	50 µg/kg	
	1,3-Dichlorobenzene	170 µg/kg	
	1,4-Dichlorobenzene	110 µg/kg	
	1,2,4-Trichlorobenzene	51 µg/kg	
	Hexachlorobenzene	22 µg/kg	
	Dibenzofuran	540 µg/kg	
	Hexachlorobutadiene	11 µg/kg	
	N-Nitrosodiphenylamine	28 µg/kg	
Pesticides	4,4'-DDD	16 µg/kg	EPA Method 8270C
	4,4'-DDE	9 µg/kg	
	4,4'-DDT	34 µg/kg	
PCBs	PCB-1016	NA	EPA Method 8270C
	PCB-1221	NA	
	PCB-1232	NA	
	PCB-1242	NA	
	PCB-1248	NA	
	PCB-1254	NA	
	PCB-1260	NA	
	Total PCBs	300 µg/kg	

Table 3
Summary of Supplemental Baseline Natural Recovery Area Sample Results

	Station		NR-06		NR-07		NR-11		NR-16		NR-17		NR-19	
	Sample ID		NR-06-Y0-D		NR-07-Y0-D		NR-11-Y0-D		NR-16-Y0-D		NR-17-Y0-D		NR-19-Y0-D	
	Sample Date		10/23/2006	Enrichment	10/23/2006	Enrichment	10/23/2006	Enrichment	10/23/2006	Enrichment	10/23/2006	Enrichment	10/23/2006	Enrichment
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio
Parameter	**Units**	**SQO**												
Conventionals														
Total Organic Carbon	mg/kg	NA	21,900	NA	22,600	NA	25,800	NA	21,600	NA	46,600	NA	27,700	NA
Total Solids	%	NA	47.7	NA	46	NA	45.5	NA	83.7	NA	62.8	NA	63.2	NA
Metals														
Antimony	mg/kg	150	6 U	NA	6 U	NA	6 U	NA	0.76 U	NA	0.8 U	NA	6 U	NA
Arsenic	mg/kg	57	10.2	0.18	9.83	0.17	11.4	0.20	3.33	0.06	4.75	0.08	6.23	0.11
Cadmium	mg/kg	5.1	0.926	0.18	0.897	0.18	1.17	0.23	0.238	0.05	0.554	0.11	0.529	0.10
Copper	mg/kg	390	80.4 J	0.21	83 J	0.21	96.8 J	0.25	20.9 J	0.05	62 J	0.16	49.6 J	0.13
Lead	mg/kg	450	55.8	0.12	51.4	0.11	69.2	0.15	7.95	0.02	26.7	0.06	41.5	0.09
Nickel	mg/kg	140	17.6	0.13	15.7	0.11	18.7	0.13	13.3	0.10	9.41	0.07	12.6	0.09
Silver	mg/kg	6.1	0.22 U	NA	0.2 U	NA	0.22 U	NA	0.21 U	NA	0.22 U	NA	0.21 U	NA
Zinc	mg/kg	410	102	0.25	109	0.27	130	0.32	35.3	0.09	65.6	0.16	84	0.20
Mercury	mg/kg	0.59	0.298	0.51	0.317	0.54	0.407	0.69	0.029 U	NA	0.032 U	NA	0.099	0.17
SVOCs														
2-Methylnaphthalene	µg/kg	670	160	0.24	150	0.22	150	0.22	99 U	NA	410	0.61	400	0.60
Acenaphthene	µg/kg	500	100 U	NA	100 U	NA	100 U	NA	99 U	NA	99 U	NA	140	0.28
Acenaphthylene	µg/kg	1,300	100 U	NA	100 U	NA	100 U	NA	99 U	NA	99 U	NA	260	0.20
Anthracene	µg/kg	960	260	0.27	210	0.22	230	0.24	99 U	NA	520	0.54	420	0.44
Fluorene	µg/kg	540	110	0.20	100 U	NA	110	0.20	99 U	NA	300	0.56	100 U	NA
Naphthalene	µg/kg	2,100	290	0.14	260	0.12	270	0.13	99 U	NA	420	0.20	510	0.24
Phenanthrene	µg/kg	1,500	510	0.34	470	0.31	560	0.37	99 U	NA	1,300	0.87	950	0.63
Total LPAH	µg/kg	5,200	1,400	0.27	1,200	0.23	1,400	0.27	350 U	NA	3,000	0.58	2,700	0.52
Benzo(a)anthracene	µg/kg	1,600	500	0.31	450	0.28	550	0.34	99 U	NA	440	0.28	**1900**	1.19
Benzo(a)pyrene	µg/kg	1,600	520	0.33	510	0.32	620	0.39	99 U	NA	380	0.24	920	0.58
Benzofluoranthenes (total)	µg/kg	3,600	1,100	0.31	1,100	0.31	1,400	0.39	99	0.03	630	0.18	1,600	0.44
Benzo(g,h,i)perylene	µg/kg	720	360	0.50	330	0.46	400	0.56	99 U	NA	200	0.28	430	0.60
Chrysene	µg/kg	2,800	620	0.22	620	0.22	700	0.25	99 U	NA	580	0.21	2,300	0.82
Dibenzo(a,h)anthracene	µg/kg	230	100 U	NA	100 U	NA	100 U	NA	99 U	NA	99 U	NA	130	0.57
Fluoranthene	µg/kg	2,500	810	0.32	770	0.31	900	0.36	99 U	NA	1,000	0.40	2,000	0.80
Indeno(1,2,3-cd)pyrene	µg/kg	690	270	0.39	270	0.39	300	0.43	99 U	NA	160	0.23	360	0.52
Pyrene	µg/kg	3,300	1,800	0.55	1,800	0.55	2,400	0.73	99 U	NA	**4,100**	1.24	**6,800**	2.06
Total HPAH	µg/kg	17,000	6,100	0.36	5,800	0.34	7,300	0.43	450 U	NA	7,500	0.44	16,000	0.94
Dimethyl phthalate	µg/kg	160	10	0.06	16	0.10	18	0.11	1.2	0.01	4 U	NA	9.6	0.06
Diethylphthalate	µg/kg	200	100 U	NA	100 U	NA	100 U	NA	99 U	NA	99 U	NA	100 U	NA
Di-n-butyl phthalate	µg/kg	1,400	100 U	NA	100 U	NA	100 U	NA	99 U	NA	99 U	NA	100 U	NA
Butyl benzyl phthalate	µg/kg	900	240	0.27	290	0.32	480	0.53	99 U	NA	99 U	NA	230	0.26
bis(2-ethylhexyl)phthalate	µg/kg	1,300	730	0.56	1,000	0.77	**2,000**	1.54	230	0.18	330	0.25	720	0.55
Di-n-octyl phthalate	µg/kg	6,200	100 U	NA	100 U	NA	100 U	NA	99 U	NA	99 U	NA	100 U	NA
Phenol	µg/kg	420	100 U	NA	100 U	NA	100 U	NA	99 U	NA	99 U	NA	100 UJ	NA
2-Methylphenol	µg/kg	63	4 UJ	NA	4 UJ	NA	4 UJ	NA	1 UJ	NA	4 UJ	NA	4 UJ	NA
3- & 4-Methylphenol	µg/kg	670	100 U	NA	100 U	NA	100 U	NA	99 U	NA	99 U	NA	100 UJ	NA
2,4-Dimethylphenol	µg/kg	29	18 J	0.62	18 J	0.62	19 J	0.66	1 UJ	NA	21 J	0.72	4 UJ	NA
Pentachlorophenol	µg/kg	360	4 UJ	NA	76	0.21	4 UJ	NA	1 U	NA	4 U	NA	77 J	0.21
Benzyl alcohol	µg/kg	73	69 UJ	NA	**75 U**	NA	**81 UJ**	NA	20 U	NA	42 U	NA	62 UJ	NA
Benzoic acid	µg/kg	650	170 UJ	NA	170 UJ	NA	190 UJ	NA	48 UJ	NA	190 UJ	NA	170 UJ	NA
1,2-Dichlorobenzene	µg/kg	50	4 U	NA	4 U	NA	4 U	NA	1 U	NA	4 U	NA	6	0.12
1,3-Dichlorobenzene	µg/kg	170	4 U	NA	4 U	NA	4 U	NA	1 U	NA	4 U	NA	4 U	NA
1,4-Dichlorobenzene	µg/kg	110	11	0.10	15	0.14	21	0.19	1.2	0.01	6.3	0.06	8.8	0.08
1,2,4-Trichlorobenzene	µg/kg	51	4 U	NA	4 U	NA	4 U	NA	1 U	NA	4 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	1 U	NA	4 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	100 U	NA	100 U	NA	100 U	NA	99 U	NA	130	0.24	120	0.22
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	1 U	NA	4 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	17	0.61	13	0.46	12	0.43	2	0.07	18	0.64	**30**	1.07

Table 3
Summary of Supplemental Baseline Natural Recovery Area Sample Results

	Station		NR-06		NR-07		NR-11		NR-16		NR-17		NR-19	
	Sample ID		NR-06-Y0-D		NR-07-Y0-D		NR-11-Y0-D		NR-16-Y0-D		NR-17-Y0-D		NR-19-Y0-D	
	Sample Date		10/23/2006	Enrichment	10/23/2006	Enrichment	10/23/2006	Enrichment	10/23/2006	Enrichment	10/23/2006	Enrichment	10/23/2006	Enrichment
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio
Parameter	**Units**	**SQO**												
Pesticides														
4,4'-DDD	µg/kg	16	4 U	NA	4 U	NA	4 U	NA	1 U	NA	4 U	NA	4 U	NA
4,4'-DDE	µg/kg	9	4 U	NA	4 U	NA	4 U	NA	1 U	NA	4 U	NA	4 U	NA
4,4'-DDT	µg/kg	34	4 U	NA	4 U	NA	4 U	NA	1 U	NA	4 U	NA	4 U	NA
PCBs														
PCB-1016	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1221	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1232	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1242	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1248	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1254	µg/kg	NA	150 J	NA	140 J	NA	200 J	NA	20 U	NA	20 U	NA	110 J	NA
PCB-1260	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCBs (total)	µg/kg	300	150 J	0.50	140 J	0.47	200 J	0.67	20 U	NA	20 U	NA	110 J	0.37

Notes:

Concentrations highlighted in **red** exceed the SQO.

NA: Not applicable

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identified, but the associated numerical value is an estimate.

UJ - The analyte was analyzed for and not detected but the associated numerical value is an estimate.

Table 3
Summary of Supplemental Baseline Natural Recovery Area Sample Results

	Station		NR-20				NR-25				SR-10		SR-11				SR-13	
	Sample ID		NR-20-Y0-D		NR-20-Y0-D1		NR-25-Y0-D		NR-25-Y0-D1		SR-10-Y0-D		SR-11-Y0-D		SR-11-Y0-D4		SR-13-Y0-D	
	Sample Date		10/23/2006	Enrichment	10/23/2006	Enrichment	10/24/2006	Enrichment	10/24/2006	Enrichment	10/25/2006	Enrichment	10/25/2006	Enrichment	10/25/2006	Enrichment	10/25/2006	Enrichment
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio
Parameter	**Units**	**SQO**																
Conventionals																		
Total Organic Carbon	mg/kg	NA	36,900	NA	35,600	NA	90,300	NA	95,100	NA	10,600	NA	3,590	NA	3,820	NA	6,040	NA
Total Solids	%	NA	56.5	NA	57.7	NA	35.8	NA	36.5	NA	79.2	NA	76.4	NA	76.3	NA	78.7	NA
Metals																		
Antimony	mg/kg	150	6 U	NA	6 U	NA	7.45	0.05	6 U	NA	6 U	NA	6 U	NA	0.79 U	NA	0.79 U	NA
Arsenic	mg/kg	57	9.62	0.17	10.6	0.19	31.4	0.55	22.8	0.40	5.81	0.10	4.23	0.07	4.29	0.08	3.93	0.07
Cadmium	mg/kg	5.1	0.952	0.19	0.994	0.19	2.36	0.46	1.96	0.38	0.249	0.05	0.251	0.05	0.251	0.05	0.285	0.06
Copper	mg/kg	390	87 J	0.22	88.8 J	0.23	173 J	0.44	136 J	0.35	31 J	0.08	25.4 J	0.07	18.3 J	0.05	27.8 J	0.07
Lead	mg/kg	450	67.4	0.15	75.7	0.17	130	0.29	108	0.24	52	0.12	18.5	0.04	13.4	0.03	14.9	0.03
Nickel	mg/kg	140	15.6	0.11	17.3	0.12	19.9	0.14	19.3	0.14	13.3	0.10	10.8	0.08	9.91	0.07	16.4	0.12
Silver	mg/kg	6.1	0.22 U	NA	0.22 U	NA	0.22 U	NA	0.22 U	NA	0.21 U	NA	0.21 U	NA	0.22 U	NA	0.22 U	NA
Zinc	mg/kg	410	167	0.41	178	0.43	254	0.62	206	0.50	77.6	0.19	56	0.14	52	0.13	58.1	0.14
Mercury	mg/kg	0.59	0.175	0.30	0.173	0.29	**0.602**	1.02	**0.771**	1.31	0.056	0.09	0.016 U	NA	0.014 U	NA	0.052	0.09
SVOCs																		
2-Methylnaphthalene	µg/kg	670	500	0.75	360		320	0.48	310	0.46	99 U	NA	84 U	NA	100 U	NA	96 U	NA
Acenaphthene	µg/kg	500	**820**	1.64	100 U	NA	280	0.56	250	0.50	99 U	NA	84 U	NA	100 U	NA	96 U	NA
Acenaphthylene	µg/kg	1,300	100 U	NA	100 U	NA	170	0.13	130	0.10	99 U	NA	84 U	NA	100 U	NA	96 U	NA
Anthracene	µg/kg	960	**1,700**	1.77	250	0.26	720	0.75	640	0.67	140	0.15	84 U	NA	100 U	NA	96 U	NA
Fluorene	µg/kg	540	**1,100**	2.04	140	0.26	350	0.65	320	0.59	99 U	NA	84 U	NA	100 U	NA	96 U	NA
Naphthalene	µg/kg	2,100	360	0.17	330	0.16	790	0.38	740	0.35	130	0.06	84 U	NA	100 U	NA	96 U	NA
Phenanthrene	µg/kg	1,500	**7,800**	5.20	640	0.43	**1,800**	1.20	1,500	1.00	480	0.32	84 U	NA	100 U	NA	96 U	NA
Total LPAH	µg/kg	5,200	**12,000**	2.31	1,800	0.35	4,500	0.87	3,900	0.75	950	0.18	290 U	NA	350 U	NA	340 U	NA
Benzo(a)anthracene	µg/kg	1,600	**2700**	1.69	780	0.49	**1700**	1.06	**1700**	1.06	390	0.24	84 U	NA	100 U	NA	96 U	NA
Benzo(a)pyrene	µg/kg	1,600	1,500	0.94	540	0.34	1,400	0.88	1,300	0.81	340	0.21	84 U	NA	100 U	NA	96 U	NA
Benzofluoranthenes (total)	µg/kg	3,600	3,400	0.94	1,300	0.36	3,200	0.89	3,400	0.94	650	0.18	100	0.03	140		180	0.05
Benzo(g,h,i)perylene	µg/kg	720	**870**	1.21	340	0.47	**820**	1.14	640	0.89	170	0.24	84 U	NA	100 U	NA	96 U	NA
Chrysene	µg/kg	2,800	2,700	0.96	1,100	0.39	2,400	0.86	2,100	0.75	520	0.19	84 U	NA	100 U	NA	130	0.05
Dibenzo(a,h)anthracene	µg/kg	230	200	0.87	100	0.43	180	0.78	140	0.61	99 U	NA	84 U	NA	100 U	NA	96 U	NA
Fluoranthene	µg/kg	2,500	**3,900**	1.56	850	0.34	2,500	1.00	**2,900**	1.16	740	0.30	84 U	NA	100 U	NA	150	0.06
Indeno(1,2,3-cd)pyrene	µg/kg	690	670	0.97	260	0.38	650	0.94	520	0.75	140	0.20	84 U	NA	100 U	NA	96 U	NA
Pyrene	µg/kg	3,300	**7,600**	2.30	2,000	0.61	**6,900**	2.09	**7,100**	2.15	1,500	0.45	130	0.04	140	0.04	200	0.06
Total HPAH	µg/kg	17,000	**24,000**	1.41	7,400	0.44	**20,000**	1.18	**20,000**	1.18	4,400	0.26	524	0.03	630	0.04	900	0.05
Dimethyl phthalate	µg/kg	160	27	0.17	47	0.29	87	0.54	46	0.29	4 U	NA	1.5	0.01	1	0.01	10	0.06
Diethylphthalate	µg/kg	200	100 U	NA	100 U	NA	100 U	NA	170	0.85	99 U	NA	84 U	NA	100 U	NA	96 U	NA
Di-n-butyl phthalate	µg/kg	1,400	100 U	NA	100	0.07	100 U	NA	100 U	NA	99 U	NA	84 U	NA	100 U	NA	96 U	NA
Butyl benzyl phthalate	µg/kg	900	520	0.58	480	0.53	**1,400**	1.56	**1,400**	1.56	99 U	NA	84 U	NA	100 U	NA	170	0.19
bis(2-ethylhexyl)phthalate	µg/kg	1,300	**1,600**	1.23	**1,600**	1.23	**3,600**	2.77	**2,700**	2.08	190	0.15	84 U	NA	100 U	NA	380	0.29
Di-n-octyl phthalate	µg/kg	6,200	100 U	NA	100 U	NA	100 U	NA	100 U	NA	99 U	NA	84 U	NA	100 U	NA	96 U	NA
Phenol	µg/kg	420	100 UJ	NA	100 J	0.24	100 U	NA	100 U	NA	99 U	NA	84 U	NA	100 UJ	NA	100 U	NA
2-Methylphenol	µg/kg	63	4 UJ	NA	4 UJ	NA	4 UJ	NA	4 UJ	NA	4 UJ	NA	1 UJ	NA	1 UJ	NA	4 UJ	NA
3- & 4-Methylphenol	µg/kg	670	100 UJ	NA	100 U	NA	100 U	NA	100 U	NA	99 U	NA	84 U	NA	100 UJ	NA	96 U	NA
2,4-Dimethylphenol	µg/kg	29	4 UJ	NA	4 UJ	NA	4 UJ	NA	4 UJ	NA	4 UJ	NA	1 UJ	NA	1 UJ	NA	4 UJ	NA
Pentachlorophenol	µg/kg	360	4 UJ	NA	4 UJ	NA	4 U	NA	4 U	NA	4 U	NA	1 UJ	NA	1 UJ	NA	4 U	NA
Benzyl alcohol	µg/kg	73	**79 UJ**	NA	71 UJ	NA	4 U	NA	4 U	NA	55 U	NA	27 UJ	NA	33 UJ	NA	51 U	NA
Benzoic acid	µg/kg	650	170 UJ	NA	190 UJ	NA	80 UJ	NA	80 UJ	NA	170 UJ	NA	51 UJ	NA	51 UJ	NA	150 UJ	NA
1,2-Dichlorobenzene	µg/kg	50	**91**	1.82	**85**	1.70	7.6	0.15	6.4	0.13	4 U	NA	1 U	NA	1 U	NA	4 U	NA
1,3-Dichlorobenzene	µg/kg	170	6	0.04	4.8	0.03	4 U	NA	4 U	NA	4 U	NA	1 U	NA	1 U	NA	4 U	NA
1,4-Dichlorobenzene	µg/kg	110	63	0.57	44	0.40	28	0.25	28	0.25	4 U	NA	1.3	0.01	1.1	0.01	4 U	NA
1,2,4-Trichlorobenzene	µg/kg	51	6.8	0.13	4.8	0.09	4 U	NA	4 U	NA	4 U	NA	1 U	NA	1 U	NA	4 U	NA
Hexachlorobenzene	µg/kg	22	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	1 U	NA	1 U	NA	4 U	NA
Dibenzofuran	µg/kg	540	270	0.50	100 U	NA	240	0.44	240	0.44	99 U	NA	84 U	NA	100 U	NA	96 U	NA
Hexachlorobutadiene	µg/kg	11	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	1 U	NA	1 U	NA	4 U	NA
N-Nitrosodiphenylamine	µg/kg	28	4 U	NA	4 U	NA	4 U	NA	4 U	NA	14	0.50	3.1	0.11	3.3	0.12	6.8	0.24

Table 3
Summary of Supplemental Baseline Natural Recovery Area Sample Results

	Station		NR-20				NR-25				SR-10		SR-11				SR-13	
	Sample ID		NR-20-Y0-D		NR-20-Y0-D1		NR-25-Y0-D		NR-25-Y0-D1		SR-10-Y0-D		SR-11-Y0-D		SR-11-Y0-D4		SR-13-Y0-D	
	Sample Date		10/23/2006	Enrichment	10/23/2006	Enrichment	10/24/2006	Enrichment	10/24/2006	Enrichment	10/25/2006	Enrichment	10/25/2006	Enrichment	10/25/2006	Enrichment	10/25/2006	Enrichment
	Sample Depth		0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio	0 to 10 cm	Ratio
Parameter	**Units**	**SQO**																
Pesticides																		
4,4'-DDD	µg/kg	16	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	1 U	NA	1 U	NA	4 U	NA
4,4'-DDE	µg/kg	9	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	1 U	NA	1 U	NA	4 U	NA
4,4'-DDT	µg/kg	34	4 U	NA	4 U	NA	4 U	NA	4 U	NA	4 U	NA	1 U	NA	1 U	NA	4 U	NA
PCBs																		
PCB-1016	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1221	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1232	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1242	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1248	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1254	µg/kg	NA	350 J	NA	490 J	NA	270 J	NA	290 J	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCB-1260	µg/kg	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA	20 U	NA
PCBs (total)	µg/kg	300	**350** J	1.17	**490** J	1.63	270 J	0.90	290 J	0.97	20 U	NA	20 U	NA	20 U	NA	20 U	NA

Notes:

Concentrations highlighted in **red** exceed the SQO.

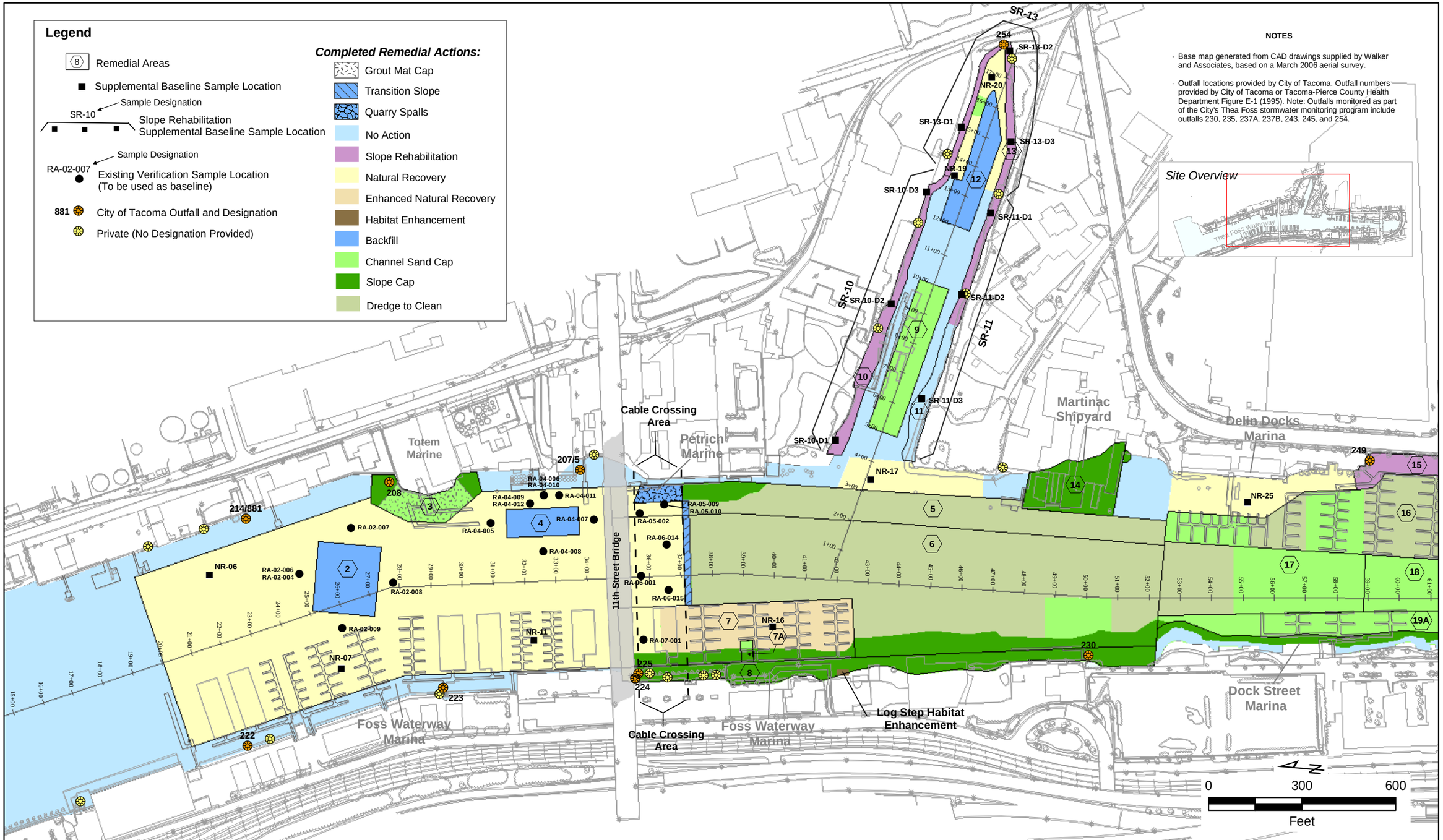
NA: Not applicable

Qualifiers:

U - Undetected

J - The analyte was analyzed for and positively identifiec

UJ - The analyte was analyzed for and not detected but



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Thea Foss and Wheeler-Osgood Waterways
OMMP

Figure 1
Baseline Natural Recovery Sample Locations

DATE: 1/25/2007 2:47:28 PM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\Natural Recovery Baseline\Figure 1-Baseline Natural Recovery Locations 012307.mxd

Attachment A

Sample Collection Forms and Photographs

Sample Collection Forms

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/23/06

Weather: overcast, foggy, no breeze

Field Personnel: Iain Wingard (See below)

10:15 Boat is at Fire boat dock.
Crew is comprised of Mike Rhubright, Bill Essemeyer, Tom Chontofalsky, and Iain Wingard
Bill and Tom have performed QA benchmark coordinates reading for GPS unit (Trimble GeoXH 2005 Series PN: 60950-00), Coordinates read at Benchmark 214 and measure coordinates were N 704660.95 E 1161060.91
Preparing equipment for sampling including decon of Samplers

10:50 Depart Fire Station Dock
11:00 Deploy marker bouy for NR-06
11:31 Collect sample at NR06 - See sample sheet
11:52 Relocate to NR07
Tie off at dock
12:05 Collect Sample at NR07 - See sample sheet
12:29 Relocate to NR11
12:42 Collected sample at NR11
13:00 Relocate to NR16
13:20 Collected sample at NR-16 - See sample sheet.
13:39 Relocate to NR17
13:50 Collected sample at NR-17 - See Sample sheet
14:14 Relocation to NR-20
14:30 Collected sample at NR20 - See Sample sheet
14:40 Relocate to NR-19
14:55 Collect Sample for NR-19 - See Sample Sheet
15:15 Arrive at Fire Station Dock

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/23/06

Weather: overcast/Foggy/No Wind/Approx 45°F

Field Personnel: Jain Winogard

Sample Type

- [x] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5. Benthic Recolonization

Sample Designation: NR-06-YØ-D

Sample Method (Van Veen Surface Grab/Slope Composite): VanVeen

Datum (Horizontal/Vertical): NAD 83 Wa State Plane S./MLLW

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept 39 ft (A) 11:00 (38ft 11:41)

Predicted Tide Elevation 6.46ft (B) 11:30

Mudline Elevation −32.6ft ~~(B-A)~~ C−A= 5.9'−38.5'≠X

Actual Tide Elevation 5.9 ft (C) 11:30 (MLLW)

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
Grab #1	11:10	707573.70	1160202.5	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	N	overfilled
Grab #2	11:22	"	"						N	overfilled
Grab #3	11:31	707592.43	1160193.89	X	X	X	X	X	Y	17cm recovery

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity; 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs - *see field ref cards):
Soft, wet, olive, silt, no odor, some shells

Sample containers filled (number and type):
1-16 oz / 1-8 oz sample jars

Laboratory analysis:
Total organic carbon, total solids, metals, Semi-Volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

~~Thick Slope Cap Composite Sampling~~ Notes:

~~Predicted tide elevation~~:

Remediation area:

~~Number of composite points~~:

1-2 cm redox layer - light olive layer on top with underlying dark grey sediment below

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/23/06

Weather: overcast, No wind, appro 50°F

Field Personnel: Jain Wingard

Sample Type

- [X] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5. Benthic Recolonization

Sample Designation: NK-07-Y0-D

Sample Method (Van Veen Surface Grab/Slope Composite): Van Veen

Datum (Horizontal/Vertical):

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? [ ] Yes [ ] No

Leadline Water Dept 37 ft (A) 12:03 (35' 12:14)
Predicted Tide Elevation 6.15 ft (B) 12:06
Mudline Elevation ~30.4 ft ~~(B-A)~~ (C-A) = 5.6' - 36' X
Actual Tide Elevation 5.6 ft MLLW(C) 12:06

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
Grab #1	12:05	707127.5	1159941.1	X	X	X	X	X	Y	17 cm Recovery

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity; 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs - *see field ref cards):
Soft, wet, olive, silt, No odor, some tubes (biota/worms)

Sample containers filled (number and type):
1-500 mL / 1-250 mL Jars

Laboratory analysis:
Total organic carbon, total solids, metals, semi-volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

~~Thick Slope Cap Composite Sampling~~

~~Predicted tide elevation:~~

~~Remediation area:~~

~~Number of composite points:~~

Notes:
1cm redox layer - light olive layer on top dark gray sediment below

Tied stern of boat to North facing finger float

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/23/06

Weather: Clouds and Sun, slight breeze from north, approx 50°F

Field Personnel: Ian - Wingard

Sample Type

- [x] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5 Benthic Recolonization

Sample Designation: NR-11-Y0-D

Sample Method (Van Veen Surface Grab/Slope Composite): Vanveen

Datum (Horizontal/Vertical): NAD 83, WA state plane S. / MLLW

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept 36 ft (A) 12:30 (36' 12:52)

Predicted Tide Elevation 6.15 (B) 12:42

Mudline Elevation -30.4ft ~~(B-A)~~ C-A = 5.6' - 36' = X

Actual Tide Elevation 5.6 ft MLLW(C) 12:42

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (include depth of sample)
Grab #1	12:33		SW	X	X	X	X	X	N	Overpenetrated
Grab #2	12:42	706525.166	1160083.49	X	X	X	X	X	Y	17cm recovery

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity; 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs - *see field ref cards):

Soft, wet, olive, silt, No odor, Several Worms.

Sample containers filled (number and type):

1-500 mL / 1-250 mL Jars

Laboratory analysis:

Total organic carbon, total solids, metals, semi-volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

~~Thick Slope Cap Composite Sampling~~

~~Predicted tide elevation:~~

~~Remediation area:~~

~~Number of composite points~~

Notes:

Approx 1cm redox layer - light olive silt on surface - dark grey silt below

Tied off stern to south facing finger float

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/23/06

Weather: clouds and sun, slight wind from north

Field Personnel: Iain Wingard

Sample Type

- [x] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5. Benthic Recolonization

Sample Designation: NR-16-10-D

Sample Method (Van Veen Surface Grab/Slope Composite): Grab

Datum (Horizontal/Vertical): NAD 83, State Plane S / MLLW

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept 30 ft (A) 13:10 (27' 1328)

Predicted Tide Elevation 6.45 ft (B) 13:18

Mudline Elevation -22.7 ft ~~(B-A)~~ C-A = 5.8' - 28.5' = X

Actual Tide Elevation 5.8 ft MLLW(C)

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
Grab #1	13:15	205762.25	1160188.97						N	Inadequate recovery
Grab #2	13:20	"	"	X	X	X	X	X	Y	12 cm recovery

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity; 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs - *see field ref cards):
Loose, wet, olive, Sand and gravel with silt, No odor

Sample containers filled (number and type):
1-500 ml / 1-250 ml Jars

Laboratory analysis:
Total organic carbon, total solids, metals, semi-volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

~~Thick Slope Cap Composite Sampling~~ Notes:

~~Predicted tide elevation~~: 1 cm silt over sand cap material.

~~Remediation area~~: 1/2 cm redox layer - light olive silt over dark gray silt over cap material

~~Number of composite points~~:

Tied up to end of north facing finger float (i.e., Tied stern of boat to north facing finger float)

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/23/06

Weather: Clouds and Sun, slight NW breeze, approx 55°F

Field Personnel: Iain Wingard

Sample Type

- [x] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5. Benthic Recolonization

Sample Designation: NR-17-Y0-D

Sample Method (Van Veen Surface Grab/Slope Composite): Van veen

Datum (Horizontal/Vertical): NAD 83 Wa State plane S./MLLW

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? [ ] Yes [ ] No

Leadline Water Dept 16.5 ft (A) 13:46 (13' 14:00)

Predicted Tide Elevation 6.9 ft (B)

Mudline Elevation -8.2 ft ~~(B-A)~~ C-A = 6.3' - 14.5' = x

Actual Tide Elevation 6.3 ft MLLW(C)

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
Grab #1	1350	705487.77	1160695.28	X	X	X	X	X	Y	13cm recovery

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity; 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs - *see field ref cards):

Medium dense, wet, olive to dark grey, fine to medium sand, H_2S odor (slight), 1-2% wood fibers, sheen spots, some worms

Sample containers filled (number and type):

1-500 mL / 1-250 mL Jars

Laboratory analysis:

Total organic carbon, total solids, metals, semi-volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

~~Thick Slope Cap Composite Sampling~~:

~~Predicted tide elevation~~:

~~Remediation area~~:

~~Number of composite points~~:

Notes

Dark grey sand with wood fibers, < 1/2 cm redox layer - light olive on surface, dark olive to dark grey sand below.

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/23/06

Weather: overcast, slight breeze from NW, approx 55° F

Field Personnel: Jean Wingard

Sample Type

- [x] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5. Benthic Recolonization

Sample Designation: NR-19-42-D

Sample Method (Van Veen Surface Grab/Slope Composite): Vanveen

Datum (Horizontal/Vertical): NAD 83 WA State plane S / MLLW

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept 7.5ft (A) 14:50 (8.0 14:55)

Predicted Tide Elevation 8.3 ft (B)

Mudline Elevation 0.0 ft ~~(B-A)~~ CA= 7.7'-7.75'=X

Actual Tide Elevation 7.7ft MLLW(C)

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
Grab#1	14:50								N	wedin jaws
Grab#2	14:55	705297.11	1161689.20	X	X	X	X	X	Y	12 cm recovery

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity; 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs - *see field ref cards):
Soft, wet, olive, sandy silt, no odor, abundant shells, mussels, barnacles, and some worms

Sample containers filled (number and type).
1-500 ml / 1-250 ml Jars

Laboratory analysis:
Total organic carbon, total solids, metals, semi-volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

~~Thick Slope Cap Composite Sampling~~

~~Predicted tide elevation:~~

~~Remediation area:~~

~~Number of composite points:~~

Notes:
Thin (½ cm) Redox layer, lighter olive on surface, dark olive below

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/23/06

Weather: Sunny with clouds, breeze out of NW, approx 55°F

Field Personnel: Jan Wingard

Sample Type

- [x] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5. Benthic Recolonization

Sample Designation: NR-20-YØ-D

Sample Method (Van Veen Surface Grab/Slope Composite): Vanveen

Datum (Horizontal/Vertical): NAD83, wa stateplane S. / MLLW

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept 7.0 ft (A) 14:20 (7.5 ft 14:30)

Predicted Tide Elevation 7.75 ft (B) 14:30

Mudline Elevation 0.0 ft ~~(B-A)~~ GA = 7.2' - 7.25' = x

Actual Tide Elevation 7.2 ft MLLW(-)

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
Grab #1	14:20								N	Plastic in Jars
Grab #2	14:25								N	insufficient recovery
Grab #3	1430	705222.3	1162204	X	X	X	X	X	Y	14 cm recovery

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity, 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs - *see field ref cards):
Soft, wet, dark olive/dark grey, Sandy silt, no odor abundant shells, mussels, worms, barnacles and some wood pieces (Note: Slight creosote odor in sample bowl)

Sample containers filled (number and type): 1-500 ml / 1-250 ml Jars - Sample duplicate NR-20-YØ-D1 was collected at this station.

Laboratory analysis: Total organic carbon, total solids, metals, semi-volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

~~Thick Slope Gap Composite Sampling~~

~~Predicted tide elevation~~: Thin redox layer of lighter olive sediment

~~Remediation area~~: Dark grey sediment beneath redox layer

~~Number of composite points~~:

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/24/06

Weather: overcast, wind approx 10 mph from South, Temp approx 45° F

Field Personnel:

8:40 Arrive at Fire Station boat dock/float
... Sampling crew is Bill Essemeyer, Mike Rhubright
... Tom Chontofalsky and Iain Wingerd
... Preparing for sampling.
8:53 Depart Dock/Enroute to NR25
9:07 Collect Sample from NR-25 see sample sheet
9:28 Arrive at Fire boat dock
Bill took readings at Benchmark 214 prior to sampling. The benchmark coordinates were 704667.46 N 1161058.26 E. The GPS unit that was used was the same as used on 10/23/06.

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/24/06

Weather: overcast, wind approx 10 mph from South, temp approx 45°F

Field Personnel: Jain Winegard

Sample Type

- [x] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5. Benthic Recolonization

Sample Designation: NR-25-YØ-D

Sample Method (Van Veen Surface Grab/Slope Composite): Van Veen

Datum (Horizontal/Vertical): NAD 83 Wa State Plane S / MLLW

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? [ ] Yes [ ] No

Leadline Water Dept 12 ft (A) 9:07 (12.0 9:14)
Predicted Tide Elevation 10.6 ft (B) 9:06
Mudline Elevation -1.3 ft ~~(B-A)~~ C-A = 10.7-12 = X
Actual Tide Elevation 10.7 ft MLLW(C)

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
Grab# 1	9:07	704294.03	1160724.17	X	X	X	X	X	Y	15 cm recovery

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity; 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs - *see field ref cards):
Soft, wet, olive gray/dark gray silt with abundant wood pieces and fibers, shells, H_2S odor slight, one fish

Sample containers filled (number and type):
1-500 ml / 1-250 ml Jars - A duplicate sample NR-25-YØ-01 was collected at this station

Laboratory analysis:
Total organic carbon, total solids, metals, semi-volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

~~Thick Slope Cap Composite Sampling~~

~~Predicted tide elevation:~~

~~Remediation area:~~

~~Number of composite points:~~

Notes:
Olive gray/dark gray silt with abundant wood,

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/25/06

Weather: overcast, no wind, approx 50°F

Field Personnel: Iain Winegard

20:00 Arrive onsite with Joe Marsh, Corps (IW and Joe Marsh)

20:15 Bill Essemeyer and Tom Chartofsky City arrive. Have performed QC for GPS, at 214 benchmark. The GPS is estimated to be 16 ft off of benchmark coordinates, Bill/Tom to check 2nd benchmark and depart

20:31 Bill/Tom return with GPS benchmarks readings which are the following

214 N 704653.90 E 1161063.38

215 N 703685.90 E 1160984.77

216 N 703210.59 E 1161011.98

The GPS that was used was the Trimble that was used for the vanveen sampling from the boat (i.e. 10/23 & 10/24/2006)

Initiate collection of SR samples from RA-10, RA-11, and RA-13. See sample collection forms for sample information.

23:15 Sample collection completed, Bill Essmeyer takes samples to City lab (Tom accompanies Bill) and departs site. Joe and I depart site.

23:25 Arrive at City office beneath 11th Street bridge. Provide Joe with sample location figure and table. Joe departs office.

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/25/06

Weather: Overcast, slight breeze

Field Personnel: Iain Wingard

Sample Type

- [x] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5. Benthic Recolonization

Sample Designation: SR-10-YØ-D

Sample Method (Van Veen Surface Grab/Slope Composite): Grab/Slope Composite

Datum (Horizontal/Vertical): NAD 83 WA State Plane S.

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? [ ] Yes [ ] No

Leadline Water Dept _____ (A)

Predicted Tide Elevation _____ (B)

Mudline Elevation _____ (B-A)

Actual Tide Elevation _____

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
SR-10-D3	2110	705404.41	1161610.57						Y	10 cm
SR-10-D2	2242	705485.75	1161244.96						Y	10 cm
SR-10-D1	2253	705626.27	1160794.67						Y	10 cm

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity; 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs - *see field ref cards): D3- Stiff, moist, Olive, Sand and gravel, few wood pieces & shells
D2- Medium, moist, olive Sand with gravel, Shell fragments orange mottling,
D1- Stiff, moist, Olive, sand and gravel

Sample containers filled (number and type): 1- 500 ml / 1 250 ml. Jars Note: Sample approx. 50% gravel

Laboratory analysis:
Total organic carbon, total solids, metals, Semi-volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

Thick Slope Cap Composite Sampling

Predicted tide elevation: _____

Remediation area: SR-10/RA-10

Number of composite points: Three

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/25/06

Weather: overcast, slight breeze, approx 50°F

Field Personnel: Jain Wingard

Sample Type

- [x] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5. Benthic Recolonization

Sample Designation: SR-11-Y0-D

Sample Method (Van Veen Surface Grab/Slope Composite): Grab/slope Composite

Datum (Horizontal/Vertical):

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? [ ] Yes [ ] No

Leadline Water Dept _____ (A)
Predicted Tide Elevation _____ (B)
Mudline Elevation _____ (B-A)
Actual Tide Elevation _____

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
SR-11-D1	2142	705194.20	1161561.78						Y	10 cm
SR-11-D2	2150	705262.88	1161294.91						Y	10 cm
SR-11-D3	2200	705362.64	1160951.93						Y	10 cm

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity; 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs - *see field ref cards): D1- medium, moist, olive, sand with silt and gravel, shell fragments
D2- Soft, wet, olive, sand with some gravel, shell fragments
D3- Soft, wet, olive, sand with shell fragments

Sample containers filled (number and type):
1-500 ml / 1-250 ml Jars - Collected duplicate sample SR-11-Y0-D4

Laboratory analysis:
Total organic carbon, total solids, metals, semi-volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

Thick Slope Cap Composite Sampling

Predicted tide elevation:

Remediation area: SR-11 / RA-11

Number of composite points: Three

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Thea Foss and Wheeler-Osgood Waterways OMMP

Date: 10/25/06

Weather: overcast, slight breeze, approx. 50°F

Field Personnel: Iain Wingard

Sample Type

- [x] 1. Performance Surface (0-10 cm)
- [ ] 2. Early Warning Recontamination (0-2 cm)
- [ ] 3. Performance Subsurface
- [ ] 4. Bioassay
- [ ] 5. Benthic Recolonization

Sample Designation: SR-13-VØ-D

Sample Method (Van Veen Surface Grab/Slope Composite): Grab/Slope Composite

Datum (Horizontal/Vertical): NAD 83 Wa. state plane S./MLLW

Sample Types 1, 2, 3, 4, 5
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept _____ (A)

Predicted Tide Elevation _____ (B)

Mudline Elevation _____ (B-A)

Actual Tide Elevation _____

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
SR-13-D2	20:50	705178.72	1162083.67						Y	10 cm Sample
SR-13-D1	21:05	705312.25	1161828.79						Y	10 cm Sample
SR-13-D3	21:35	705149.37	1161794.51						Y	10 cm Sample

Acceptance criteria: 1 Overlying water is present; 2 Water has low turbidity; 3 Sampler is not over filled; 4 Sample surface is flat; or 5 Desired sample depth is reached.

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other obs, *see field ref cards): D2 - medium, wet, olive & dark gray, sand, some wood pieces, leaves, shells H2S odor
D1 - medium, wet, brown sand and gravel (Habitat mix)
D3 - medium, moist, brown sand and gravel (Habitat mix)

Sample containers filled (number and type): 1-500 mL / 1-250 mL Jars

Laboratory analysis:
Total organic carbon, total solids, metals, semi-volatile organic compounds, pesticides, and PCBs in accordance with the Final OMMP Table B-1-2.

Thick Slope Cap Composite Sampling

Predicted tide elevation:

Remediation area: RA-B / SR-13

Number of composite points: Three

Photographs

Channel and Harbor Area
Sample Photographs

IMG_0284 2006-10-23 11-33-31

IMG_0285 2006-10-23 11-39-43

IMG_0286 2006-10-23 12-07-26

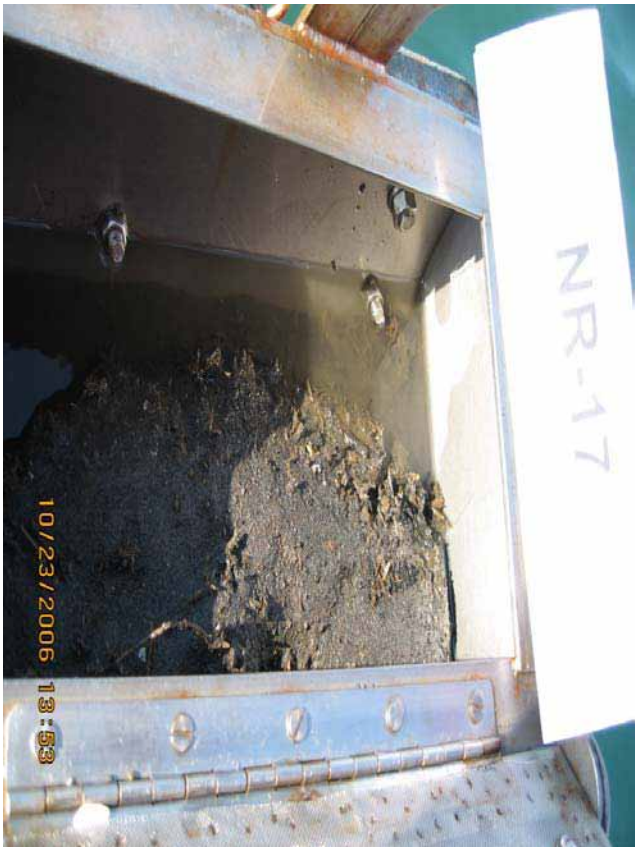
IMG_0288 2006-10-23 12-13-22

IMG_0289 2006-10-23 12-48-36

IMG_0291 2006-10-23 12-52-30

IMG_0293 2006-10-23 13-24-13

IMG_0294 2006-10-23 13-27-56



IMG_0297 2006-10-23 13-53-05

IMG_0298 2006-10-23 13-59-32

IMG_0304 2006-10-23 14-59-14

IMG_0305 2006-10-23 15-04-49

IMG_0299 2006-10-23 14-31-23

IMG_0301 2006-10-23 14-41-29

IMG_0306 2006-10-24 09-12-25

IMG_0308 2006-10-24 09-20-06

Wheeler-Osgood Waterway Shoreline
Sample Location Photographs

IMG_0279 2006-10-19 13-29-45 SR-10-Y0-D1-C

IMG_0280 2006-10-19 13-30-08 SR-10-Y0-D1-C

IMG_0264 2006-10-18 11-29-38 SR-10-Y0-D2-C

IMG_0265 2006-10-18 11-30-12 SR-10-Y0-D2-C

IMG_0274 2006-10-18 17-04-03 SR-10-Y0-D3-C

IMG_0276 2006-10-18 17-05-03 SR-10-Y0-D3-C

IMG_0270 2006-10-18 12-36-40 SR-11-Y0-D1-C

IMG_0271 2006-10-18 12-37-20 SR-11-Y0-D1-C

IMG_0268 2006-10-18 12-07-57 SR-11-Y0-D2-C

IMG_0269 2006-10-18 12-08-13 SR-11-Y0-D2-C

IMG_0266 2006-10-18 11-45-52 SR-11-Y0-D3-C

IMG_0267 2006-10-18 11-46-21 SR-11-Y0-D3-C

IMG_0277 2006-10-19 13-05-59 SR-13-Y0-D1-C

IMG_0278 2006-10-19 13-06-21 SR-13-Y0-D1-C

IMG_0272 2006-10-18 12-59-57 SR-13-Y0-D2-C

IMG_0273 2006-10-18 13-00-28 SR-13-Y0-D2-C

IMG_0281 2006-10-19 14-40-54 SR-13-Y0-D3-C

IMG_0282 2006-10-19 14-41-41 SR-13-Y0-D3-C

Wheeler-Osgood Waterway Shoreline
Sample Photographs

Wheeler-Osgood 25 Oct 06 026 2006-10-25 22-49-46 SR-10-D1

Wheeler-Osgood 25 Oct 06 024 2006-10-25 22-37-31 SR-10-D2

Wheeler-Osgood 25 Oct 06 008 2006-10-25 21-03-59 SR-10-D3

IMG_0317 2006-10-25 23-19-02 Composite Sample SR-10-Y0-D

Wheeler-Osgood 25 Oct 06 011 2006-10-25 21-36-32 SR-11-D1

Wheeler-Osgood 25 Oct 06 014 2006-10-25 21-44-30 SR-11-D2

Wheeler-Osgood 25 Oct 06 017 2006-10-25 21-56-59 SR-11-D3

IMG_0312 2006-10-25 22-18-55 Composite Sample SR-11-Y0-D

Wheeler-Osgood 25 Oct 06 006 2006-10-25 20-58-28 SR-13-D1

Wheeler-Osgood 25 Oct 06 003 2006-10-25 20-45-18 SR-13-D2

Wheeler-Osgood 25 Oct 06 010 2006-10-25 21-29-35 SR-13-D3

IMG_0314 2006-10-25 22-28-52 Composite Sample SR-13-Y0-D

Attachment B

Laboratory Analytical and Data Validation Reports

(On Enclosed CD)

Appendix C

Benthic Recolonization Monitoring

This task was not performed during this Baseline Monitoring Event. However, for consistency in reporting, the structure of the Baseline OMMP Report, and subsequent annual reports will follow the outline of the OMMP. This will provide consistent presentation and placement of information generated during the monitoring of remedial actions performed as part of the Thea Foss and Wheeler-Osgood Waterways Remediation Project. Benthic recolonization data will be included in Annual OMMP Reports for Monitoring Years 2, 4, 7, and 10.

Appendix D

Confined Disposal Facility Monitoring

Attachment D-1

Post-Construction Hydrogeologic Conditions Report

(on enclosed CD)

THEA FOSS AND WHEELER-OSGOOD WATERWAYS
REMEDIATION PROJECT

POST-CONSTRUCTION HYDROGEOLOGIC CONDITIONS REPORT

NOVEMBER 22, 2006

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY

Prepared by:

CITY OF TACOMA
FLOYD|SNIDER

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Appendices

Appendix A	Boring / Monitoring Well Logs and Photographs
Appendix B	Slug Test Data, Methodology, and Results
Appendix C	Tidal Study Test Data, Methodology, and Results

1.0 Introduction

This report was prepared to document the post-construction hydrogeologic conditions in and adjacent to the St. Paul Waterway Confined Disposal Facility (CDF) located in Commencement Bay, Tacoma, Washington (Figure 1). The St. Paul CDF was constructed to dispose of and confine contaminated dredged sediment from the Thea Foss and Wheeler-Osgood Waterways Remediation Project. Construction of the CDF was completed in 2006.

Contaminated sediment contained within the CDF are separated from direct contact with surface water by a containment berm across the St. Paul Waterway on the north, the St. Paul/Middle Waterway Peninsula on the west, the Simpson Tacoma Kraft property to the east, and the landmass comprising the Simpson log storage property to the south (Figure 2). Commencement Bay, the outer St. Paul Waterway, Middle Waterway, and the Puyallup River are surface waters located in proximity to the CDF. Monitoring of the CDF is being performed as part of the EPA-approved Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways (City of Tacoma 2006).

The objective of the CDF monitoring program is to protect water quality in adjacent surface water bodies from migration of contaminants from the confined dredged material. The primary, potential mechanism for contaminant transport is groundwater flow through the CDF and into the adjacent water bodies. The monitoring program is designed to evaluate groundwater flow and quality in and around the CDF to ensure compliance with the performance criteria.

The overall components of the St. Paul CDF monitoring program as outlined in the OMMP are the following:

- Installation of 15 monitoring wells in and adjacent to the CDF (i.e., MW-01 through MW-15) (Figure 2);
- Conducting a 72-hour tidal study and slug tests to evaluate the post-construction groundwater gradients and flow conditions in the area of the CDF;
- Documentation of the hydrogeologic conditions in the Post-Construction Hydrogeologic Conditions Report to be submitted to EPA;
- Selection of monitoring wells to be used for baseline groundwater quality monitoring;
- Performance of quarterly groundwater and surface water monitoring for two years to identify baseline conditions;
- Documentation of the baseline conditions in a report to be submitted to EPA;
- Identifying the performance monitoring program for the CDF;
- Monitoring groundwater quality over time in accordance with the performance monitoring program; and
- Performing visual observations of the berms and CDF cap.

Evaluation of the post-construction hydrogeologic conditions and preparation of this report are initial components of the CDF monitoring program. This Post-Construction Hydrogeologic Conditions Report presents the following:

- Summary of field activities including installation of 15 new monitoring wells, slug testing, and a 72-hour tidal study;
- Geologic information from the 15 new borings completed as monitoring wells in and around the St. Paul CDF;
- The hydraulic conductivity values resulting from slug testing performed on the monitoring wells; and
- Groundwater gradients and flow information resulting from a 72-hour tidal study.

The Post-Construction Hydrogeologic Conditions Report for St. Paul CDF has been prepared in accordance with the requirements specified in the EPA-approved OMMP for the Thea Foss and Wheeler-Osgood Waterways Remediation Project.

2.0 Field Activities

Multiple field activities were performed between August 28, 2006 and October 6, 2006, to evaluate the post-construction hydrogeological conditions at the St. Paul CDF. Field activities that were completed include the following:

- Advancement and logging of 15 soil borings;
- Installation of 15 monitoring wells in the completed borings;
- Monitoring well development;
- Monitoring well slug testing; and
- Performance of a 72-hour tidal study.

The following sections describe each of the field activities that have been performed.

2.1 BORINGS AND WELL INSTALLATION

2.1.1 Borehole Completion

Fifteen borings were advanced in and around the St. Paul CDF between August 28, 2006 and September 6, 2006 (Figure 2). Soil boring was performed by Boart Longyear's Holt Drilling Division (Puyallup, WA) under the oversight of Floyd|Snider. A Foremost-Mobile Model B-59 drill rig equipped with a 4-inch inner diameter hollow stem auger was used to advance the borings to depths ranging from 19 to 91 feet below ground surface. Each boring that was advanced was also completed as a monitoring well. Table 1 provides a summary of boring locations and depths. A log of each boring that documents field observations and soil characteristics during boring advancement was prepared and is included in Appendix A.

Samples were collected from each boring over discrete sample intervals by driving a 1.5-foot long by 2-inch diameter stainless steel split spoon sampler with a 140-lb auto-hammer in accordance with the split spoon sampling techniques described in ASTM D1586-98. Split-spoon samples were collected at 5-foot depth intervals by a Floyd|Snider field representative for the purpose of logging site soil characteristics and to facilitate monitoring well screen placement. The samples were characterized in accordance with the Unified Soil Classification System (USCS) and the soil classification was recorded on the boring logs. Sample material was placed into 16-ounce, pre-cleaned glass jars and retained for possible additional evaluation of soil characteristics during well installation. Each jar was labeled with a unique sample number, the boring location, the depth interval over which the sample was collected, time of collection, and date.

Drilling equipment was decontaminated prior to drilling at each boring location. All auger flight sections were steam-cleaned and the decontamination water generated from steam-cleaning was collected into 55-gallon drums. Soil cuttings generated from the borings were placed into 55-gallon drums segregated by borehole that were sealed, labeled, and stored on-site pending disposal.

2.1.2 Monitoring Well Construction

Each boring location was completed as a monitoring well. A total of 15 monitoring wells (MW-01 through MW-15) were installed from August 28, 2006 through September 6, 2006 (Figure 2). The monitoring wells were installed in accordance with Appendix D, Confined Disposal Facility Monitoring Operations Manual, of the OMMP and Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC). Table 1 includes a summary of well construction at each location. A well completion log documenting the details of well construction was prepared for each monitoring well location and is included in Appendix A.

Eight of the monitoring wells were completed at shallow depths (MW-01 through MW-04, MW-06, MW-09, MW-10, and MW-13). The shallow wells are located and screened to evaluate hydrogeologic conditions in near-surface soil, fill, and material used to construct the containment and offset berms and to allow characterization and monitoring of the quality of groundwater that is most likely to be impacted by the saltwater washout effect (i.e., where the lowest saline groundwater and stormwater infiltration come in contact with and flow over the surface of contaminated sediment placed in the CDF). The shallow-depth wells were constructed with 10-foot long well screens, set to target an elevation interval from approximately +10 feet Mean Lower Low Water (MLLW) to 0 feet MLLW (Table 1). In accordance with the OMMP, minor adjustments to the well screen placement elevation were made for several shallow wells based on soil characteristics observed during logging of the boreholes (Appendix A). Screen placement was field-adjusted from the target screen interval to span more conducive, water-bearing soils when less conducive soil was identified at the target interval during borehole logging. Shallow well screen interval placements were adjusted up to approximately 2.4 feet deeper than the target well screen elevation for Monitoring Wells MW-02, MW-04, and MW-10.

Three of the wells were completed at intermediate depths (MW-07, MW-11, and MW-14). The intermediate-depth wells were constructed with 10-foot long well screens, set to target an elevation interval of approximately 0 feet MLLW to elevation -10 feet MLLW (Table 1). The intermediate wells are located and screened to evaluate hydrogeologic conditions and allow characterization and monitoring of the quality of groundwater at an intermediate depth. Minor adjustments to the well screen placement elevation were made for MW-07. The screen was placed 1.7 feet lower than anticipated to penetrate into sandy material having a lower content of wood fragments.

Four of the wells were completed as deep wells (MW-05, MW-08, MW-12, and MW-15). The deep wells were constructed with 20-foot long well screens and were designed to evaluate hydrogeologic conditions and allow characterization and monitoring of groundwater quality at the bottom of the CDF (i.e., approximately -60 feet MLLW). The target screen interval was -40 feet MLLW to -60 feet MLLW for Monitoring Wells MW-05, MW-08, and MW-12 (Table 1). The screen placement was field-adjusted for Monitoring Well MW-15, where the screen was placed approximately 10.7 feet deeper than the target elevation. The boring for Monitoring Well MW-15 was advanced approximately 11 feet deeper in an effort to locate more conducive, water bearing soils with a coarser matrix than was observed at the target screen interval. The soil at greater depth at the bottom of Monitoring Well MW-15 contained marginally lower amounts of silt and wood fragments at the bottom of the boring and, therefore, the screen was set at the bottom of the boring, approximately 11 feet deeper than the target elevation (Table 1).

Each monitoring well was constructed using 2-inch inside diameter, 0.020-inch (20-slot), flush-threaded, machine-slotted Schedule 40 PVC screen and 2-inch inside diameter, flush-threaded Schedule 40 PVC casing supplied in 10-foot long sections. Additionally, 2-inch inside diameter, flush-threaded Schedule 40 PVC end caps (sumps) were attached to the bottom of the screened interval of each well. The sand pack for each well was constructed using Oglebay-Norton 10-20 Colorado Silica Sand. Bentonite seals for the shallow and intermediate wells were constructed using Haliburton Baroid 3/8-inch nominal diameter bentonite chips and Haliburton Baroid Bentonite Quik-Grout was used for the deep wells. Flush-mount and stick-up well completions were secured in-place using Basalite Concrete and/or Jet-Set.

Monitoring well installation was completed using the following procedures:

- Upon completion of the boring to the final depth, 10-20 silica sand was carefully poured through the hollow, inner portion of the auger and deposited at the bottom of the borehole to form a 2 to 4-inch thick pad for the PVC well end-cap, screen, and casing assembly to rest on.
- The well end-cap, screen, and casing assembly were lowered into the borehole. Additional sections of well casing were threaded onto the top of the assembly as it was continuously lowered to greater depths within the borehole until the end cap came into contact with the sand layer placed at the bottom of the borehole.
- The uppermost end of the installed casing was either trimmed or extended to facilitate installation of either a flush-mount or stick-up well completion.
- A twist-locking J-plug was fitted into the top of each well casing and was secured with a brass lock.
- The annular space of the borehole was then backfilled with 10-20 silica sand as the auger was withdrawn from the borehole. A weighted tape was used to monitor filter pack placement and depth during installation to prevent contact between the well end-cap, screen, and casing assembly and the in-situ soils. Additionally, the sand was introduced in a protracted fashion to ensure that bridging did not occur at depth. Backfilling of the borehole with sand in this fashion continued until the sand was placed to a level approximately 3-feet above the upper end of the screened section.
- Bentonite chips (3/8-inch nominal diameter) were used to backfill the annular borehole space from the top of the sand pack to within 12 to18-inches from the ground surface for both shallow- and intermediate-depth well installations (MW-01 through MW-04, MW-06, MW-07, MW-09 through MW-11, MW-13, and MW-14). The bentonite chips were hydrated using potable water when the chips were placed above the water table. For deep well installations (MW-05, MW-08, MW-12, and MW-15) bentonite grout was tremmied into the annular borehole space from the top of the sand pack to within 5 to 10 feet below ground surface. Then bentonite chips were used to backfill the remainder of the annular space between the bentonite grout and concrete surface seal. Bentonite grout was used for the deep well installations to eliminate the possibility of bentonite chips bridging at depth in the deep wells.
- Finally, Monitoring Wells MW-01, MW-02, MW-04, MW-05, and MW-09 through MW-15 were completed with flush-mount monuments. Monitoring Wells MW-03, and MW-6

through MW-08 were completed with stick-up monuments. Photographs of each well completion are presented in Appendix A with the boring and well installation logs.

The top of casing (TOC) elevations of the 15 monitoring wells, as well as the tide gage and the surface water swale stilling well, were surveyed by the City of Tacoma to enable conversion of the water level data to MLLW.

2.2 MONITORING WELL DEVELOPMENT

Monitoring wells MW-01 through MW-15 were developed between September 12, 2006 and September 18, 2006. Development activities, including purging and surging, were performed on each monitoring well to remove water and fines from the well casing, filter pack, and surrounding formation that were the result of or affected by well installation and to establish a hydraulic connection between each well and the surrounding aquifer. The goal of well development is to allow groundwater representative of the formation to flow into the well. Table 2 summarizes monitoring well measurements and observations during well development.

The procedures used during well development included the following:

- Upon arriving at each well location, the depth to static water level and the depth to the bottom of the well or sediment present at the bottom of the well were measured using a Solinst brand water level indicator with 0.01-inch increments. The depth to the water level and total depth were recorded on the well development log;
- The volume of water within the well casing was calculated for the well by multiplying the height of the observed water column by the volume of water contained within one linear foot of the well casing (i.e., there are 0.016 gallons of water per foot for a 2-inch inside-diameter PVC well casing). The volume of water within the well casing was recorded on the well log for use in tracking well development.
- One-half inch disposable PVC tubing was then attached to the Pro Active brand submersible 12-Volt electric pump and the pump was lowered to the bottom of the well. The pump was then engaged and purge water was pumped into a 5-gallon bucket to determine and adjust the purge rate, visually examine the water and observe the fines (i.e., sediment and sand) content in the water, evaluate for the presence of an odor, and to collect field measurements of turbidity. The pump was agitated at the bottom of the well during purging to entrain and facilitate the removal of sand and sediment that had accumulated in the end cap during well installation.
- When the turbidity in well purge water began to improve the submersible pump was removed and a solid PVC surge rod was lowered into the well using disposable poly rope. The well was then surged by repeatedly raising and lowering the surge rod along the length of the screened interval to push water through the screen and into the filter pack.
- Following surging, the pump was placed back into the well and positioned at varying depths in the water column to promote lateral groundwater inflow at various elevations throughout the length of the screened interval. This procedure was performed to flush the sand pack.

- When the variation in successive turbidity readings dropped below 10 percent development was considered complete. Turbidity was measured with an HF Scientific brand turbidimeter. In cases where turbidity readings did not stabilize or satisfy the 10 percent criterion following the purging of large quantities of water from a well (i.e., MW-11), development was considered complete when the well discharge appeared to reach relatively steady-state turbidity.
- In the case of MW-11, turbidity did not stabilize or drop appreciably in the course of development activities, during which over 28 well casing volumes (85 gallons) of water were pumped from the well, as indicated by its final turbidity measurement of 720 NTU. Additionally, strong hydrogen sulfide-like and marine-like odors emanated from the well throughout development. Development was terminated when it became clear that additional purging was not improving the observed level of turbidity in the water or reducing the level of detected odor for this well. It is hoped that additional purging performed prior to sampling will reduce the turbidity in MW-11 to acceptable levels. All remaining wells declined to a reasonable level of turbidity relative to the initial turbidity level in the course of development.
- Upon completion of well development, a final depth to static water level and depth to the bottom of the well were recorded on the well development log prepared for each well.

Non-disposable equipment, including the submersible pump, surge block, and water level indicator, were decontaminated between well locations using a three-step decontamination process consisting of an Alconox solution wash, potable water rinse, and final de-ionized water rinse. New lengths of disposable poly rope and PVC tubing were used at each well location and were discarded after use.

All purge water and decontamination water generated during well development activities for MW-04 and MW-05, the two monitoring wells installed within the CDF, were collected into 55-gallon drums that were labeled to indicate date of generation, monitoring well source, and volume of contents. The wells containing purge water are stored on-site pending disposal. Purge water generated from development of the remaining wells was discharged on-site in accordance with Appendix D, Confined Disposal Facility Monitoring Operations Manual, of the OMMP.

2.3 MONITORING WELL SLUG TESTING

Following well development activities, slug tests were conducted on Monitoring Wells MW-01 through MW-15 in general accordance with ASTM D 4044-96 (ASTM 2000). Slug testing of the monitoring wells was performed on September 27, 2006 and September 28, 2006. Slug tests are performed to estimate aquifer hydraulic conductivity in the vicinity of the well.

The procedures for slug testing each well included the following:

- Upon arriving at each well location, the depth to static water level was measured using a Solinst brand depth to water level indicator with 0.01-foot increments;
- A pressure transducer was then placed at a distance below the static water level that enabled full submersion of the slug rod below the water line and provided a measurable buffer distance between the bottom of the slug rod and the top of the transducer;

- After stabilization of the groundwater level from the water column displacement caused by installation of the pressure transducer, the slug rod was submerged in the water column;
- The pressure transducer was monitored for recovery of the perturbed water level until it returned to within 95 percent of the initial head measured by the transducer prior to the introduction of the slug rod;
- Then the slug rod was quickly removed from the water column and the change in hydraulic head (i.e., groundwater level) over time was recorded by a data logger and the water level in the well was monitored to identify when the recovery was within 95 percent of the initial water level.
- Once the groundwater level recovered to within 95 percent of the initial water level, the depth to groundwater was manually measured, the test was concluded, and the pressure transducer was removed.

Replicate slug tests were performed on Monitoring Wells MW-11 and MW-15 for quality assurance / quality control (QA/QC) purposes as a check on slug test procedures and analyses.

The slug test data, data evaluation methods, hydrographs, and hydraulic conductivity results are presented in Appendix C. The results of slug testing are discussed in Section 3.2.1.

2.4 TIDAL STUDY

A 72-hour tidal study was completed to assess tidal effects on groundwater levels in the 15 monitoring wells installed in and around the CDF. The tidal study was performed on October 3, 2006 through October 6, 2006. Groundwater levels were recorded at 15-minute intervals at each well location and surface water levels were monitored and recorded at a tide gauge established in the Middle Waterway and a still well established in the surface water swale located on the eastern boundary of the CDF using a network of pressure transducers and data loggers. Figure 2 shows the locations of the transducers and data loggers placed in monitoring wells, the tide gauge, and the still well.

The procedures for performing the tidal study included the following:

- Prior to the initiation of the tidal study, 17 pressure transducers, provided by In-Situ Incorporated of Fort Collins, CO, were time-synchronized and programmed to record the height of the column of water above the pressure transducer at 15-minute intervals;
- A transducer was then placed into each monitoring well (MW-01 through MW-15) at an elevation determined to capture the anticipated range of water level fluctuations within each well;
- A tide gauge was constructed by installing a pressure transducer within an open-bottom, 1.5-inch inside-diameter PVC casing attached to a piling in the Middle Waterway (Figure 2). The transducer was installed at an elevation that captured tidal elevation data within the range of tidal elevations predicted throughout the study;
- A pressure transducer was also deployed within an open-bottom, 1.5-inch inside-diameter PVC casing that was installed within the surface water swale located on the eastern boundary of the CDF;

- Following initiation of the data loggers and deployment of the transducers, periodic depth-to-water (from the top of the casing or TOC) measurements were recorded at each transducer location using a manual water level indicator. Transducer head (i.e., height of the water column above the transducer) readings were recorded from the data logger coincident with the manual depth-to-water measurements. The manual water level measurements provided reference data for use in converting the transducer-collected relative head elevations into elevations referenced to MLLW. A series of four to five manual water level measurements were collected over the course of the tidal study for each transducer location.

At the conclusion of the tidal study on October 6, 2006, the 17 transducers were removed from the monitoring locations and all collected data were downloaded to a laptop computer.

3.0 Hydrogeologic Conditions

3.1 SOIL AND FILL MATERIALS COMPRISING THE CDF AND ADJACENT AREAS

Information on the characteristics of site soil and fill was collected from the advancement of the 15 borings that were completed as monitoring wells. As described in Section 2.1.1, samples of the soil and fill were collected at 5-foot intervals during advancement of the borings and characterized in accordance with the Unified Soil Classification System. The resulting soil classification was documented in the boring logs presented in Appendix A.

Four general soil units were identified based on the soil borings advanced in and adjacent to the CDF as shown on the generalized geologic cross-sections for the site (Figures 3 through 6).

The soil units observed consist of the following:

- Recently placed, engineered CDF offset and containment berm materials;
- Historical fill materials;
- Recently placed dredged material fill; and
- Native deltaic and shallow marine sediment.

Two of the four soil units, historical fill materials and deltaic and shallow marine sediments, were previously identified during investigations to support design of the CDF. The two remaining units, berm construction materials and dredged material fill, are more recent and were placed as part of the construction and filling of the CDF.

Monitoring Wells MW-01 and MW-09 were installed in the CDF containment berm and offset berm, respectively (Figure 3). The containment and offset berms were constructed of rip rap armoring and select fill materials. The select fill comprising the center of the berms into which boring was performed to install Monitoring Wells MW-01 and MW-09 is composed of fine to course sand and gravel. Relatively few fines (i.e., silt and clay) are present in the select fill as the construction documents specified a maximum fines content of two percent. As required by the design, minimal variation exists in the soil characteristics of the berm structures.

Historical fill materials were observed in all areas surrounding the CDF where monitoring wells were installed. The historical fill materials were observed in the borings advanced to install Monitoring Wells MW-02, MW-03, MW-06 through MW-08, and MW-10 through MW-15. Generally, historical fill material was encountered from ground surface down to approximately 10 feet deep that consisted of sandy silt, silty sand, gravel, and sand. Wood fragments intermixed with historical fill materials were encountered in the borings for Monitoring Wells MW-07, MW-12, and MW-15. Cobbles, asphalt and concrete were observed in the top three feet in the borings for Monitoring Wells MW-13 through MW-15.

Previous design investigations also identified historical fill materials in all borings surrounding the CDF. The historical fill material was identified to range from 16 to 31 feet deep and to consist predominantly of poorly graded sand with silt layers and wood at the boring locations investigated during design. Based on the current and previous investigations, the historical fill ranges from 10 to 31 feet deep in the area around the CDF.

The material dredged from the Thea Foss and Wheeler-Osgood Waterways and disposed of in the CDF was observed in the borings advanced to install Monitoring Wells MW-04 and MW-05. The dredged material placed in the CDF is comprised of silt with fine sand and fine sand with silt. Abundant to trace wood fragments and scattered shell fragments were also observed to be present in the dredged material fill.

The native soil underlying the historical fill material was observed in borings for Monitoring Wells MW-02, MW-03, MW-06 through MW-08, MW-10 through MW-12, and MW-13 through MW-15. The soil underlying the historical fill consists of deltaic and shallow marine sediment comprised of sands, silty sands, and sandy silts. The deltaic and shallow marine sediments are generally similar in composition to the historical fill. Abundant to trace wood fragments and scattered shell fragments were also observed to be present in the deltaic and shallow marine sediment. Often, the presence of sand and silt oscillated back and forth as borings for Monitoring Wells MW-08 and MW-15 were advance to greater depths.

Previous investigations had also identified the deltaic and shallow marine sediment in deeper geotechnical and sediment borings. Previous investigations identified variable layers of sand, silty sand, and sandy silt beginning at approximately 5 feet MLLW to -10 feet MLLW, and continuing to at least elevation -100 feet MLLW. The deltaic and shallow marine deposits were identified to be associated with sedimentation from the Puyallup River.

Monitoring wells installed in historical fill and deltaic and shallow marine sediment (i.e., Monitoring Wells MW-02, MW-03, MW-06 and MW-08, MW-10 and MW-12, and MW-13 and MW-15) were screened in a combination of sand, silty sand, and sandy silt. The sediment in the screened intervals of monitoring wells installed in the CDF (i.e., Monitoring Wells MW-04 and MW-05) consists of silt with fine sand. The monitoring wells installed in the containment and offset berms (Monitoring Wells MW-01 and MW-09) were screened in sand and gravel. The soil type that each well was screened in affects the hydraulic conductivity as discussed in the following section.

3.2 HYDRAULIC CONDUCTIVITY

3.2.1 Methodology for Determining Hydraulic Conductivity

The data that is collected during a slug test consists of the measurement of hydraulic head (i.e., height of the water column above the transducer) at each time interval after the slug rod is removed. The speed with which the hydraulic head changes over time is used to identify the hydraulic conductivity value for a specific well.

Two methodologies were used to estimate hydraulic conductivity values based on the results of slug tests performed on wells in and adjacent to the CDF. The methodology used to evaluate the results for a specific well was based on the response that was observed in a plot of the slug test data. The estimated hydraulic conductivity values calculated are presented in Table 3 and are shown with respect to well location in Figure 7. The slug test data and hydraulic conductivity evaluations for each well are presented in Appendix B.

Bouwer and Rice Method

The majority of the data for the wells slug tested in and adjacent to the CDF were analyzed using the Bouwer and Rice method (Bouwer and Rice 1976 and 1989). This method was used to calculate the hydraulic conductivity for all monitoring wells except MW-12 as the plots of the normalized test data for these wells were graphically an upward, concave shape. The best-fit regression line methodology specified by Bouwer and Rice is readily applicable to the slug test data observed for Monitoring Wells MW-01 through MW-11 and MW-13 through MW-15.

Application of the Bouwer and Rice method initially involves selecting data points from a plot of slug test data. Data points are selected from the early time portion of the plot following removal of the slug rod. Care is taken to select points representing the aquifer response rather than points thought to reflect drainage effects from the filter pack around the well casing. The selected data points are then used to calculate a regression line that represents a best-fit line for the data. Two normalized hydraulic head values occurring along this line, the time interval between the values, well construction parameters, and water level data are then entered into an equation to calculate the estimated hydraulic conductivity (K) around the well. This method is described further in Appendix B.

Butler and Garnett Method

A sinusoidal response (i.e., an oscillating increase and decrease in the water elevation) was observed in the slug test results for Monitoring Well MW-12. An oscillating response in the slug test data is typically observed in wells screened in formations of high hydraulic conductivity or wells with long columns of water above the top of the screen in formations of moderate or higher conductivity (Butler and Garnett 2000). The response displayed by Monitoring Well MW-12 appeared as a dampened sinusoidal fluctuation, thereby precluding the use of the straight line, best-fit methodology of the Bouwer and Rice method. The slug test data from Monitoring Well MW-12 was analyzed using the methods suitable for slug test data that indicates well screened in formations with high hydraulic conductivities described by Butler and Garnett (Butler and Garnett 2000).

The Butler and Garnett method was applied to the results of slug testing in Monitoring Well MW-12 using software available from the Kansas Geological Survey Open File Report 2000-40 (Butler and Garnett, 2000). The slug test data, beginning at the onset of the slug test, is entered into the spreadsheet provided by the software to create a normalized plot of hydraulic head versus time. A graph of a theoretical sinusoidal curve is generated by the spreadsheet and superimposed on a plot of the test data. Match points are selected between the theoretical curve and the test data curve. The spreadsheet then calculates the radial hydraulic conductivity using the match point ratio and dimensionless time parameter values and well construction parameters. This method is described further in Appendix B.

3.2.2 Hydraulic Conductivity Results

As discussed in Section 3.1, the soil in and adjacent to the CDF is comprised of recently deposited sand and gravel material used to construct the containment and offset berms, dredged material fill disposed of in the CDF, historically placed fill, and deltaic and shallow marine sediment deposits that are not laterally continuous across the site. The estimated

hydraulic conductivity values for the soil and fill within and adjacent to the CDF ranged from a minimum of $1.2x10^{-4}$ centimeters per second (cm/sec) or 0.35 feet per day (ft/day) in Monitoring Well MW-05, located within the fill area, to a maximum of $4.6x10^{-1}$ cm/sec or 1,320 ft/day in Monitoring Well MW-01, located in the containment berm. The heterogeneity of the soil and sediment types is reflected in the range of hydraulic conductivities exhibited in the wells installed in and adjacent to the CDF.

Shallow Well Hydraulic Conductivity Values

The hydraulic conductivity values for the shallow wells (MW-01 through MW-04, MW-06, MW-09, MW-10, and MW-13) range from $4.08x10^{-4}$ cm/sec or 1.16 ft/day at Monitoring Well MW-04 installed in the CDF to $4.64x10^{-1}$ cm/sec or 1,320 ft/day at Monitoring Well MW-01 installed in the CDF containment berm. Generally, the wells screened in coarser, less silty soil and sediment yielded higher hydraulic conductivity values than wells screened in finer, silty soil and sediment.

Monitoring Well MW-04, installed within the CDF, exhibited the lowest hydraulic conductivity value of shallow wells ($4.08x10^{-4}$ cm/sec or 1.16 ft/day), reflecting the low permeability of the predominantly fine sandy silt dredged material recently placed in the CDF (Figure 7). The highest hydraulic conductivity values for shallow monitoring wells were observed in Monitoring Wells MW-01 and MW-09 and ranged from $3.57x10^{-1}$ cm/sec or 1,010 ft/day to $4.64x10^{-1}$ cm/sec or 1,320 ft/day. Monitoring Wells MW-01 and MW-09 are located within the containment and offset berms, respectively, and are screened over highly-permeable coarse gravel and sand fill placed during construction of the berms.

Mid-range hydraulic conductivity values from $1.25x10^{-2}$ cm/sec or 35.5 ft/day to $7.38x10^{-2}$ cm/sec or 209 ft/day were observed in shallow monitoring wells MW-02, MW-03, MW-10, and MW-13. The mid-range hydraulic conductivity values reflects the hydraulic properties of the silty fine-sand to coarse sand deposits in which these shallow wells are screened.

Intermediate Well Hydraulic Conductivity Values

Hydraulic conductivity values for the intermediate depth wells (MW-07, MW-11, and MW-14) ranged from $5.02x10^{-4}$ or 1.42 ft/day at Monitoring Well MW-14 to $3.30x10^{-2}$ cm/sec or 93.2 ft/day at Monitoring Well MW-11. The soil and sediment in which these wells are screened consists of silts to medium sands, which correlates well with the range of hydraulic conductivity values observed in these wells.

Hydraulic conductivity values estimated for Monitoring Wells MW-07 and MW-11 are of similar magnitude, while the hydraulic conductivity value for MW-14 is lower than the other intermediate wells by a factor of approximately one to two orders of magnitude, respectively. Despite the general similarity of materials over which the intermediate wells are screened, differences in material deposition in the location of MW-14 may account for the lower hydraulic conductivity value. Monitoring Well MW-15, the deep well co-located with Monitoring Well MW-14, exhibits a similar hydraulic conductivity value of $6.54x10^{-4}$ or 1.85 ft/day. The similar hydraulic conductivity values for Monitoring Wells MW-14 and MW-15 indicate that depositional characteristics specific to the intermediate and deep screen locations for these wells likely control the hydraulic conductivity values at this location.

Deep Well Hydraulic Conductivity

The hydraulic conductivity values for the deep monitoring wells (MW-05, MW-08, MW-12, and MW-15) ranged from $1.24x10^{-4}$ cm/sec or 0.35 ft/day at Monitoring Well MW-05 to $3.38x10^{-2}$ cm/sec or 95.8 ft/day at MW-12. Monitoring Well MW-05 and MW-15 exhibit the lowest hydraulic conductivity values ($1.24x10^{-4}$ cm/sec or 0.35 ft/day and $6.5.34x104x10^{-4}$ or 1.85 ft/day, respectively) for the deep wells. Monitoring Wells MW-05 and MW-15 are screened in predominantly fine sandy-silt. The hydraulic conductivity values estimated for Monitoring Wells MW-08 and MW-12 ($2.87x10^{-2}$ cm/sec or 81.5 ft/day and $3.38x10^{-2}$ cm/sec or 95.8 ft/day, respectively) represent the highest values for the deep wells, which correlates with the expected range of conductivities associated with the fine to medium sand in which the wells are screened.

3.2.3 Summary of CDF Hydraulic Conductivity Values

Hydraulic conductivity varies across the site along the shallow, intermediate and deep screening levels. This variability is the result of differences in the soil unit characteristics encountered in a given horizon. The estimated hydraulic conductivities are consistent with the soil conditions where more coarse materials such as those comprising the CDF berms exhibit higher conductivities than do finer grained silts comprising the recently deposited dredged material.

The hydraulic conductivity values measured at the CDF are highest in the containment and offset berms. The two wells located within the berms, MW-01 and MW-09, show similar hydraulic conductivity values of $4.64x10^{-1}$ cm/sec or 1,320 ft/day and $3.57x10^{-1}$ cm/sec or 1,010 ft/day, respectively. Monitoring Wells MW-01 and MW-09 are screened over highly-permeable coarse gravel and sand fill placed during construction of the berms.

The wells located adjacent to the Middle Waterway (MW-02, MW-06 through MW-08 and MW-10 through MW-12) show similar hydraulic conductivity values ranging from 2.02×10^{-2} cm/sec or 57.2 ft/day at Monitoring Well MW-07 to $1.1x\ 10^{-1}$ cm/sec or 310 ft/day at Monitoring Well MW-06. Hydraulic conductivities estimated for Monitoring Wells MW-06 through MW-08 and MW-10 through MW-12 were within the mid-range of conductivities observed at the site. The mid-range hydraulic conductivity values reflect the hydraulic properties of the silty fine-sand to coarse sand comprising the historical fill and deltaic and shallow marine deposits in which these wells are screened.

The two wells installed within the dredged material disposed of in the CDF, Monitoring Wells MW-04 and MW-05, exhibit the lowest estimated hydraulic conductivity values at the site. Monitoring Wells MW-04 and MW-05 have similar hydraulic conductivity values of $4.08x10^{-4}$ cm/sec or 1.16 ft/day and $1.24x10^{-4}$ cm/sec or 0.35 ft/day, respectively. The low conductivity values reflect the low permeability of the predominantly fine sandy silt dredged material fill disposed of in the CDF.

Based on the slug test results performed on wells in and adjacent to the CDF, the hydraulic conductivity values for the sediment disposed of in the CDF is generally two to three orders of magnitude slower than the hydraulic conductivity values for the soil and sediment surrounding the CDF. The information for hydraulic conductivities indicates that the silt and fine sand comprising the dredged fill material placed in the CDF will reduce the hydraulic connection

between groundwater within the CDF and groundwater and surface water surrounding the CDF and the potential transport of contaminants out of the dredged fill material.

3.3 GROUNDWATER RESPONSE TO TIDAL FLUCTUATIONS

Groundwater elevations in all 15 monitoring wells, as well as surface water elevations at two additional locations, were recorded at 15-minute intervals during a 72-hour tidal study using pressure transducers with internal electronic data loggers. Data for the elevation of groundwater in each well was compared to the surface water elevations in the Middle Waterway to evaluate the affect of tidal fluctuations on groundwater in and adjacent to the CDF. The locations of the transducers during the tidal study are shown in Figure 2. The data recorded during the tidal study is presented in Appendix C.

3.3.1 Methodology for Evaluation of Groundwater Response to Tidal Fluctuations

The pressure transducers used in the tidal study measure and record the pressure resulting from the weight of the column of water (i.e., hydraulic head) above the transducer. The data loggers within the pressure transducers record the changes in pressure that are the result of the change in the weight of the water column over time, in response to tidal fluctuations. The internal data loggers are programmed to automatically convert the pressure readings (i.e., weight of the water column) to the height of the water column, in feet, above the transducer.

Measurement of the depth to the water surface from the surveyed top of the well casing, for groundwater wells, and top of the surveyed still well casing and tide gauge, for surface water monitoring locations, were used to convert the relative measurements recorded by the transducers to elevations in feet MLLW. The depth to the surface of the water (i.e., groundwater and surface water) were measured manually using a water level indicator. The height of the water column being read by the transducer was recorded concurrently with the depth to the surface of the water and was used to correlate the measurement of the height of the water column to elevation at the surface of the water in feet MLLW. Additional detail describing conversion of transducer measurements to water surface elevations are presented in Appendix C.

The data loggers within the transducers recorded the water level in each monitoring well and surface water monitoring location every 15 minutes over the course of the 72-hour tidal study resulting in 288 measurements of the elevation of the water surface at each location. The hydrographs presenting the recorded water elevation data and depicting the changes in groundwater and surface water elevations are presented in Appendix C.

For an unknown reason, all of the transducers recorded multiple water elevations for the same time intervals for times between 2:00 and 2:45 on October 5, 2006. The duplication was repeated in every transducer, and is likely a programming error in the software used to transfer the data from the transducer to an electronic file for data evaluation. However, the measurement duplication does not impact the trends observed in the groundwater levels and the overall mean groundwater elevation.

The hydrographs for each monitoring well (i.e., Monitoring Wells MW-01 through MW-15) show the change in the groundwater surface elevation in relationship to tidal fluctuations (i.e.,

changes in the elevation of surface water in the Middle Waterway as measured by the tide gauge) over the 72-hour tidal study (Appendix C). Additionally, the hydrograph for Monitoring Well MW-09 includes the surface water elevation data from the still well in the surface water swale located immediately adjacent to MW-09. Table 4 presents the highest and lowest groundwater and surface water elevations recorded at each monitoring location during the 72-hour tidal study and the calculated tidal lag time for each monitoring well.

3.3.2 Groundwater Response to Tidal Fluctuations

During the tidal study, the tide elevation ranged from a low of 0.15 feet MLLW to approximately 13 feet MLLW for an overall change in tidal elevation of approximately 13 feet. The greatest change in the groundwater surface elevation in response to the tidal fluctuations was observed in Monitoring Well MW-01 located in the containment berm and was approximately seven feet. The least amount of change in the groundwater surface elevation was observed in Monitoring Well MW-13 and was 0.11 feet or approximately one inch.

Shallow Well Tidal Response

The hydrograph for shallow monitoring well MW-01 indicates a relatively rapid response between changes in tidal elevation in adjacent surface water and water within the CDF containment berm. The time lag between tidal fluctuations and changes in groundwater elevations in Monitoring Well MW-01 is relatively short at 15 minutes (Table 4). As stated above, the greatest change in the groundwater elevation was observed in Monitoring Well MW-01 and was approximately seven feet. At Monitoring Well MW-09 the groundwater elevations within the offset berm closely mimic the surface water elevations within the surface water swale both in magnitude of change and lag time. The relatively large time lag observed in the surface water swale and Monitoring Well MW-09 is a result of the distance of the swale from the surface water in the Middle Waterway. The overall response of groundwater elevations as a result of tidal fluctuations in Monitoring Wells MW-01 and MW-09 is indicative of the material used to construct the berms (i.e., sand and gravel).

The hydrographs for shallow monitoring wells MW-02, MW-06, and MW-10 indicate a moderately rapid response of groundwater elevation to changes in tidal fluctuations. The lag time between tidal fluctuations and groundwater elevations within the shallow wells west of the CDF ranges from 15 to 45 minutes. The magnitude of change in the groundwater elevations in Monitoring Wells MW-02, MW-06, and MW-10 ranged between approximately 4.5 and 5.5 feet. The moderately rapid hydraulic connection and magnitude of change in groundwater elevations in response to tidal fluctuations in wells west of the CDF is indicative of the sand, silty sand, and sandy silt present in historical fill and deltaic and shallow marine deposits.

Although the hydrographs and calculated lag times for shallow monitoring wells adjacent to the CDF show a relatively rapid response to tidal fluctuations, the hydrographs for Monitoring Well MW-04 installed within the CDF had minimal response to tidal fluctuations. The groundwater elevation change in shallow monitoring well MW-04 was three inches. The calculated lag time for Monitoring Well MW-04 was 165 minutes (i.e., 2 hours and 45 minutes). The relatively small response to tidal fluctuations and long lag time in Monitoring Well MW-04 are indicative of the fine sandy, silt present in the CDF and indicates that there is limited hydraulic connection between tidal fluctuations and groundwater present in the CDF.

Similarly, the hydrographs and calculated lag times for Monitoring Wells MW-03 and MW-13 also indicate limited hydraulic connection between these monitoring wells and tidal fluctuations in the adjacent surface water. Groundwater elevation changes in shallow monitoring wells MW-03 and MW-13 were approximately one inch and six inches, respectively. The calculated lag times for Monitoring Well MW-03 and MW-13 were 120 and 255 minutes, respectively (i.e., 2 hours and 4 hours and 15 minutes, respectively). The limited hydraulic connection between Monitoring Wells MW-03 and MW-13 and tidal fluctuations may be a result of the presence of the dredged material within the CDF between these wells and adjacent surface water.

Intermediate Well Tidal Response

The hydrographs for intermediate monitoring wells MW-07 and MW-11 indicate a moderately rapid response in groundwater elevation in response to changes in tidal fluctuations. The calculated lag time for Monitoring Wells MW-07 and MW-11 is 30 minutes. Groundwater elevation change in intermediate monitoring wells MW-07 and MW-11 was approximately 6.5 feet. The moderately rapid communication and range in the groundwater elevation response to tidal fluctuations in the intermediate wells west of the CDF is indicative of the sand, silty sand, and sandy silt present in deltaic and shallow marine deposits.

The hydrograph and calculated lag time for Monitoring Well MW-14 indicates limited hydraulic connection between MW-14 and tidal fluctuations in the adjacent surface water. The groundwater elevation change in intermediate monitoring well MW-14 was approximately two inches. The calculated lag time for Monitoring Well MW-14 was 150 minutes (i.e., 2 hours and 30 minutes). The limited hydraulic connection between Monitoring Well MW-14 and tidal fluctuations may be a result of the presence of the dredged material within the CDF between MW-14 and adjacent surface water.

Deep Well Tidal Response

The hydrographs for deep monitoring wells MW-08 and MW-12 indicate a moderately rapid response in groundwater elevation in response to changes in tidal fluctuations in deep soil west of the CDF. The calculated lag time for Monitoring Wells MW-08 and MW-12 is 60 minutes. Groundwater elevation change in deep monitoring wells MW-08 and MW-12 was approximately 4.75 and 3.5 feet, respectively. The relatively rapid hydraulic connection and range in the groundwater elevation in response to tidal fluctuations in the deep wells west of the CDF is indicative of the sand, silty sand, and sandy silt present in deltaic marine deposits.

Although the hydrographs and calculated lag times for deep monitoring wells adjacent to the CDF show a relatively rapid response to tidal fluctuations, the hydrographs for Monitoring Well MW-05 installed within the CDF had minimal response to tidal fluctuations. The groundwater elevation change in deep monitoring well MW-05 was six inches. The calculated lag time for Monitoring Well MW-05 was 135 minutes (i.e., 2 hours and 15 minutes). The relatively small response to tidal fluctuations and long lag time in Monitoring Well MW-05 are indicative of the fine sandy, silt present in the CDF and indicates that there is limited hydraulic connection between tidal fluctuations and groundwater present in the CDF.

The hydrographs for deep monitoring well MW-15 indicates a delayed response in groundwater elevation in response to changes in tidal fluctuations. However, the change in groundwater elevation indicates moderate communication between Monitoring Well MW-15 and tidal fluctuations in adjacent surface water. The calculated lag time for Monitoring Well MW-15 is 195 minutes (i.e., 3 hours and 15 minutes). The groundwater elevation change in deep monitoring wells MW-15 was approximately two feet. Monitoring Well MW-15 is screened in materials similar to MW-13 and MW-14 and is a similar distance away from surface water but had a greater response to tidal fluctuations. Additionally, Monitoring Well MW-15, is screened 10 feet deeper (i.e., from -70 feet MLLW to -50 feet MLLW) than other deep monitoring wells and is screened to a depth 10 feet below the bottom of the CDF potentially indicating that the silty sediment in the CDF is inhibiting the response of tidal fluctuations on groundwater elevations at Monitoring Wells MW-13 and MW-14.

3.3.3 Summary of Groundwater Response to Tidal Fluctuations

The hydrographs for shallow wells installed in the containment and offset berms and shallow and intermediate wells west of the CDF indicate a relatively rapid to moderately rapid response in groundwater elevation in response to tidal fluctuations with calculated lag times ranging from 15 to 45 minutes. Additionally, the change in groundwater elevations ranged from approximately four to seven feet.

Although the shallow wells installed in the berms and shallow and intermediate wells installed west of the CDF had significant responses to changes in tidal fluctuations, Monitoring Wells MW-04 and MW-05 installed within the CDF had a limited response to tidal fluctuations. The calculated lag time for Monitoring Wells MW-04 and MW-05 were 165 and 135 minutes, respectively (i.e., 2 hours and 45 minutes and 2 hours and 15 minutes, respectively). Groundwater elevation changes in shallow monitoring well MW-04 and deep monitoring well MW-05 were three inches and approximately six inches, respectively. The relatively small response to tidal fluctuations in Monitoring Wells MW-04 and MW-05 are indicative of the fine sandy, silt that was disposed of in the CDF.

The hydrographs for Monitoring Wells MW-03, MW-13, and MW-14 installed east of the CDF also indicated minimal response to tidal fluctuations. However, deep monitoring well MW-15 located east of the CDF exhibited a greater response to tidal fluctuations than the shallow and intermediate wells. The greater response to tidal fluctuations exhibited by Monitoring Well MW-15 indicates that the presence of the silty dredged material fill in the CDF is likely inhibiting the response in Monitoring Wells MW-03, MW-13, and MW-14.

The information from groundwater responses to tidal fluctuations corroborates the results of hydraulic conductivities and further indicates that the silt and fine sand comprising the dredged fill material placed in the CDF limits the hydraulic connection between groundwater within the CDF and groundwater and surface water surrounding the CDF and the potential transport of contaminants out of the dredged fill material.

3.4 MEAN GROUNDWATER ELEVATION, GRADIENTS, AND FLOW DIRECTION

Groundwater elevation data was used to determine the average groundwater elevation at each monitoring well location to identify groundwater gradients across the CDF. Groundwater

elevations in all 15 monitoring wells, as well as surface water elevations at two additional locations, were recorded during a 72-hour tidal. The groundwater gradients identified from the tidal study are used to infer overall groundwater flow directions at the CDF and areas of potential groundwater discharge to surface water. The data recorded during the tidal study is presented in Appendix C.

3.4.1 Methodology for Determining Mean Groundwater Elevation, Gradients, and Flow Direction

The groundwater elevations recorded on 15 minute intervals at each monitoring well location were used to calculate the mean groundwater elevation over the 72-hour tidal study. The mean groundwater elevations for shallow, intermediate, and deep monitoring wells are plotted on Figures 8 through 10 and used to identify the horizontal groundwater gradients (i.e., the slope of the groundwater surface) and inferred groundwater flow direction for each monitoring well depth (i.e., shallow, intermediate, and deep). The mean groundwater elevations were also used to identify the vertical groundwater gradient between each monitoring well depth. As groundwater flows from areas of higher hydraulic head (higher groundwater elevations) to areas with lower hydraulic head (lower groundwater elevations), the horizontal and vertical direction of groundwater flow is indicated from the groundwater elevation gradients. The magnitude of the difference in the hydraulic head from one location to another location indicates the relative potential for the groundwater to flow between the two locations.

Mean groundwater elevations were calculated for the wells in and adjacent to the CDF using the method described by Serfes (Serfes 1991). A detailed description of the method used to calculate the mean groundwater elevation is presented in Appendix C. The method described by Serfes uses a 72-hour set of groundwater elevation measurements and filters out tidal fluctuation to determine a mean groundwater elevation.

The calculated mean groundwater elevation for each well over the tidal study, the maximum and minimum groundwater elevations, groundwater elevation observed at the highest, high tide and lowest, low tide during the 72-hour tidal study, and the tidal time lag are presented in Table 4. Additionally, Table 4 summarizes elevations measured at the tide gauge and still well located within the surface water swale. Table 5 summarizes the mean vertical hydraulic gradients for the shallow to intermediate and intermediate to deep well depths for each of the three, three-well clusters at the St. Paul CDF.

Figures 8 through 10 indicate that net groundwater flow is to the west at the St. Paul CDF. Although net groundwater flow is to the west, the groundwater elevation data from the tidal study shows that the horizontal hydraulic gradients change in response to tidal fluctuation in the St. Paul and Middle Waterways and Commencement Bay. The groundwater flow direction temporarily reverses during flood tide as was observed during the 72-hour tidal study (Table 4). However, the reversal of the groundwater gradient is transient and the overall net groundwater gradient is to the west.

3.4.2 Groundwater Gradients and Flow Directions

The estimated groundwater gradients and flow directions for each well depth are discussed in the following sections.

Shallow Monitoring Well Groundwater Gradients and Flow Directions

The gradient of mean groundwater elevations calculated for the shallow monitoring wells indicate that shallow groundwater generally flows to the west as depicted in Figure 8. The highest mean groundwater elevation was measured in Monitoring Well MW-03 located on the northeastern boundary of the CDF adjacent to the Simpson Tacoma Kraft Mill property. The lowest mean groundwater elevation was identified in Monitoring Well MW-10 located adjacent to the west central portion of the CDF and bordering the Middle Waterway. The next lowest mean groundwater elevations were identified at Monitoring Wells MW-01 and MW-06. The groundwater gradient resulting from the mean groundwater elevations in the shallow wells indicates that shallow groundwater flows towards and discharges to the St. Paul and Middle Waterways.

The mean groundwater elevation in Monitoring Well MW-02 was approximately 0.6 feet higher than the mean groundwater elevations at the adjacent shallow monitoring well locations (MW-01 and MW-06). Monitoring Well MW-02 has a lower (i.e., slower) hydraulic conductivity in comparison to MW-01 and MW-06 and was observed to be less tidally responsive than adjacent shallow wells (Table 4). More landmass is also present waterward of Monitoring Well MW-02 than at adjacent Monitoring Wells MW-01 and MW-06. The presence of greater landmass and the lower hydraulic conductivity at Monitoring Well MW-02 is likely why Monitoring Well MW-02 has a higher mean groundwater elevation.

The overall greatest horizontal groundwater gradients were identified in shallow groundwater. The largest difference in mean elevation (i.e., gradient) in shallow depth groundwater wells was between Monitoring Wells MW-03 and MW-10. The mean groundwater elevation at shallow monitoring well MW-06 is approximately 1.5 feet lower than at Monitoring Well MW-03 over a distance of approximately 570 feet. The change in elevation is equivalent to a horizontal groundwater gradient of 0.0027 ft/ft. Similarly, the mean groundwater elevation at shallow monitoring well MW-10 is approximately 0.75 feet lower than at Monitoring Well MW-09 over a distance of approximately 490 feet which is equivalent to a horizontal groundwater gradient of 0.0015 ft/ft. A representative average gradient for shallow groundwater across the site is approximately 0.0021 ft/ft.

Intermediate Monitoring Well Groundwater Gradients and Flow Direction

Mean groundwater elevations calculated for the intermediate monitoring wells indicate that intermediate depth groundwater generally flows to the west as depicted in Figure 9. The highest mean groundwater elevation was measured in Monitoring Well MW-14 located on the southeastern boundary of the CDF on the Simpson log storage property. The mean groundwater elevation at the downgradient, intermediate Monitoring Wells MW-07 and MW-11 is the same (i.e., 7.7 feet MLLW). The groundwater gradient resulting from the mean groundwater elevations in the intermediate depth wells indicates that groundwater at the intermediate depth discharges to the Middle Waterway. Less variation in the mean groundwater elevations was observed in the intermediate depth wells than the co-located shallow wells located on the west side of the CDF bordering the Middle Waterway (i.e., Monitoring Wells MW-06 and MW-10).

Although exhibiting a similar flow direction, the horizontal groundwater gradients for the intermediate depth groundwater wells were marginally less than groundwater gradients in shallow depth wells. The largest difference in mean elevation in intermediate depth groundwater wells was between Monitoring Wells MW-11 and MW-14. The mean groundwater elevation at intermediate monitoring well MW-11 is approximately 1.4 feet lower than at Monitoring Well MW-14 over a distance of approximately 770 feet. The change in elevation is equivalent to a horizontal groundwater gradient of 0.0018 ft/ft. The average horizontal groundwater gradient for intermediate depth wells is 0.0014 ft/ft, which is less steep than the average horizontal groundwater gradient calculated for the shallow groundwater.

Deep Monitoring Well Groundwater Gradient and Flow Direction

The mean groundwater elevations calculated for the deep monitoring wells indicates the groundwater gradient at depth is relatively flat as depicted in Figure 10. The highest mean groundwater elevation was measured in Monitoring Well MW-15 located on the southeastern boundary of the CDF on the Simpson log storage property. The largest measured difference in mean groundwater elevations in deep wells is between Monitoring Wells MW-15 and MW-08 and is 0.11 feet or approximately 1.3 inches over the distance of 1,270 feet. The change in elevation between Monitoring Wells MW-15 and MW-08 is equivalent to a horizontal groundwater gradient of 0.0001 ft/ft. Additionally, the mean groundwater elevations for Monitoring Wells MW-05, MW-08, and MW-12 are within 0.02 feet or less than one-quarter inch of each other and, therefore, are essentially the same.

3.4.3 Vertical Groundwater Gradients and Flow Direction

As stated above, Table 5 summarizes the mean vertical hydraulic gradients for the shallow to intermediate and intermediate to deep well depths for each of the three, three-well clusters at the St. Paul CDF (i.e., MW-06 through MW-08, MW-10 through MW-12, and MW-13 through MW-15).

At the monitoring well clusters located downgradient of the CDF and adjacent to the Middle Waterway (i.e., MW-06 through MW-08 and MW-10 through MW-12), the mean groundwater gradients indicate that the vertical gradient is upward from the deep well depth toward the intermediate depth and downward from the shallow depth toward the intermediate depth. The upward vertical gradient from the deep well depth toward the intermediate well depth bordering the Middle Waterway indicates that groundwater is not likely to transport contaminants into deeper deltaic marine sediment downgradient of the CDF. Additionally, because both sets of gradients (i.e., shallow / intermediate and intermediate / deep) are toward the intermediate depth horizon, intermediate depth groundwater, downgradient of the dredged material recently placed in the CDF, has the potential to transport contamination.

At the well cluster located upgradient of the CDF (i.e., Monitoring Wells MW-13 through MW-15), the net vertical gradient is upward from the intermediate well depth toward the shallow well depth and downward from the intermediate well depth to the deep well depth. The gradients observed in Monitoring Wells MW-13 through MW-15 may indicate that the vertical groundwater gradients reverse, as groundwater approaches Commencement Bay or that the presence of the CDF may cause vertical gradients to reverse as upgradient groundwater present in more conductive soil approaches the less conductive soil in the CDF.

3.4.4 Summary of Groundwater Elevations, Gradients and Flow Directions

Mean groundwater elevations for shallow and intermediate depth monitoring wells show that groundwater flow is west toward the St. Paul and Middle Waterways. The groundwater gradients for the shallow and intermediate depths were similar in magnitude and greater than the gradient for deep groundwater which is essentially flat.

The vertical groundwater gradients at monitoring wells located downgradient of the CDF and adjacent to the Middle Waterway indicate that the vertical gradient is upward from the deep well depth toward the intermediate depth and downward from the shallow depth toward the intermediate depth. The upward vertical gradient from the deep well depth toward the intermediate well depth adjacent to the Middle Waterway indicates that groundwater is not likely to transport contaminants into deeper deltaic marine sediment downgradient of the CDF. Additionally, because both sets of gradients (i.e., shallow / intermediate and intermediate / deep) are toward the intermediate depth horizon, intermediate depth groundwater has the potential to transport contamination from the dredged material recently placed in the CDF.

4.0 Conceptual Model for CDF Post-Construction Hydrogeologic Conditions

As described in the previous sections, the hydraulic conductivities of the soil and fill at the CDF, groundwater response to tidal fluctuations, direction of groundwater flow, and hydraulic gradients influence potential contaminant transport and discharge to surface water. The following sections summarize the conclusions for each of these parameters resulting from the post-construction investigation and evaluation hydrogeologic conditions at the St. Paul CDF.

Hydraulic Conductivity

- Information for hydraulic conductivities indicates that the silt and fine sand comprising the dredged fill material placed in the CDF has lower hydraulic conductivities than the materials surrounding the CDF which will reduce the hydraulic connection between groundwater within the CDF and groundwater and surface water surrounding the CDF and the potential transport of contaminants out of the dredged fill material.

Groundwater Response to Tidal Fluctuations

- Information from groundwater responses to tidal fluctuations corroborates the results of hydraulic conductivities and further indicates that the silt and fine sand comprising the dredged fill material placed in the CDF will reduce the hydraulic connection between groundwater within the CDF and groundwater and surface water surrounding the CDF and the potential transport of contaminants out of the dredged fill material.

Groundwater Gradients and Flow Direction

- The groundwater flow direction at the shallow and intermediate well depths is to the west and indicates that groundwater at these depths likely discharges to the St. Paul and Middle Waterways.
- The average horizontal groundwater gradient for the shallow groundwater interval was slightly greater than that of the intermediate depth groundwater interval whereas the groundwater gradient for the deep monitoring well interval is relatively flat.
- The vertical groundwater gradients at monitoring wells located west of the CDF (i.e., horizontally downgradient from the CDF) and adjacent to the Middle Waterway indicate that groundwater flows upward from the deep well depth toward the intermediate depth and downward from the shallow depth toward the intermediate depth.

The hydrogeologic conditions identified during the post-construction investigation were similar to the findings of previous site investigations and the hydrogeologic conditions that were expected during design of the CDF as described in the OMMP. Historical fill materials and deltaic and shallow marine deposits were observed in and adjacent to the CDF during previous site investigations. Hydraulic conductivities previously reported ranged from $7x10^{-3}$ to $4x10^{-2}$ for historically placed fill and deltaic and shallow marine deposits which is within the range of hydraulic conductivities estimated for these materials as part of the post-construction hydrogeological investigation. Additionally, although the horizontal groundwater gradient is reversed during flood tide, the net groundwater flow is toward the outer St. Paul and Middle

Waterways. Finally, the vertical gradient is upward in the deeper deltaic and shallow marine deposits as was expected during design.

5.0 Potential for Contaminant Transport from Recently Placed Dredged Material in the CDF

The objective of the CDF monitoring program is to protect water quality in adjacent surface water from migration of contaminants from the confined dredged material. Contaminated sediment contained within the CDF is separated from direct contact with surface water by a containment berm across the St. Paul Waterway on the north, the St. Paul/Middle Waterway Peninsula on the west, the Simpson Tacoma Kraft property to the east, and the landmass comprising the Simpson log storage property to the south (Figure 2). Commencement Bay, the outer St. Paul Waterway, Middle Waterway, and the Puyallup River are surface waters located in proximity to the CDF.

The primary, potential mechanism for contaminant transport is groundwater flow through contaminated dredged material contained within the CDF and into adjacent surface water. The monitoring program is designed to evaluate groundwater flow and quality in and around the CDF to ensure compliance with the performance criteria. Identification of potential pathways for contaminant transport from the dredged material recently placed within the CDF to adjacent water bodies is key to determining the wells to be selected for establishing baseline groundwater quality conditions.

Based on the findings of the hydrogeological investigation of the CDF and adjacent areas and the conceptual model for post-construction hydrogeologic conditions described in Section 4.0, the following conditions identify potential contaminant transport mechanisms.

- Shallow groundwater, downgradient of the dredged sediment recently placed in the CDF is most likely to be impacted by saltwater washout effects and to transport contaminants from the CDF. Modeling performed as part of the design, identified that contaminant release is most likely to occur where less-saline groundwater and stormwater infiltration come in contact with confined, contaminated dredged materials and then flows away from (i.e., downgradient from) the CDF. Hydrogeological investigations indicate that shallow groundwater generally flows to the west toward the outer St. Paul and Middle Waterways.
- Intermediate depth groundwater, downgradient of the CDF, also has the potential to transport contamination from the confined, contaminated dredged materials. Evaluation of vertical groundwater gradients shows that shallow and deep groundwater flowing through the CDF converge at the intermediate depth horizon. Therefore, groundwater from all depths that has been in contact with the contaminated dredged material has the potential to flow from the CDF within the intermediate depth horizon. Hydrogeological investigations indicate that intermediate depth groundwater flows to the west toward the Middle Waterway.

6.0 References

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Table 1
Summary of Boring and Monitoring Well Completions

Monitoring Well Type	Monitoring Well Designation	Completion Date	Department of Ecology Identification Number	Monitoring Well Location Coordinates[1]		Ground Surface Elevation (MLLW)	Total Depth of Boring (feet bgs)	Top Of Casing Elevation (MLLW)	Top of Screen Elevation (MLLW)	Bottom of Screen Elevation (MLLW)	Type of Well Completion[2]
				Northing	Easting						
Shallow	MW 01	8/28/2006	ALK 061	709968.2	1161154.3	18.2	18.64	17.99	9.61	-0.39	Flush-Mount
Shallow	MW 02	8/28/2006	ALK 060	709903.6	1160969.7	19.8	23.06	19.65	7.62	-2.38	Flush-Mount
Shallow	MW 03	9/5/2006	ALK 072	709924.5	1161472.7	17.8	21.50	20.07	10.11	0.11	Stick-Up
Shallow	MW 04	9/6/2006	ALK 073	709580.1	1161398.1	18.7	21.21	18.55	7.94	-2.06	Flush-Mount
Deep	MW 05	9/5/2006	ALK 071	709585.0	1161397.5	18.7	80.80	18.60	-41.87	-61.87	Flush-Mount
Shallow	MW 06	8/30/2006	ALK 066	709667.0	1160956.3	18.3	22.10	21.08	9.21	-0.79	Stick-Up
Intermediate	MW 07	8/30/2006	ALK 067	709662.7	1160953.2	17.9	32.50	20.36	-1.68	-11.68	Stick-Up
Deep	MW 08	8/31/2006	ALK 068	709662.3	1160958.0	18.6	82.00	20.97	-40.71	-60.71	Stick-Up
Shallow	MW 09	8/28/2006	ALK 062	709337.0	1161706.4	21.3	21.50	21.37	10.45	0.45	Flush-Mount
Shallow	MW 10	8/30/2006	ALK 065	709151.3	1161258.3	18.5	20.00	18.41	8.92	-1.08	Flush-Mount
Intermediate	MW 11	8/29/2006	ALK 064	709155.4	1161255.5	18.6	30.00	18.39	-0.98	-10.98	Flush-Mount
Deep	MW 12	8/29/2006	ALK 063	709159.6	1161252.6	18.6	80.50	18.47	-41.33	-61.33	Flush-Mount
Shallow	MW 13	9/6/2006	ALK 074	708941.4	1161990.5	20.4	21.00	20.16	9.92	-0.08	Flush-Mount
Intermediate	MW 14	9/1/2006	ALK 070	708944.7	1161994.3	20.5	30.00	20.13	0.68	-9.32	Flush-Mount
Deep	MW 15	9/1/2006	ALK 069	708948.2	1161998.5	20.6	91.50	20.28	-50.68	-70.68	Flush-Mount

Notes:

MLLW Mean Lower Low Water

feet bgs Feet below ground surface

1 Survey data provided in NAD 83-91 Horizontal Datum, Washington State Plane Coordinate system, South Zone, units of feet.

2 Wells were completed with protective casings that are either flush with the ground surface (i.e., flush mount) or that stick-up above the ground surface (i.e., stick-up).

Table 2
Summary of Monitoring Well Development Measurements and Observations

Monitoring Well Designation	Monitoring Well Measurements							Purge Volumes and Rates				Groundwater Characteristics During Development					
	Pre-Development Measurements			Post-Development Measurements								Turbidity		Water Color			
	Depth to Water (ft TOC)	Depth to Bottom of Well (ft TOC)	Time	Depth to Water (ft TOC)	Depth to Bottom of Well (ft TOC)	Time	Fines Removed From Well[1] (ft)	Volume of Well Casing (gal)	Total Purge Volume (gal)	Average Purge Rate (GPM)	Relative Well Recovery Rate	Initial Tubidity (NTU)	Final Tubidity (NTU)	Initial Color	Final Color	Apparent Odor	Visible Sheen
MW-01	7.55	18.49	14:41	8.10	18.50	15:42	0.01	1.78	62.5	1.3	Fast	570	6	Lt. Brown	Clear	None	None
MW-02	9.33	22.11	13:20	10.12	22.25	16:54	0.14	2.11	52.0	0.5	Slow	200	12	Dk. Gray	Clear	Faint Marine	None
MW-03	9.78	18.42	17:13	9.92	20.18	18:55	1.76	1.70	57.0	0.6	Medium	470	20	Dk. Gray	Lt. Yellow	None	None
MW-04	8.04	19.69	11:12	12.13	20.81	16:56	1.12	2.08	26.5	0.2	Slow	150	40	Dk. Gray	Clear	None	Faint
MW-05	10.19	79.97	11:15	10.90	80.69	17:11	0.72	11.49	115.0	0.7	Fast	152	57	Dk. Gray	Lt. Gray	Strong Marine, H_2S	Moderate
MW-06	14.02	21.86	9:21	12.48	22.09	10:46	0.23	1.32	62.0	0.8	Fast	43	14	Lt. Brown	Clear	None	None
MW-07	13.26	31.81	9:18	11.29	32.38	11:33	0.57	3.12	69.0	0.8	Fast	41	16	Gray	Clear	None	None
MW-08	11.94	79.92	14:39	12.45	81.90	16:10	1.98	11.40	75.0	1.0	Fast	350	35	Dk. Gray	Clear	None	None
MW-09	14.02	21.13	10:10	13.45	21.14	11:15	0.01	1.16	45.0	1.4	Fast	14	6	Lt. Brown	Clear	None	None
MW-10	9.46	19.03	15:36	9.55	19.83	13:06	0.80	1.69	57.0	0.6	Medium	92	11	Dk. Gray	Clear	None	None
MW-11	10.86	29.28	14.23	10.99	29.59	16.03	0.31	3.05	125.0	1.4	Fast	>1,000	720	Dk. Gray	Dk. Gray	Strong Marine, H_2S	None
MW-12	10.54	79.02	9:12	9.88	80.02	11:02	1.00	11.33	82.0	0.8	Fast	700	12	Dk. Gray	Clear	Faint Marine	None
MW-13	11.20	20.07	11:31	11.24	20.46	13:55	0.39	1.51	67.5	0.9	Fast	400	9	Dk. Gray	Clear	Faint Marine	None
MW-14	11.02	28.02	14:20	11.63	29.67	17:33	1.65	3.04	70.0	0.6	Medium	150	43	Dk. Gray	Dk. Gray	Faint Marine	Faint[2]
MW-15	11.86	89.73	12:40	11.42	91.18	15:02	1.45	12.93	90.0	0.9	Fast	102	15	Dk. Gray	Lt. Yellow	Faint Marine	None

Notes:

ft	Feet.
ft TOC	Feet from top of casing.
gal	Gallon.
GPM	Gallons per miute.
NTU	Nephlometric turbidity units.
1	Fines removed from the well is the difference between the depth to the bottom of the well pre-develoopment and depth to bottom of the the well post-development.
2	A faint organic sheen was observed.

Table 3
Summary of Slug Test Results

Monitoring Well Designation	Soil / Sediment Type at Well Screen Interval	Hydraulic Conductivity (cm/sec)[1]	Hydraulic Conductivity (ft/day)
MW-01	Sand and Gravel	4.64×10^{-1}	1.32×10^{3}
MW-02	Silt and Fine Sand	1.25×10^{-2}	3.55×10^{1}
MW-03	Fine Sand	1.99×10^{-2}	5.64×10^{1}
MW-04	Silt and Fine Sand	4.08×10^{-4}	1.16×10^{0}
MW-05	Silt and Fine Sand	1.24×10^{-4}	3.52×10^{-1}
MW-06	Silt and Fine to Medium Sand	1.10×10^{-1}	3.10×10^{2}
MW-07	Silt and Fine to Medium Sand	2.02×10^{-2}	5.72×10^{1}
MW-08	Silt and Fine to Medium Sand	2.87×10^{-2}	8.15×10^{1}
MW-09	Sand and Gravel	3.57×10^{-1}	1.01×10^{3}
MW-10	Silt and Fine Sand	6.96×10^{-2}	1.97×10^{2}
MW-11[3]	Silt and Fine to Medium Sand	3.76×10^{-2}	1.06×10^{2}
		2.84×10^{-2}	8.04×10^{1}
MW-12	Fine to Medium Sand	3.38×10^{-2} [2]	9.58×10^{1}
MW-13	Fine to Coarse Sand	7.38×10^{-2}	2.09×10^{2}
MW-14	Silt and Fine to Medium Sand	5.02×10^{-4}	1.42×10^{0}
MW-15[3]	Silt and Fine Sand	6.54×10^{-4}	1.85×10^{0}
		6.53×10^{-4}	1.85×10^{0}

Notes:

cm/sec centimeters per second.

ft/day feet per day.

1 Bouwer and Rice method (Bouwer and Rice 1976 and 1989) was used to calculate hydraulic conductivity except where noted otherwise.

2 High-K techniques developed by Butler, J. Jr., and Garnett, E., Kansas Geological Survey (Butler and Garnett, 2000) used to calculate hydraulic conductivity.

3 Replicate slug tests (i.e., a second complete test) were performed at Monitoring Wells MW-11 and MW-13 to provide a quality assurance / quality control check on slug test procedures and analysis.

Table 4
Summary of Groundwater and Surface Water Elevations

Transducer Location	Lowest Measured Groundwater Elevation (ft MLLW)	Highest Measured Groundwater Elevation (ft MLLW)	Difference of Low/High Groundwater Elevations (ft)	Tidal Lag Time (minutes)	Mean Elevation (ft MLLW)	Lowest Low Tide Elevation (10/4/06 9:00) (ft MLLW)	Highest High Tide Elevation (10/5/06 15:30) (ft MLLW)
Shallow Monitoring Wells							
MW-01	5.93	12.82	6.89	15	8.61	6.84	12.76
MW-02	7.59	11.89	4.30	30	9.19	7.94	11.77
MW-03	9.89	10.34	0.45	120	10.12	10.04	10.20
MW-04	9.45	9.70	0.25	165	9.60	9.54	9.65
MW-06	6.63	12.30	5.67	15	8.58	6.88	12.24
MW-09	7.41	11.82	4.41	90	8.83	7.64	10.85
MW-10	6.34	9.85	3.50	45	8.11	6.50	9.72
MW-13	8.93	9.04	0.11	255	8.99	9.00	8.97
Intermediate Monitoring Wells							
MW-07	4.21	10.78	6.57	30	7.68	4.35	10.69
MW-11	4.10	10.74	6.64	30	7.66	4.27	10.66
MW-14	8.95	9.10	0.15	150	9.04	9.02	9.05
Deep Monitoring Wells							
MW-05	7.85	8.38	0.53	135	8.17	8.03	8.29
MW-08	5.54	10.26	4.72	60	8.15	5.73	10.08
MW-12	6.35	9.65	3.31	60	8.19	6.63	9.48
MW-15	7.03	9.18	2.16	195	8.26	7.50	8.35
Surface Water Monitoring Locations							
Tide Gauge	0.15	12.93	12.78	NA	7.15	0.15	12.93
Still Well	7.47	11.83	4.36	90	8.87	7.68	10.91

Notes:

ft MLLW Feet Mean Low Low Water.

NA Not applicable.

Table 5
Vertical Hydraulic Gradients

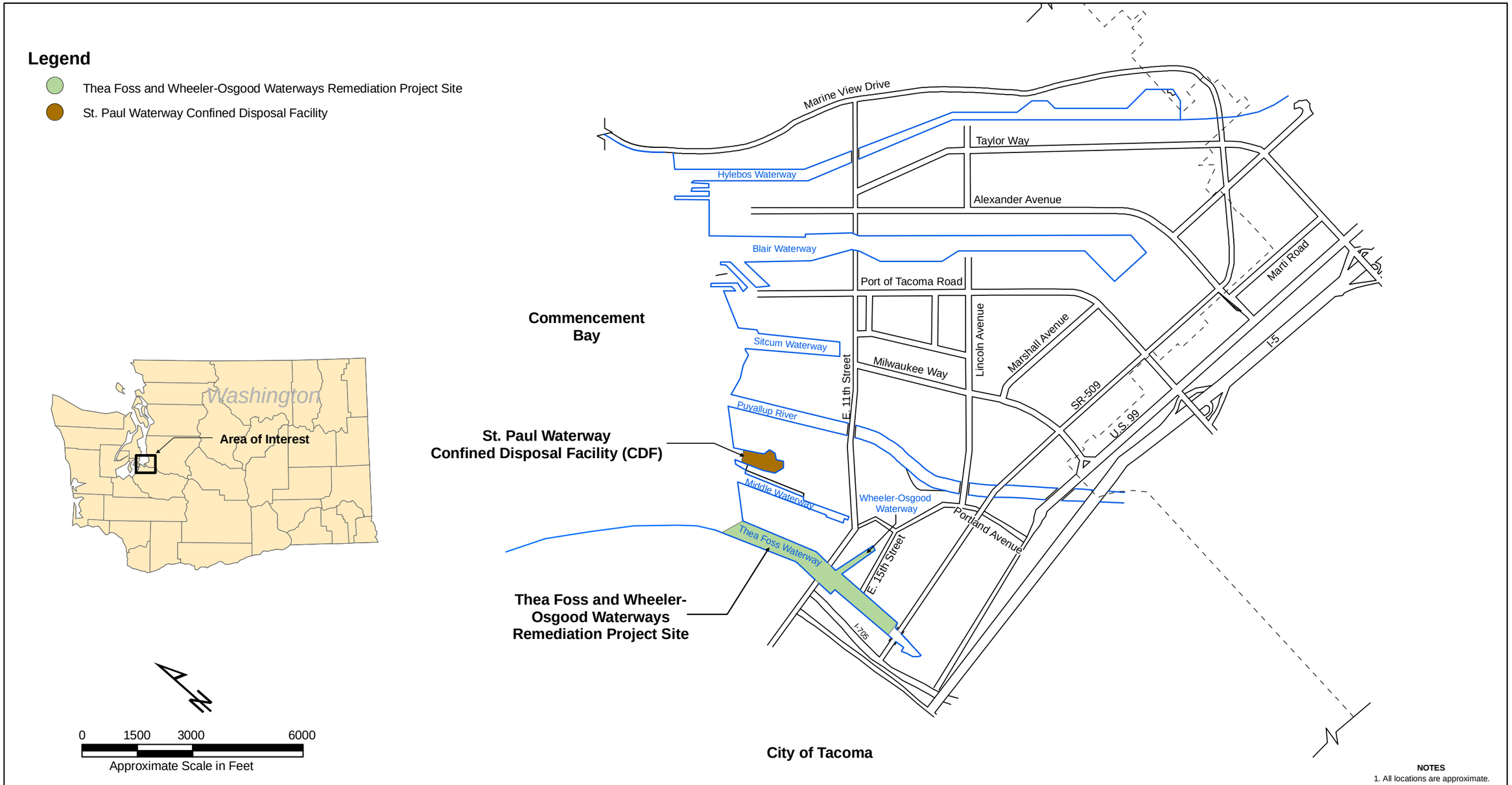
Gradient from Shallow to Intermediate Depth[1]		
MW-06/MW-07	MW-10/MW-11	MW-13/MW-14
0.083	0.045	-0.005
Gradient from Intermediate to Deep Depth[1]		
MW-07/MW-08	MW-11/MW-12	MW-14/MW-15
-0.011	-0.012	0.014

Notes:

1 Units are in feet/feet corresponding to the change in groundwater elevation relative to the change in the screened depth.

Negative value indicates upward vertical gradient.

Positive value indicates downward vertical gradient.



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Thea Foss and Wheeler-Osgood Waterways
Post-Construction Hydrogeologic Conditions Report

Figure 1
Vicinity Map

DATE: 11/10/2006 10:47:36 AM
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Figure 2
Site Map and Monitoring Locations

DATE: 11/10/2006 11:05:17 AM
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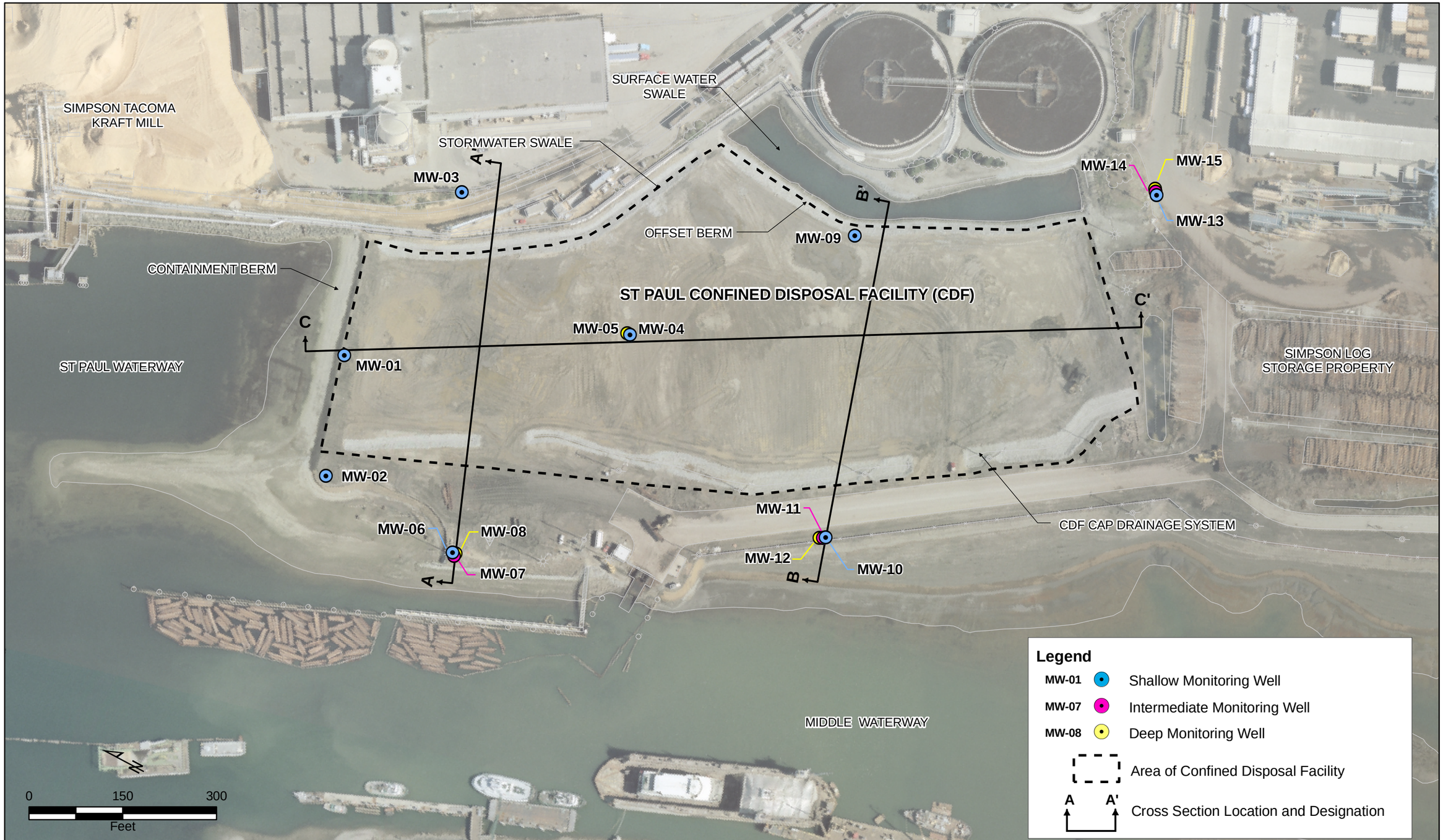

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Figure 3
Cross Section Locations

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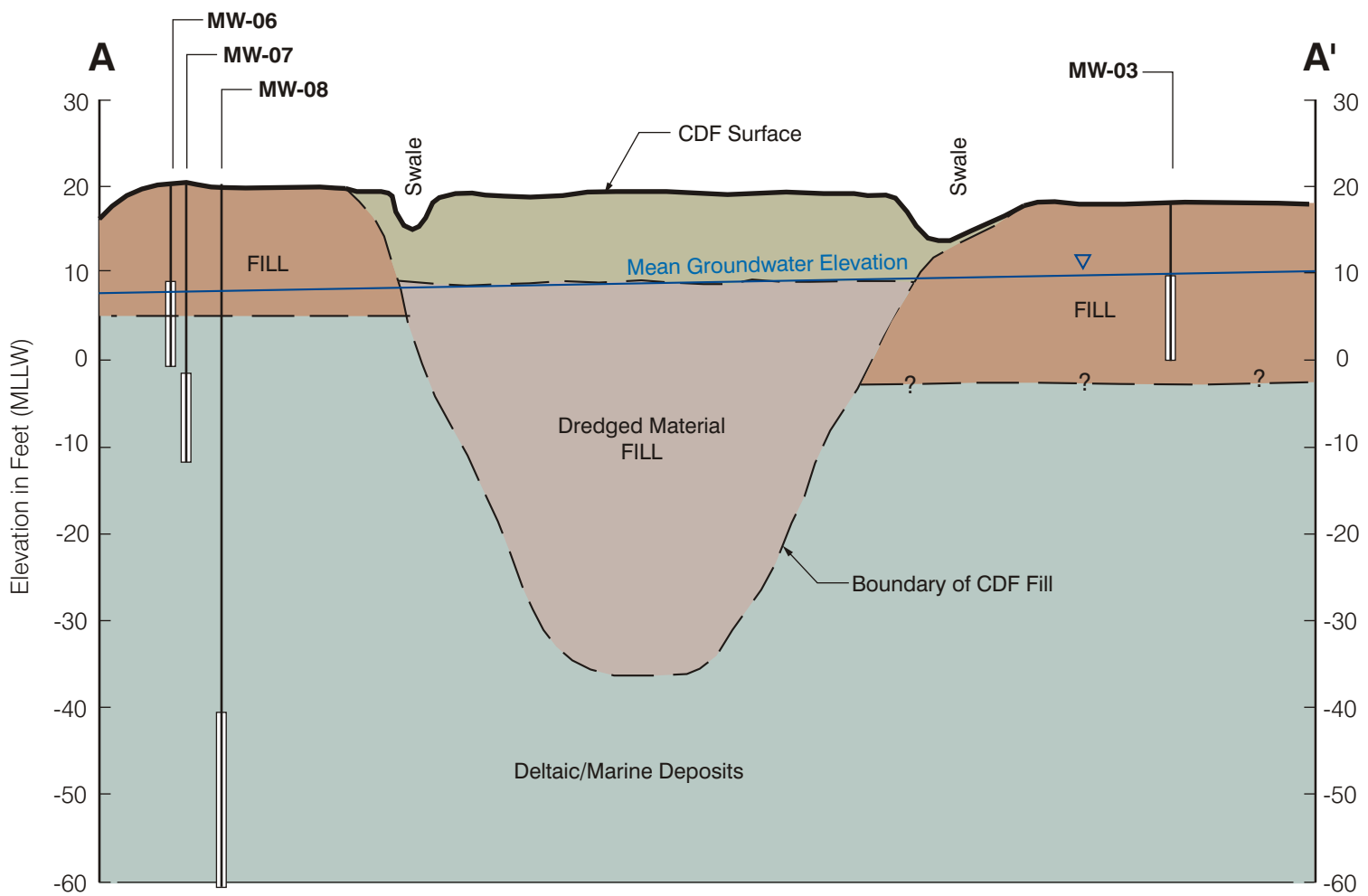

Note: Geologic descriptions based of field explorations presented in the Round 3 Data Evaluation and Pre-design Report (City of Tacoma, 1999).

Horizontal Scale in Feet

0 100 200

0 20 40

Vertical Scale in Feet
Vertical Exaggeration x 5

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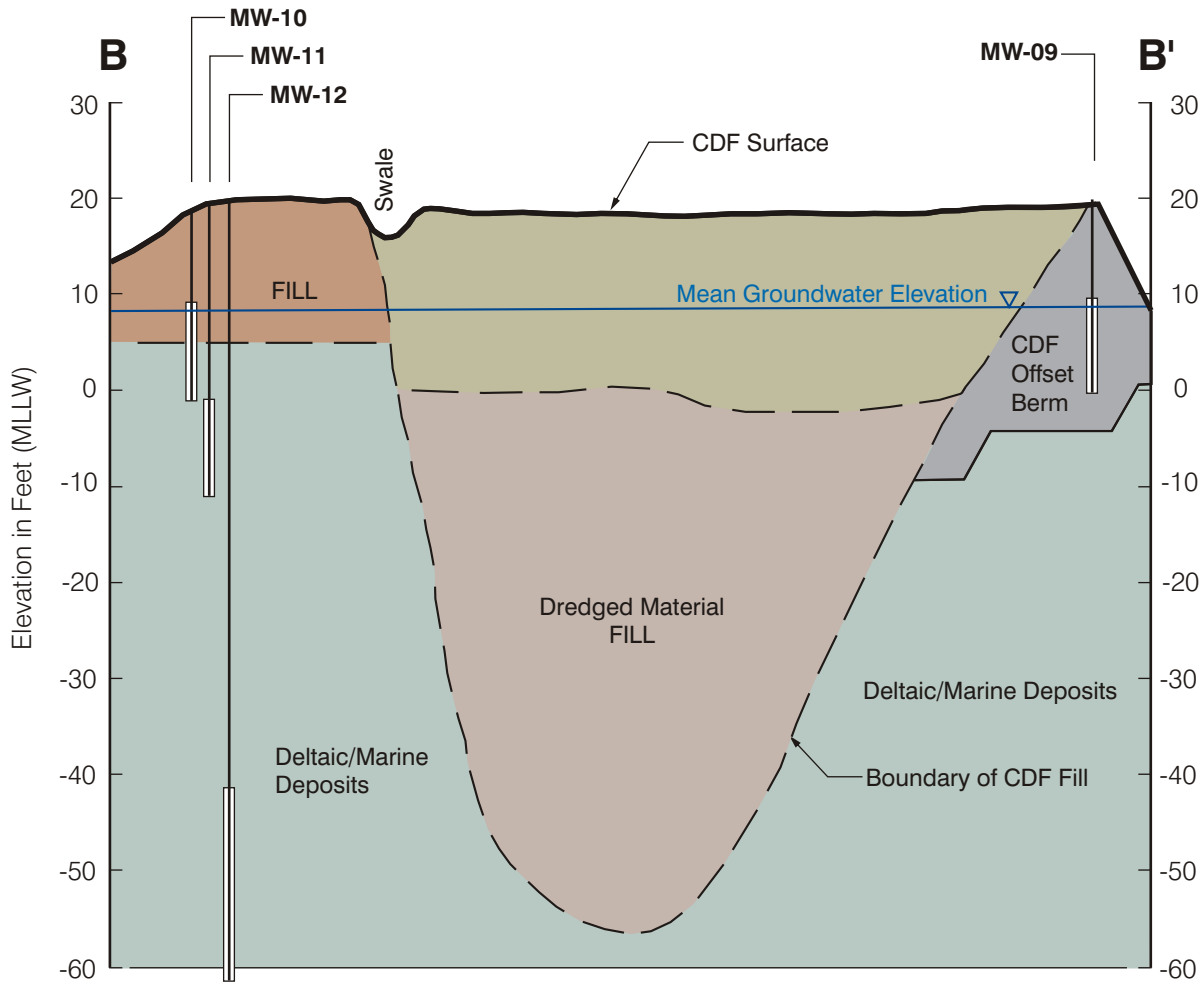
Figure 4
Generalized Geologic Cross Section A-A'



Geologic descriptions based of field explorations presented in the Round 3 Data Evaluation and Pre-design Report (City of Tacoma, 1999).

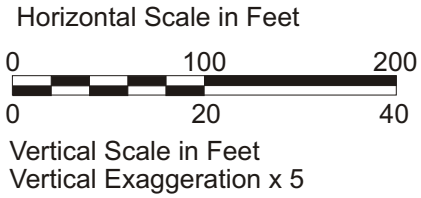


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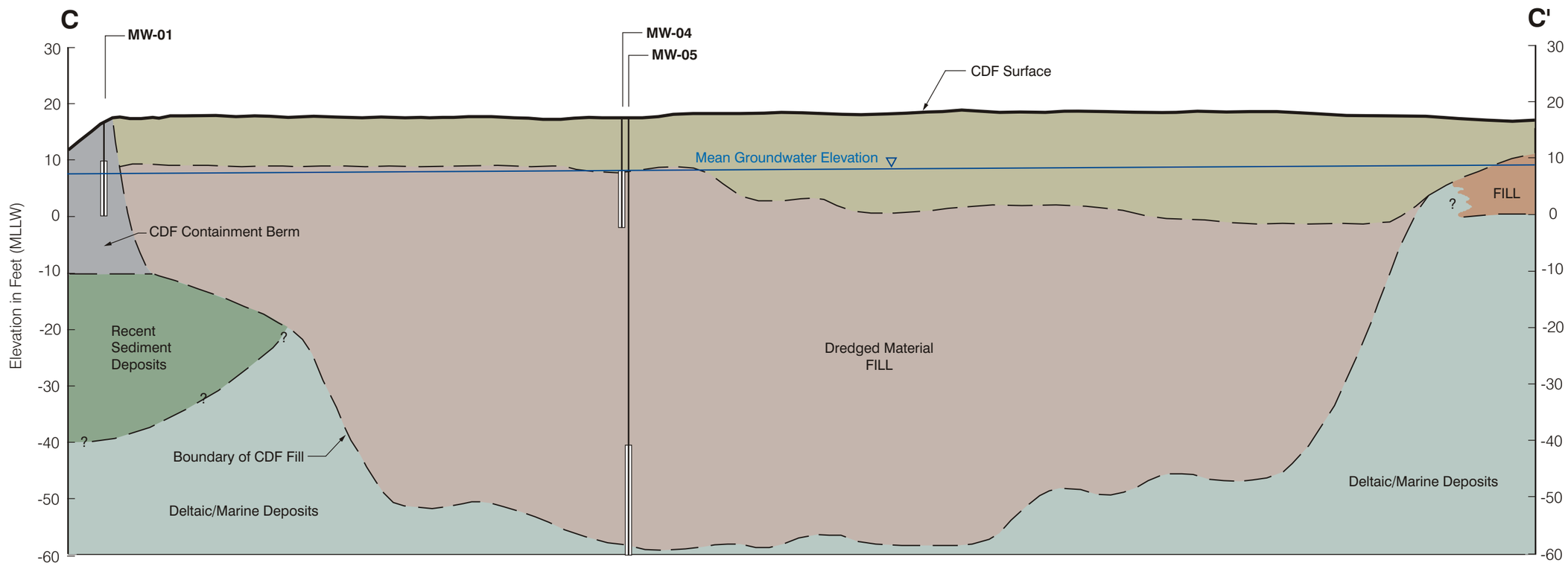
Figure 5
Generalized Geologic Cross Section B-B'



Geologic descriptions based of field explorations presented in the Round 3 Data Evaluation and Pre-design Report (City of Tacoma, 1999).

Horizontal Scale in Feet

0 100 200

0 20 40

Vertical Scale in Feet
Vertical Exaggeration x 5

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Figure 6
Generalized Geologic Cross Section C-C'

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Post-Construction Hydrogeologic Conditions Report

Figure 7
Hydraulic Conductivity Values

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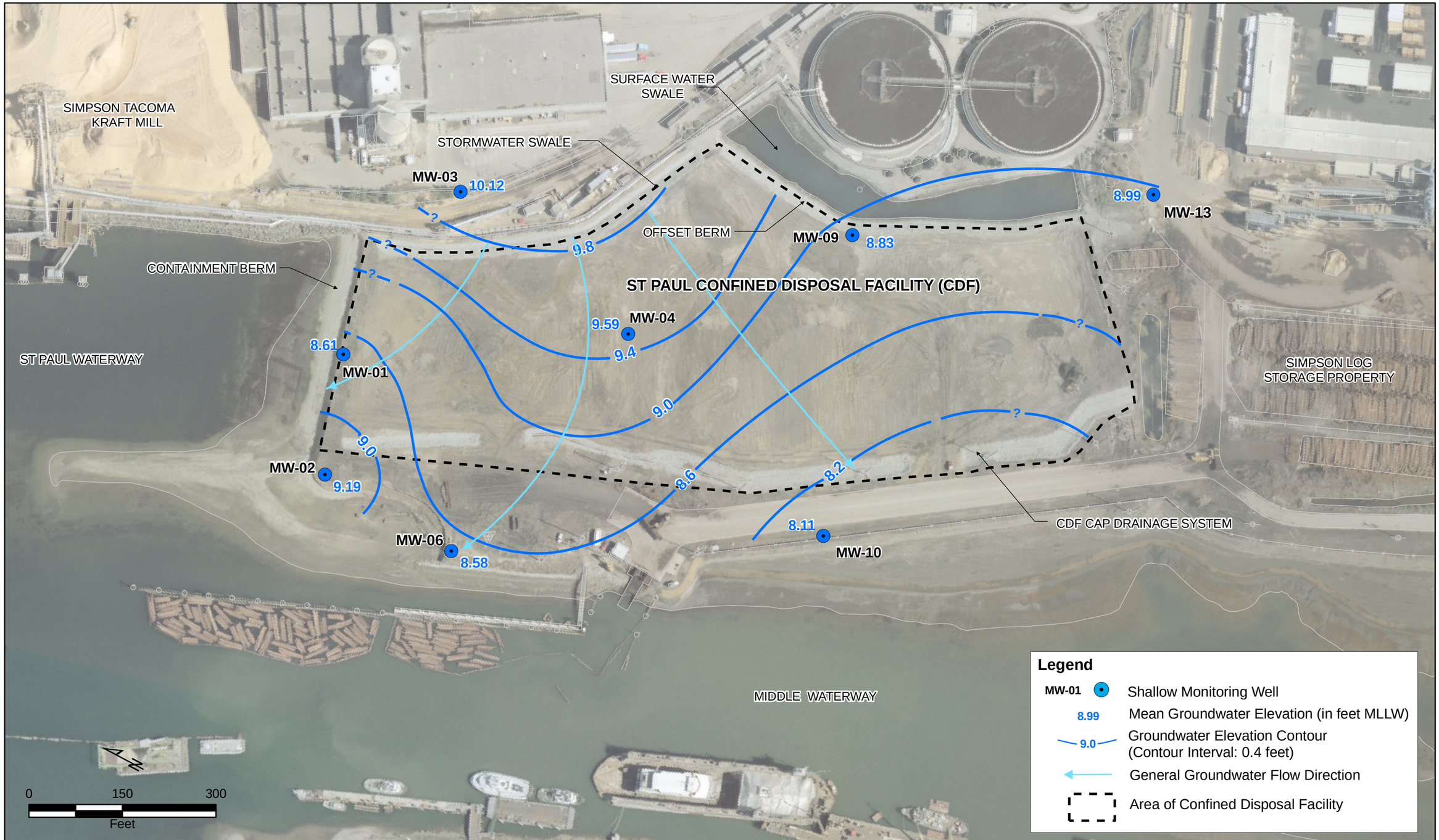

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Figure 8
Groundwater Elevations Map
Shallow Wells, October 2006

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Post-Construction Hydrogeologic Conditions Report

Figure 9
Groundwater Elevations Map
Intermediate Wells, October 2006

DATE: 11/15/2006 3:31:57 PM
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Post-Construction Hydrogeologic Conditions Report

Figure 10
Groundwater Elevations Map
Deep Wells, October 2006

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APPENDIX A

BORING / MONITORING WELL LOGS AND PHOTOGRAPHS

Attachment A-1

Boring / Monitoring Well Logs

Log of Soil Boring and Well Construction B01/MW-01

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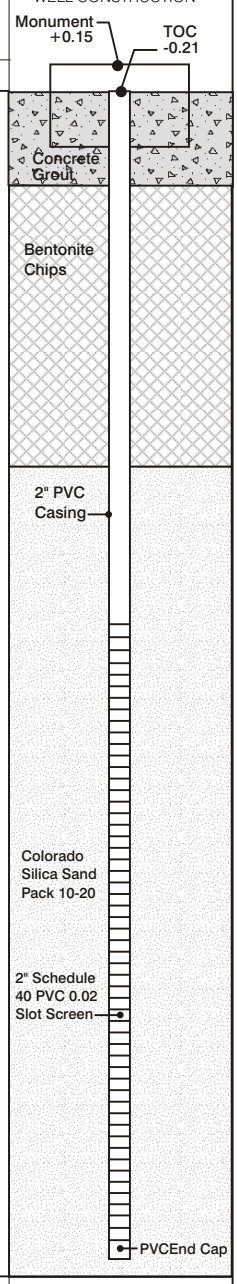
Floyd Snider
Boring B-01/MW-01 Date 8-28-06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Sunny
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 19.0 ATD Water Level Depth 9.0 Ft
Ground Surface Elevation 18.2

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
						Brown, Dry, GRAVEL with Silt and Sand. (Fill)
S-1	6 7 5	2.5	4.0	☒	GW	Brown to gray, damp GRAVEL with fine to coarse Sand.
S-2	2 3 3	7.5	9.0	☒	SW	Brown to gray, fine to coarse, moist SAND and Gravel.
S-3	2 2 3	12.5	14.0	☒	SW	Gray to brown, fine to coarse, wet SAND with Gravel. (Mostly slough. Limited recovery.)
S-4	8 3 5	17.5	19.0	☒	GW	Gray, wet GRAVEL with fine to coarse Sand. (Limited recovery.)
						Bottom of boring at 19.0 feet.

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B02/MW-02

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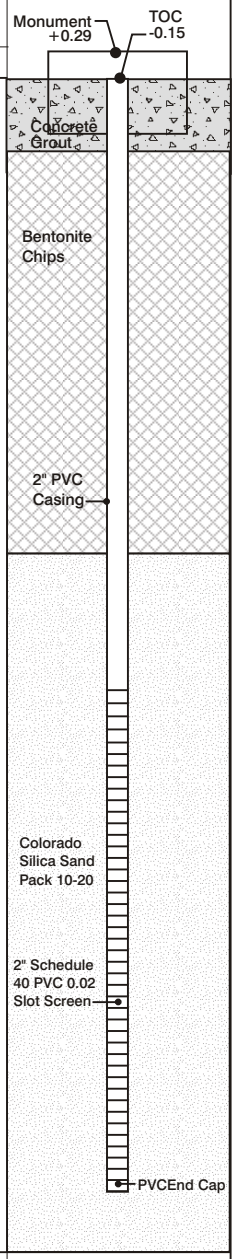
Floyd Snider
Boring B-02/MW-02 Date 8-28-06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Clear/Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Split Spoon
Bottom of Boring 23.5 ATD Water Level Depth 13.75 Ft
Ground Surface Elevation 19.8

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
S-1	8 9 15	3.5	5.0		GM	Dark gray, moist, GRAVEL with Silt and Sand.
S-2	3 3 2	8.5	10.0		SM	Dark gray to brown, moist, fine SAND with Silt.
S-3	0 0 1	13.5	15.0		ML	Gray to black, moist, SILT with Sand. (Abundant wood fragments present throughout drive.)
S-4	0 1 2	18.5	20.0		SM ML	Dark brown, wet, SILT with fine Sand to fine Sand with Silt. (Wood fragments present throughout drive.)
S-5	1 2 4	22.0	23.5		SM	Dark gray, wet, SAND with Silt. (Abundant wood fragments throughout drive. H_2S like odor.)

Bottom of boring at 23.5 feet.

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B03/MW-03

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Floyd Snider
Boring B-03/MW-03 Date 9-5-06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 19.5 ATD Water Level Depth 9.9 Ft
Ground Surface Elevation 17.8

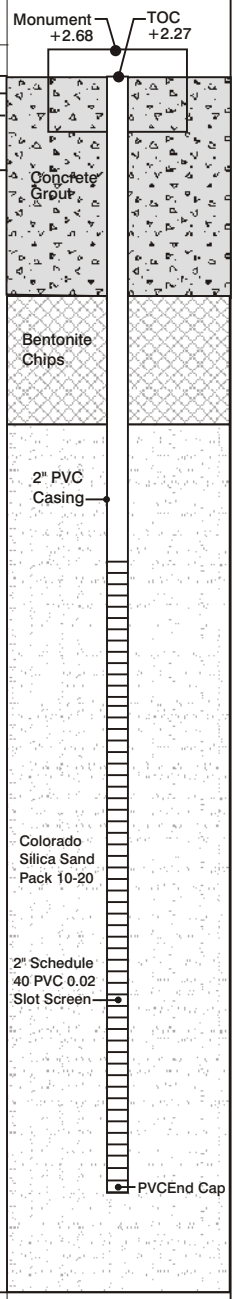
Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
						ASPHALT
						Removed via Vac Truck
						Large 3" to 5" diameter cobbles
S-1	NA	0.6	1.5			Gray, damp, fine SAND.
						(Sample S-1 collected by hand from 0.6' to 1.5' depth interval.)
						0.0' to 0.25' Asphalt 0.25' to 0.60' Large 3" to 5" diameter cobbles 0.60' to ? Gray, damp fine SAND
						Brown to gray, damp GRAVEL with fine to coarse Sand. (Excavated 0' to 10' using vacuum truck due to utility concerns.)
S-2	2	13.0	14.5		SP	Dark gray, wet, fine SAND with trace Silt.
S-3	2	18.0	19.5		SM	Dark gray, wet, fine to medium SAND with Silt.
						Bottom of boring at 19.50 feet.

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Blow counts: 0, 1, 1 (S-2); 0, 1, 1 (S-3)

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B04/MW-04

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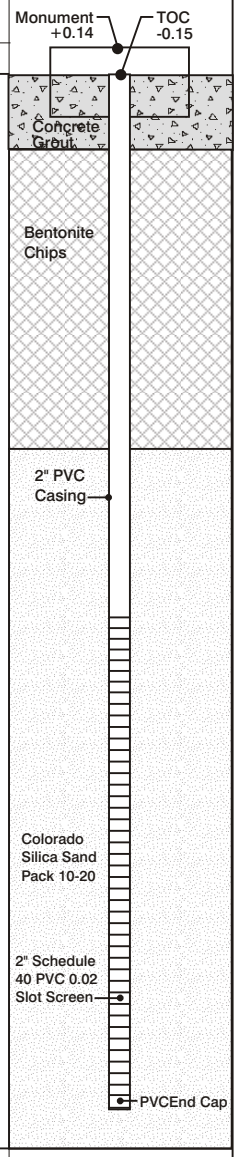
Floyd Snider
Boring B-04/MW-04 Date 9/06/06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 21.5 ATD Water Level Depth 12.20 Ft
Ground Surface Elevation 18.7

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
					GM	Brown, loose, damp, GRAVEL with Silt and Sand. (Fill)
						Cuttings show abundant damp wood fragments.
S-1	4	13.5	15.0		ML	Dark gray, moist to wet, SILT with fine Sand. (Abundant wood fragments.)
S-2	1	18.5	20.0		SM-ML	Dark brown, wet, SILT with abundant fine Sand. (Scattered wood fragments throughout drive.)
S-3	2	20.0	21.5			
						Bottom of boring at 21.5 feet.

Blow Count N/12": 3, 2, 2 (S-1); 2, 1, 0, 0, 1, 1 (S-2, S-3)

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B05/MW-05

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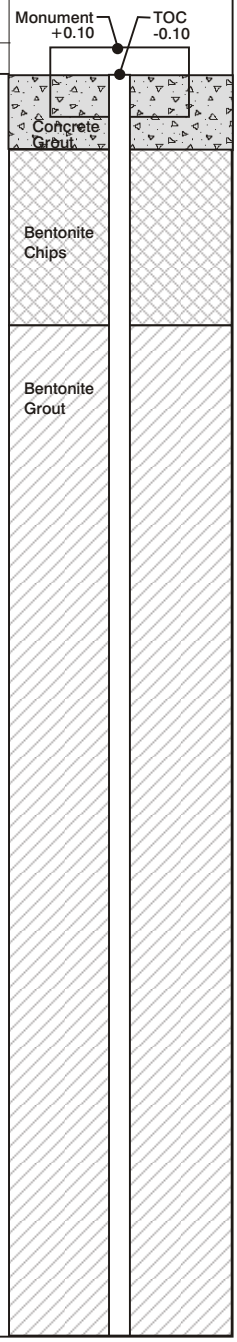
Floyd Snider
Boring B-05/MW-05 Date 9/05/06 Sheet 1 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Overcast
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 81.0 ATD Water Level Depth 12.85 Ft
Ground Surface Elevation 18.7

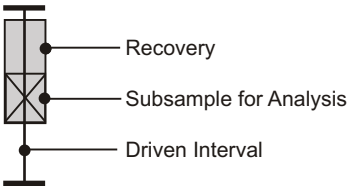
Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
					GM	Brown, damp, silty, sandy, gravelly, FILL at ground surface.
S-1	14	3.5	5.0			No Recovery
S-2	12	8.0	9.5		SM	Brown, gray, moist, fine SAND with Silt and trace Gravel. (Wood fragments noted from 8.0' to 8.5' depth.)
S-3	15	13.0	14.5		ML	Brown, gray, wet, SILT with fine Sand and Gravel. (Scattered wood fragments throughout drive.)
S-4	1	18.0	19.5		GM	Gray, wet, GRAVEL with fine Sand and Silt. (Likely slough material in sampler. Very little recovery.)
S-5	7	23.0	24.5		SM	Dark gray, wet fine SAND and Silt. (Abundant wood fragments throughout drive.)

Blow Count N/12": 5, 7, 7 (S-1); 2, 4, 8 (S-2); 3, 6, 9 (S-3); 0, 1, 0 (S-4); 1, 3, 4 (S-5)

WELL CONSTRUCTION





▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B05/MW-05

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Floyd Snider
Boring B-05/MW-05 Date 9/05/06 Sheet 2 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Overcast
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 81.0 ATD Water Level Depth 12.85 Ft
Ground Surface Elevation 18.7

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-6	3	28.5	30.0		SM	Dark gray, wet, fine SAND with Silt. (Scattered wood fragments throughout drive.)	Bentonite Grout
S-7	2	33.0	34.5		ML	Dark gray, wet, SILT with fine Sand. (Scattered wood fragments.)	
S-8	4	38.0	39.5		ML	Dark gray, wet, SILT with fine Sand. (Scattered shell fregments noted.)	
S-9	12	43.0	44.5		SM	Dark gray, wet, fine SAND with Silt. (Very abundant wood fragments. Strong sulphur-like odor. Scattered shells.)	
S-10	0	48.0	49.5		ML	Dark gray, wet, SILT with fine Sand. (Scattered wood fragments.)	

Depth scale: 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

Blow counts: 2, 2, 1 (S-6); 0, 0, 2 (S-7); 0, 2, 2 (S-8); 4, 6, 6 (S-9); 1, 0, 0 (S-10)

Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B05/MW-05

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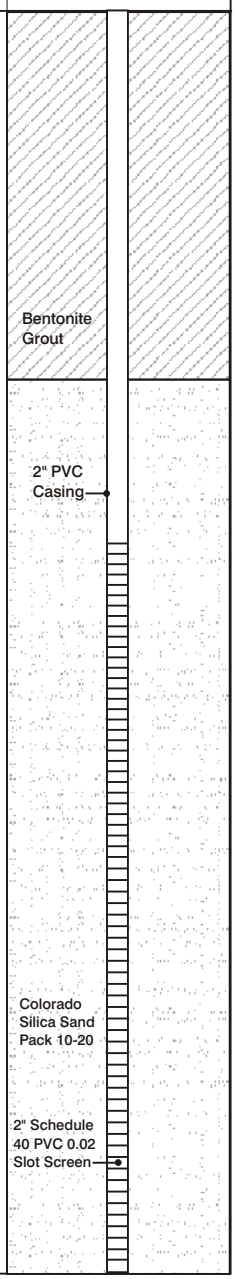
Floyd Snider
Boring B-05/MW-05 Date 9/05/06 Sheet 3 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Overcast
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 81.0 ATD Water Level Depth 12.85 Ft
Ground Surface Elevation 18.7

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
S-11	2	53.0	54.5		ML	Dark gray, wet, SILT with fine Sand. (Scattered wood fragments.)
S-12	2	58.0	59.5		ML	Dark gray, wet, SILT with fine Sand.
S-13	0	63.0	64.5		ML	Dark gray, wet, SILT with fine Sand. (Strong sulfur-like odor. Scattered shells.)
S-14	2	68.0	69.5		ML	Dark gray, wet, SILT with fine Sand. (Scattered wood fragments.)
S-15	8	73.0	74.5		ML	Dark gray, wet SILT with fine Sand and gravel. (Scattered shell and wood fragments noted. Faint chemical odor noted.)

Blow counts: 53 = 0, 0, 2; 58 = 0, 0, 2; 63 = 0, 0, 0; 68 = 0, 1, 1; 73 = 2, 3, 5

WELL CONSTRUCTION



▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B05/MW-05

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Floyd Snider
Boring B-05/MW-05 Date 9/05/06 Sheet 4 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Overcast
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 81.0 ATD Water Level Depth 12.85 Ft
Ground Surface Elevation 18.7

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY		USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-16	0	78.0	79.5		0 0 0	ML	Dark gray, wet, SILT with fine Sand. (Scattered shells. Creosote odor. Trace wood fragments.)	Colorado Silica Sand Pack 10-20 2" Schedule 40 PVC 0.02 Slot Screen PVCEnd Cap
							Bottom of boring at 81.0 feet.	

Depth scale: 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

Recovery
Subsample for Analysis
Driven Interval

∇ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B06/MW-06

FLOYD | SNIDER
strategy ▪ science ▪ engineering

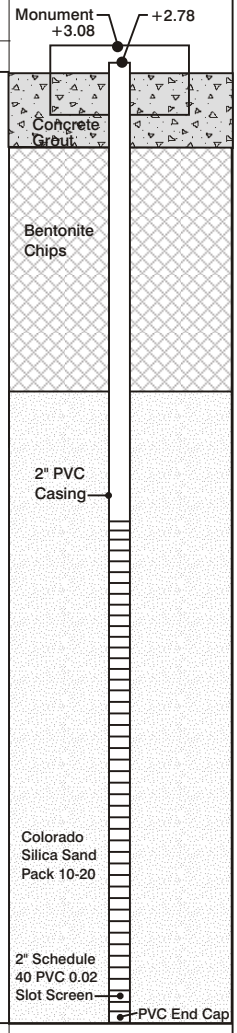
Floyd Snider
Boring B-06/MW-06 Date 8/30/06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 19.0 ATD Water Level Depth 12.5 Ft
Ground Surface Elevation 18.3

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
					GP-GM	Dry, brown, silty sandy gravelly FILL
S-1	6	12.5	14.0		SP	Dark gray, fine to medium, wet, SAND.
S-2	2	17.5	19.0		ML	Dark gray, wet SILT with fine to medium Sand.
					SM	Dark gray, wet, fine to medium SAND with Silt.
						Bottom of boring at 19.0 feet.

Blow Count: 1, 3, 3 (13–14); 2, 1, 1 (18–19)

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B07/MW-07

FLOYD | SNIDER
strategy ▪ science ▪ engineering

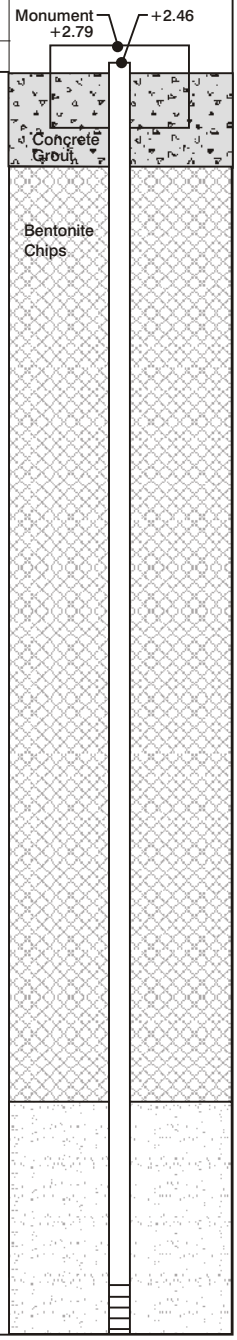
Floyd Snider
Boring B-07/MW-07 Date 8-30-06 Sheet 1 of 2
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 29.5 ATD Water Level Depth NA
Ground Surface Elevation 17.9

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
					GP-GM	Silty, sandy, gravelly FILL.
S-1	50	2.5	4.0		GP-GM	Light brown, fractured, dry to damp, GRAVEL with Sand and Silt. (Abundant wood fragments.)
S-2	14	7.5	9.0			NO RECOVERY (One 1.2" diameter rock in sampler.)
S-3	4	12.5	14.0		SP	Dark gray, fine to medium, wet SAND. (Scattered wood fragments noted.)
S-4	3	17.5	19.0		SP	Dark gray, fine to medium, wet SAND. (Scattered wood fragments noted.)

Blow Count N/12": 8, 18, 32 (S-1); 10, 9, 5 (S-2); 2, 2, 3 (S-3); 0, 1, 2 (S-4)

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B07/MW-07

FLOYD | SNIDER
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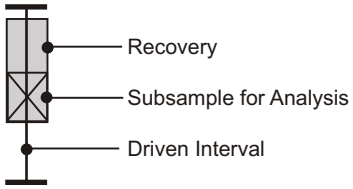
Floyd Snider
Boring B-07/MW-07 Date 8-30-06 Sheet 2 of 2
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 29.5 ATD Water Level Depth NA
Ground Surface Elevation 17.9

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY		USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-5	7	22.5	24.0		2, 3, 4	SM-ML	Dark gray, fine to medium, wet SAND. (23' to 24') Dark gray, wet SILT with Sand. (22.5' to 23') (Wood fragments and H_2S-like odor noted throughout drive.)	Colorado Silica Sand Pack 10-20
S-6	2	27.5	29.0		1, 1, 1	SP	Dark gray, fine to medium, wet SAND.	2" PVC Casing; 2" Schedule 40 PVC 0.02 Slot Screen; PVC End Cap
							Bottom of Boring at 29.5 Feet.	



▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B08/MW-08

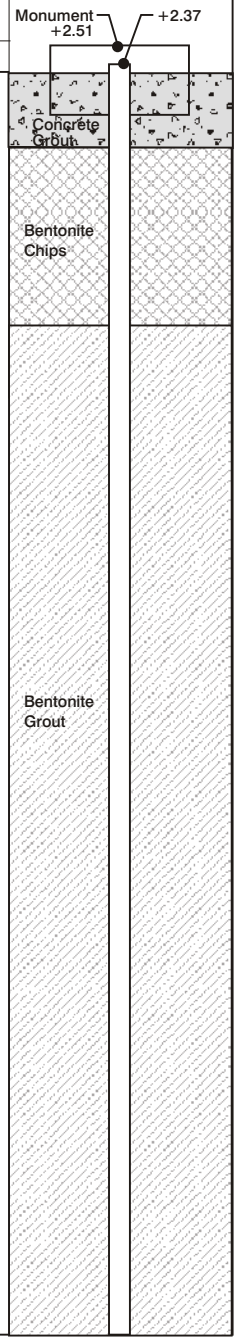
FLOYD | SNIDER
strategy ▪ science ▪ engineering

Floyd Snider
Boring B-08/MW-08 Date 8/31/06 Sheet 1 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 79.5 ATD Water Level Depth 11.8 Ft
Ground Surface Elevation 18.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	Depth	Blows	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
					0–1		GP-GM	Brown, damp, silty, sandy, gravelly FILL.
S-1	89/10"	3.0	4.5		3–4	6, 39, 50/4	GP-GM	Gray, damp, fractured GRAVEL with Sand and Silt. (Broken rock clogs shoe.)
S-2	11	8.0	9.5		8–9	6, 6, 5	ML	Gray, damp SILT with fine Sand. (3" thick Sand lense at 8.5').
					12		▽	
S-3	4	13.0	14.5		13–14	2, 2, 2	SP	Dark gray, wet, fine to medium SAND.
S-4	5	18.0	19.5		18–19	1, 3, 2	SP	Dark gray, wet, fine to medium SAND with scattered Silt lenses. (Scattered silt lenses throughout drive.)
S-5	2	23.0	24.5		23–24	0, 1, 1	ML	Dark, gray, wet, SILT with fine Sand. (Fine sand layer for first 3.5" of drive.)

WELL CONSTRUCTION



▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B08/MW-08

FLOYD | SNIDER
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Floyd Snider
Boring B-08/MW-08 Date 8/31/06 Sheet 2 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 79.5 ATD Water Level Depth 11.8 Ft
Ground Surface Elevation 18.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-6	2	28.5	30.0		SM	Dark, gray, wet, fine SAND with Silt. (Limited recovery.)	Bentonite Grout
S-7	2	33.0	34.5		ML	Dark, gray, moist, SILT with fine Sand.	
S-8	6	38.0	39.5		SM-ML	Dark, gray, wet, fine SAND with Silt. (Material is near sand-silt transition.)	
S-9	7	43.0	44.5		ML	Gray, wet, SILT with fine Sand. (Grades to sandy silt at bottom of drive.)	
S-10	6	48.0	49.5		SM-ML	Gray, wet, SILT with fine Sand. (Alternating fine sand and silt layers throughout drive, 4" thick. Lots of slough in split spoon.)	

Depth scale: 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

Blow counts: 29: 2, 1, 1; 33: 0, 1, 1; 38: 1, 3, 3; 43: 0, 3, 4; 48: 1, 2, 4

Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B08/MW-08

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Floyd Snider
Boring B-08/MW-08 Date 8/31/06 Sheet 3 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 79.5 ATD Water Level Depth 11.8 Ft
Ground Surface Elevation 18.6

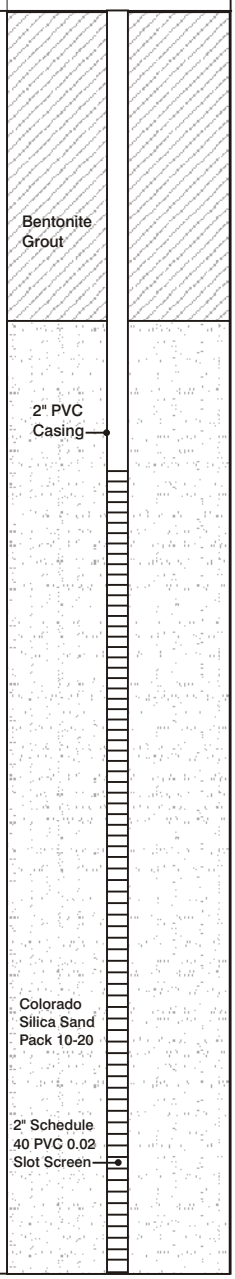
Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
S-11	2	53.0	54.5		SM	Dark, gray, wet, fine SAND with Silt. (Lots of slough in split spoon.)
S-12	0	58.0	59.5		ML	Dark, gray, wet, SILT with fine Sand. (Mostly silt with trace fine sand.)
S-13	8	63.0	64.5		SM-ML	Dark, gray, wet, SILT with fine Sand. (Material is near silt-sand transition.)
S-14	10	68.0	69.5		ML	Dark, gray, wet, SILT with fine Sand. (Becomes sandier toward lower 12" of drive. Very silty for upper 6" of drive.)
S-15	13	73.0	74.5		SM	Dark gray, wet, fine to medium SAND with Silt. (Wood fragments noted from 74.0' to 74.5' depth.)

Depth scale: 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75

Blow counts: S-11: 1, 1, 1; S-12: 0, 0, 0; S-13: 1, 3, 5; S-14: 2, 4, 6; S-15: 4, 6, 7

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

∇ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B08/MW-08

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Floyd Snider
Boring B-08/MW-08 Date 8/31/06 Sheet 4 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 79.5 ATD Water Level Depth 11.8 Ft
Ground Surface Elevation 18.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY		USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-16	1	78.0	79.5		0 0 1	SP-ML	Dark, gray, wet, fine to medium SAND (78.0' to 78.5') Dark, gray, wet, SILT with fine Sand. (78.5' to 79.5')	Colorado Silica Sand Pack 10-20 2" Schedule 40 PVC 0.02 Slot Screen PVC End Cap
							Bottom of boring at 79.5 feet.	

Depth scale: 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

Recovery
Subsample for Analysis
Driven Interval

∇ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B09/MW-09

FLOYD | SNIDER
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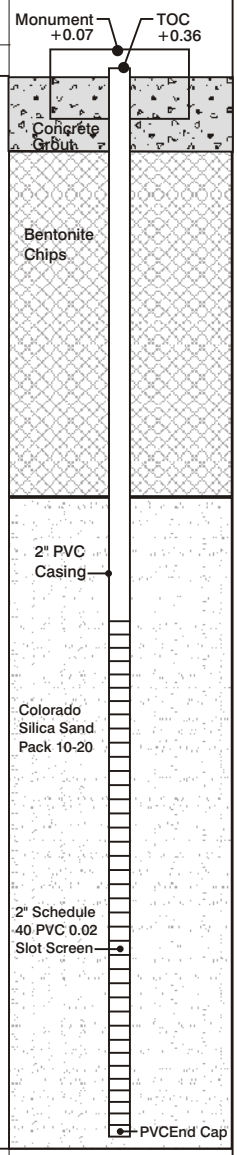
Floyd Snider
Boring B-09/MW-09 Date 8/28/06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 21.5 ATD Water Level Depth 14.0 Ft
Ground Surface Elevation 21.3

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
S-1	11	2.5	4.5		ML	Brown, damp SILT with Sand (Fill).
S-2	9	8.0	9.5		GM	Brown, damp, GRAVEL with fine to coarse Sand and Silt. (Limited recovery.)
S-3	2	13.0	14.5		SW	Brown, wet, fine to coarse SAND with Gravel. (Limited recovery.)
S-4	12	18.0	19.5		SW	Gray, wet, fine to coarse SAND with GRAVEL.
						Bottom of boring at 21.5 feet.

Blow Count N/12": 6, 6, 5 (S-1); 4, 4, 5 (S-2); 1, 1, 1 (S-3); 2, 8, 4 (S-4)

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B10/MW-10

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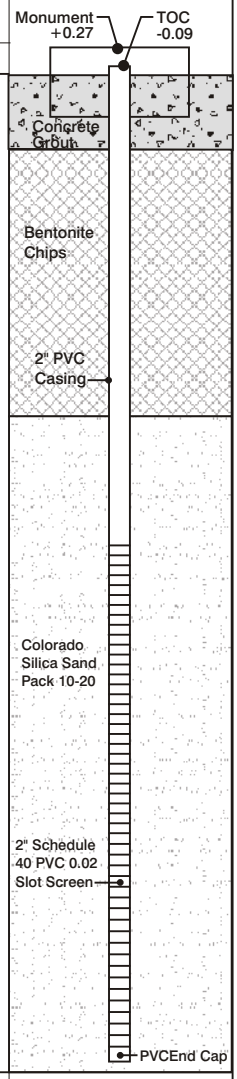
Floyd Snider
Boring B-10/MW-10 Date 8/30/06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Overcast/60°
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 20.0 ATD Water Level Depth NA
Ground Surface Elevation 18.5

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
						Silty, Sandy, Gravelly FILL at ground surface.
S-1	2	13.0	14.5		SM	Very loose, wet, black fine SAND with Silt. (Scattered wood fragments throughout drive.)
S-2	1	18.0	19.5		ML	Very soft, moist to wet, black, fine SILT with fine Sand. (Shell fragments throughout bottom 8" of drive. Wood fragments throughout drive.)
						Bottom of boring at 20 feet.

Blow Count: 13 — 1, 1, 1; 18 — 1, 0, 1

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B11/MW-11

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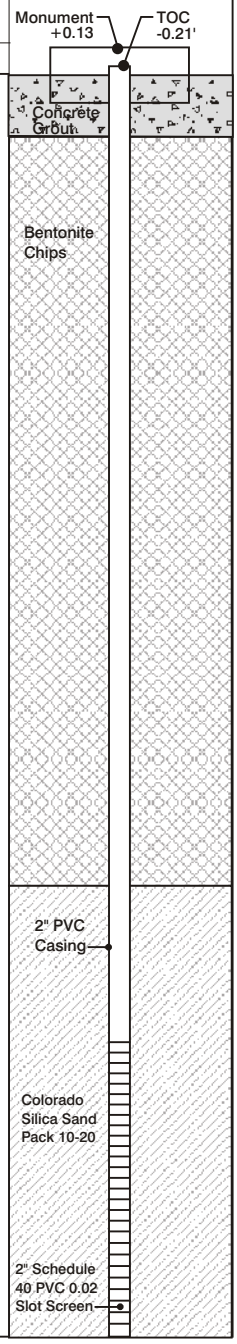
Floyd Snider
Boring B-11/MW-11 Date 8/29/06 Sheet 1 of 2
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 30.0 ATD Water Level Depth 11.1
Ground Surface Elevation 18.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY		USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
					0		(Did not collect samples from 0.0' to 23.0' depth.)
					1		
					2		
					3		
					4		
					5		
					6		
					7		
					8		
					9		
					10		
					11		
					12		
					13		
					14		
					15		
					16		
					17		
					18		
					19		
					20		
					21		
					22		
					23		
S-1	7	23.0	24.5	☒	3	SP	Loose, wet, dark gray, fine to medium SAND. (Scattered wood fragments throughout drive.)
					24 3 4		
					25		

WELL CONSTRUCTION



▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B11/MW-11

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Floyd Snider
Boring B-11/MW-11 Date 8/29/06 Sheet 2 of 2
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 30.0 ATD Water Level Depth
Ground Surface Elevation 18.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY		USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-2	0	28.0	29.5		0 0 0	ML	Very soft, wet, dark gray, SILT with fine Sand. (Shell fragments through bottom of drive. White colored shells)	Colorado Silica Sand Pack 10-20 2" Schedule 40 PVC 0.02 Slot Screen PVCEnd Cap
							Bottom of boring at 30 feet.	

Depth: 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B-12/MW-12

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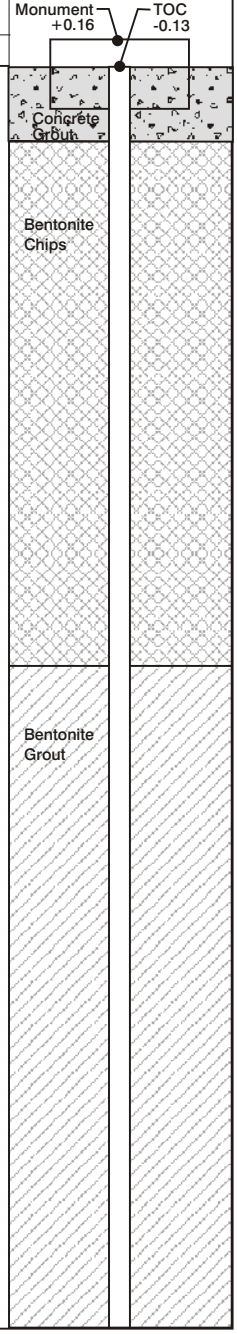
Floyd Snider
Boring B-12/MW-12 Date 8/29/06 Sheet 1 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 80.02 ATD Water Level Depth 11.5
Ground Surface Elevation 18.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
S-1	29	3.0	4.5		SM	Gray, damp, fine to medium SAND with Gravel and Silt (FILL).
S-2	2	8.0	9.5		SP	Dark brown, moist to wet, fine SAND. (Trace Gravel (FILL). Wood fragments present throughout drive.)
S-3	3	13.0	14.5		SP	Dark gray, wet, fine SAND with Silt.
S-4	1	18.0	19.5		SM-ML	Gray, wet, SILT with fine SAND. (Material is near Sand-Silt transition.)
S-5	11	23.0	24.5		SP	Gray, wet, fine to medium SAND. (Faint H_2S-like odor.)

Blow Counts: 0–3: 15, 16, 13; 8–9: 2, 1, 1; 13–14: 0, 1, 2; 18–19: 1, 0, 1; 23–24: 1, 4, 7

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B-12/MW-12

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Floyd Snider
Boring B-12/MW-12 Date 8/29/06 Sheet 2 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 80.02 ATD Water Level Depth 11.5
Ground Surface Elevation 18.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-6	0	28.0	29.5		ML	Gray, wet, SILT with fine Sand.	Bentonite Grout
S-7	4	33.0	34.5		SM	Gray, wet, fine SAND with Silt. (Scattered wood fragments throughout drive.)	
S-8	9	38.0	39.5		SM	Gray, wet, fine SAND with Silt.	
S-9	3	43.0	44.5		SM-ML	Gray, wet, fine SAND with Silt. (Alternating Sand/Silt layers throughout drive.)	
S-10	5	48.0	49.5		SP	Gray, wet, fine to medium SAND.	

Blow Counts: 25–28: 0; 29: 0; 0; 30–32; 33: 2; 34: 2; 2; 35–37; 38: 3; 39: 4; 5; 40–42; 43: 2; 44: 2; 1; 45–47; 48: 1; 49: 2; 3; 50

Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B-12/MW-12

FLOYD | SNIDER
strategy ▪ science ▪ engineering

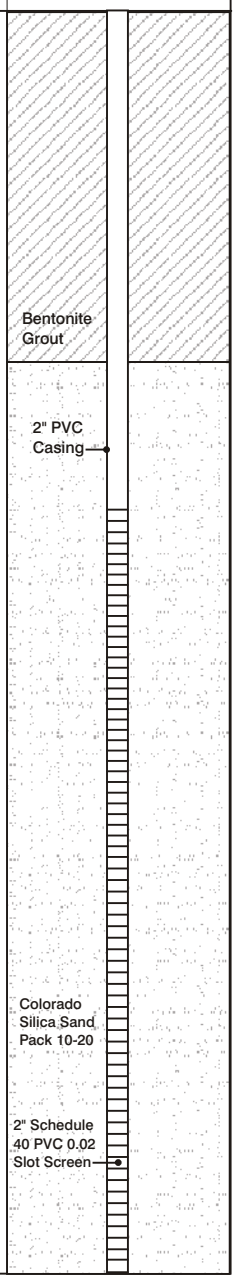
Floyd Snider
Boring B-12/MW-12 Date 8/29/06 Sheet 3 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 80.02 ATD Water Level Depth 11.5
Ground Surface Elevation 18.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
S-11	13	53.0	54.5		SP	Gray, wet, fine to medium SAND. (Blow counts are not representative: heaving during sample drive caused slough to collect in sampler. S-11 sample material is mostly slough (disturbed) but appears to be representative.)
S-12	10	58.0	59.5		SM	Gray, wet to fine medium SAND with Silt. (Scattered wood fragments.) .
S-13	9	63.0	64.5		SP	Gray, wet, fine SAND. (Scattered wood fragments.)
S-14	10	68.0	69.5		SP	Gray, wet, fine to medium SAND.
S-15	40	73.0	74.5		SP	Gray, wet, fine to medium SAND. (Limited recovery.)

Blow counts: 53–54: 0, 7, 6; 58–59: 3, 4, 6; 63–64: 3, 4, 5; 68–69: 4, 5, 5; 73–74: 5, 19, 21

WELL CONSTRUCTION



▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B-12/MW-12

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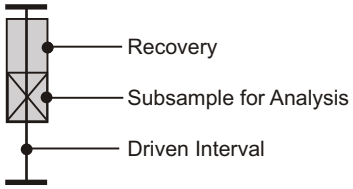
Floyd Snider
Boring B-12/MW-12 Date 8/29/06 Sheet 4 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 80.02 ATD Water Level Depth 11.5
Ground Surface Elevation 18.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY		USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-16	7	78.0	79.5		2 2 5	ML	Gray, wet, SILT with fine Sand. (Fine Sand in bottom of shoe suggests Sand may extend deeper.)	Colorado Silica Sand Pack 10-20; 2" Schedule 40 PVC 0.02 Slot Screen; PVCEnd Cap
							Bottom of boring at 80.5 feet.	



▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B-13/MW-13

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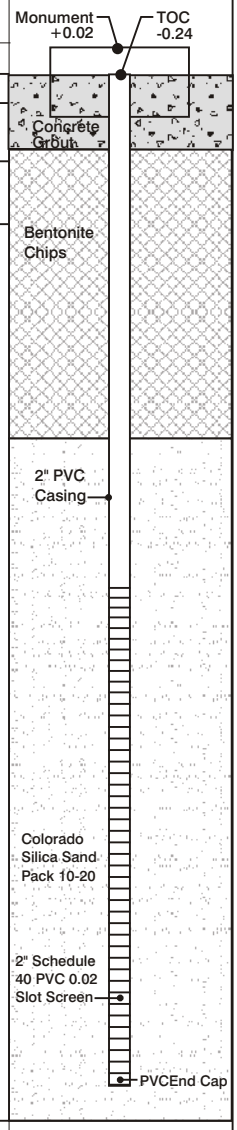
Floyd Snider
Boring B-013/MW-13 Date 9/06/06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 21.0 ATD Water Level Depth 11.9 Ft
Ground Surface Elevation 20.4

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
						ASPHALT — Removed via Vac Truck
						CRUSHED CONCRETE
						RIP-RAP AND DAMP GRAY SAND
						*Only collecting samples for material within anticipated screened interval of 0' to 10' MLLW.
S-1	16	13.0	14.5		SW	Dark gray, wet, fine to coarse SAND. (Very little recovery.)
S-2	7	18.5	20.0		SP	Dark gray, wet, fine to medium SAND. (Scattered shell fragments. Abundant wood fragments.) .
						Bottom of boring at 21.0 feet.

Blow Count: 8, 9, 7 (13–14); 2, 3, 4 (18–19)

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B-14/MW-14

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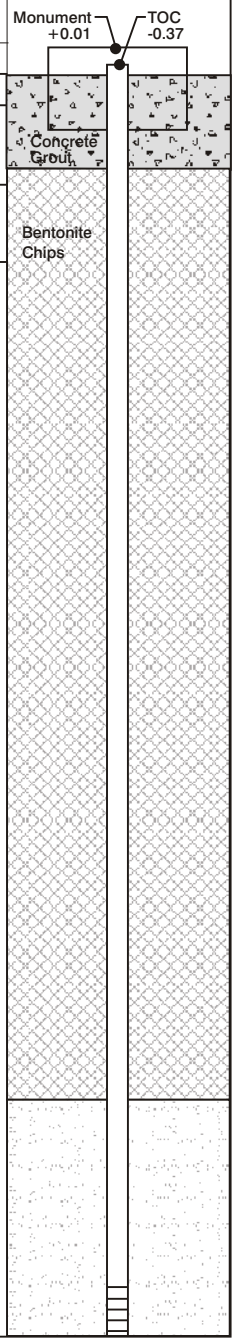
Floyd Snider

Boring B-14/MW-14 Date 9/1/06 Sheet 1 of 2
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 30.0 ATD Water Level Depth 12.4
Ground Surface Elevation 20.5

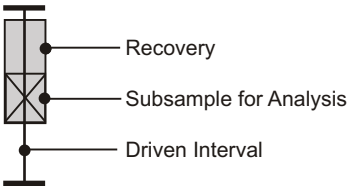
Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
						ASPHALT — Removed via Vac Truck
						CRUSHED CONCRETE
						RIP-RAP AND DAMP GRAY SAND
						* Only collecting samples through intended screened interval. (0' - 10' MLLW)

WELL CONSTRUCTION



0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B-14/MW-14

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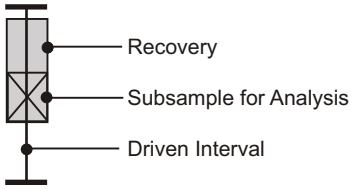
Floyd Snider
Boring B-14/MW-14 Date 9/1/06 Sheet 2 of 2
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 30.0 ATD Water Level Depth 12.4
Ground Surface Elevation 20.5

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-1	1	23.0	24.5		SP	Dark gray, wet, fine to medium SAND (Scattered shell fragments. Trace Gravels ~0.25". Organic-like sheen (faint) observed on cuttings 26' to 28'.)	Colorado Silica Sand Pack 10-20; 2" PVC Casing; 2" Schedule 40 PVC 0.02 Slot Screen; PVC End Cap
S-2	2	28.0	29.5		SM / ML	Dark gray, wet, fine to medium SAND with Silt. Grades to dark gray, damp to moist SILT with Sand. (Wood fragments throughout SILT portion of interval.)	

Bottom of Boring at 30.0 Feet.



▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B-15/MW-15

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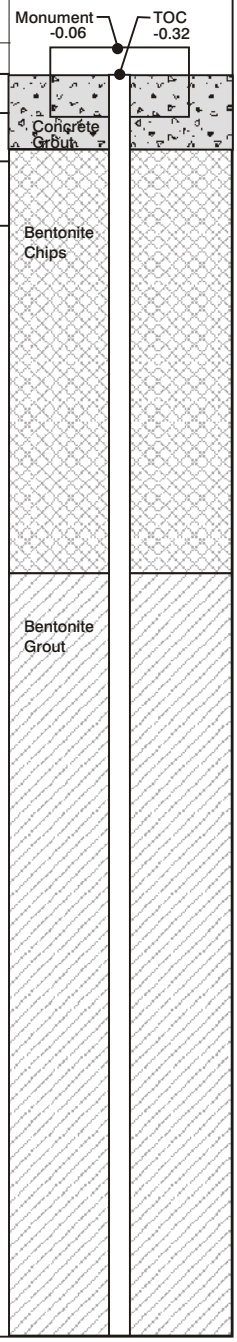
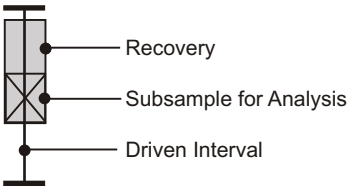
Floyd Snider
Boring B-15/MW-15 Date 9/05/06 Sheet 1 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 91.0 ATD Water Level Depth 12.75 Ft
Ground Surface Elevation 20.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	Depth	Blows	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
					0			ASPHALT — Removed via Vac Truck
					1			CRUSHED CONCRETE
					2			Rip-rap and Sand.
					3			
S-1	59	3.5	5.0		4	6, 25, 34	GM	Gray, fractured, damp, GRAVEL with fine to medium Sand and Silt. (FILL).
					5			
					6			
					7			
S-2	53	8.0	9.5		8	4, 24, 29	SP	Brown, decaying, damp, WOOD (8.0' to 9.0')
					9			Gray, fine, damp, SAND (9' to 9.5')
					10			
					11			
					12			
S-3	7	13.0	14.5		13	2, 3, 4	SP	Dark gray, fine to medium, wet, SAND (Trace 0.25" Gravels. Scattered wood fragments.)
					14			
					15			
					16			
					17			
S-4	2	18.0	19.5		18	0, 1, 1	SP	Dark gray, fine to medium, wet SAND with trace Gravel. (Scattered wood fragments and shells. Faint Creoste-like odor.)
					19			
					20			
					21			
					22			
S-5	3	23.0	24.5		23	1, 2, 1	SP	Dark gray, fine to to medium, wet SAND with Silt and scattered 0.3" Gravels. (Scattered shell fragments. Creosote-like odor.)
					24			
					25			

WELL CONSTRUCTION





▽ Groundwater Observed At Time of Drilling

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Floyd Snider

Boring B-15/MW-15 Date 9/05/06 Sheet 2 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 91.0 ATD Water Level Depth 12.75 Ft
Ground Surface Elevation 20.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	Depth	Blows	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-6	3	28.0	29.5		28–29	1, 1, 2	ML	Dark gray, moist SILT with fine Sand. (Scattered wood fragments. Trace Gravels.)	Bentonite Grout
S-7	9	33.0	34.5		33–34	2, 4, 5	SM-ML	Dark gray, wet, fine SAND with Silt to Silt with fine Sand. (Scattered wood fragments.)	
S-8	6	38.0	39.5		38–39	10, 5, 1		No Recovery.	
S-9	0	43.0	44.5		43–44	0, 0, 0	ML	Dark gray, wet, SILT with fine Sand. (Plastic, gooey, very flexible.)	
S-10	0	48.0	49.5		48–49	0, 0, 0	ML	Dark gray, wet, SILT with fine Sand. (Plastic, gooey, very flexible.)	

Depth scale: 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50

Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

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Floyd Snider

Boring B-15/MW-15 Date 9/05/06 Sheet 3 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 91.0 ATD Water Level Depth 12.75 Ft
Ground Surface Elevation 20.6

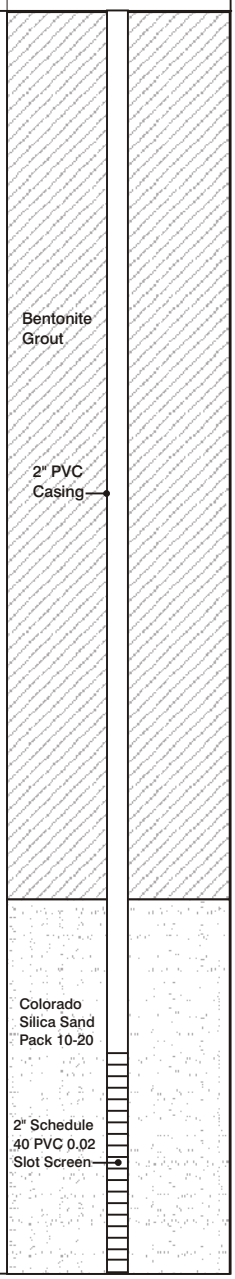
Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
S-11	3	53.0	54.5		ML-CL	Dark gray, wet, clayey SILT with fine Sand. (Scattered wood fragments).
S-12	4	58.0	59.5		SM-ML	Dark gray, wet, SILT with fine Sand. (Material is near Sand-Silt transition. Trace wood fragments.)
S-13	11	63.0	64.5		ML	Gray, wet, SILT with fine Sand. (Abundant wood fragments throughout drive.)
S-14	2	68.0	69.5		ML	Gray, wet, SILT with fine Sand. (Scattered wood fragments throughout drive.)
S-15	7	73.0	74.5		ML	Gray, wet, SILT with fine Sand. Slightly greater Sand content than S-14. (Scattered wood fragments throughout drive.)

Depth scale: 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75

Blow counts: 1, 2, 1 (S-11); 3, 2, 2 (S-12); 2, 5, 6 (S-13); 2, 1, 1 (S-14); 5, 4, 3 (S-15)

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

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Floyd Snider

Boring B-15/MW-15 Date 9/05/06 Sheet 4 of 4
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 91.0 ATD Water Level Depth 12.75 Ft
Ground Surface Elevation 20.6

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY		USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	WELL CONSTRUCTION
S-16	10	78.0	79.5		4 2 8	SM-ML	Gray, wet, fine SAND with Silt. (Material is transitional between Silt and Sand. Scattered wood fragments throughout drive.)	Colorado Silica Sand Pack 10-20; 2" Schedule 40 PVC 0.02 Slot Screen
S-17	18	83.0	84.5		3 9 9	SM-ML	Gray, wet, fine SAND with Silt. (Material is transitional between Silt and Sand. Scattered wood fragments throughout drive.)	
S-18	15	88.0	89.5		5 5 10	SM-ML	Gray, wet, SILT with fine Sand. (Material is at Sand-Silt transition. Slightly Siltier than S-17.)	PVCEnd Cap

Bottom of boring at 91.0 feet.

Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Attachment A-2

Monitoring Well Completion Photographs

Monitoring Well MW-01 in Containment Berm
- Photograph looking east

Monitoring Well MW-02 in St. Paul/
Middle Waterway Peninsula
- Photograph looking north

Monitoring Well MW-03 Adjacent to
Simpson Tacoma Kraft Mill
- Photograph looking north

Monitoring Well MW-03 Adjacent to
Simpson Tacoma Kraft Mill
- Photograph looking north

Monitoring Wells MW-04 and MW-05 in CDF
- Photograph looking east

Monitoring Wells MW-06, MW-07, and MW-08
in St. Paul/Middle Waterway Peninsula
- Photograph looking west

Monitoring Well MW-09 in Offset Berm
- Photograph looking north

Monitoring Wells MW-10, MW-11, and MW-12 in St. Paul/Middle Waterway Peninsula
- Photograph looking south

Monitoring Wells MW-13, MW-14, and MW-15 in Simpson Log Storage Property - Photograph looking south

Monitoring Wells MW-13, MW-14, and MW-15 in Simpson Log Storage Property - Photograph looking south

APPENDIX B

SLUG TEST DATA, METHODOLOGY, AND RESULTS

Attachment B-1

Slug Test Data

Note: The slug test data is provided on enclosed CD.

Attachment B-2

Bouwer and Rice Hydraulic Conductivity Method and Results

The Bouwer and Rice Method for Estimating Saturated Hydraulic Conductivity (K) of Aquifer Materials

The method of Bouwer and Rice (1976) for analyzing slug test data is commonly used to estimate saturated hydraulic conductivity (K) of aquifer materials. A mathematical solution by Bouwer and Rice (1976) is used to determine the hydraulic conductivity. Application of the Bouwer and Rice method to determine hydraulic conductivity involves calculating the slope of a straight line fit to the head response data collected during a slug test on a semi-log plot of normalized head vs. time. The line is fit to a segment of the data that is deemed to be representative of the undisturbed aquifer response.

The analytical solution of the mathematical model describing the Bouwer and Rice method (Bouwer 1989) can be written as:

$$K = \frac{r_c^2 \ln\left(R_e / r_w\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

where:

K = hydraulic conductivity;

r_c= radius of the well casing;

L_e= effective screen length;

t = time;

y = normalized head;

y_0 = y at time zero; and

y_t = y at time t.

The parameter R_e/r_w (effective radial distance over which y is dissipated, divided by the radial distance of well development) may be determined by one of two analytical solutions. Selection of the correct solution is dependant on whether the well fully penetrates the water-bearing formation.

The solution of a fully penetrating well is:

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln\left(L_w / r_w\right)} + \frac{C}{L_e / r_w} \right]^{-1}$$

While the solution of a partially penetrating well is:

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln\left(L_w / r_w\right)} + \frac{A + B \ln\left[(H - L_w)/r_w\right]}{L_e / r_w} \right]^{-1}$$

where:

L_w= depth of the well;

H = Saturated thickness above confining layer; and

A, B, and C = dimensionless empirical parameters that are a function of $\frac{L_e}{r_w}$ and are used for calculation of ln($\frac{R_e}{r_w}$).

The wells were considered to be partially penetrating because observations during coring and well installation did not identify the presence of discrete water bearing zones of limited vertical extent in any of the wells locations. Consequently, the wells were evaluated using the partially penetrating solution provided above.

An illustration of parameters A, B, and C is presented in Bouwer (1989). The values for these dimensionless parameters for monitoring wells MW-01 through MW-11 and MW-13 through MW-15 were calculated using a polynomial fit reported by Van Rooy (1988) and Boak (1991).

Table 1 presents the applicable well construction details and method parameters, as well as the resulting calculated hydraulic conductivities.

References

Boak, R. A., 1991. Auger Hole, Piezometer, and Slug Tests: A Literature Review, M.Sc. thesis, Civil Eng. Dept., Univ. of Newcastle upon Tyne, U.K.

Bouwer H., and R.C. Rice, 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, V.12 No. 3, 423-428, Water Resources Research.

Bouwer H., 1989. The Bouwer and Rice Slug Test – An Update, Vol. 27, No. 3, Groundwater.

Van Rooy, D., 1988. A Note on the Computerized Interpretation of Slug Test Data, Inst. Hydrodyn. Hydraulic Eng. Prog. Rep. 66, Tech. Unive., Denmark, 47, 1988.

Table 1
Slug Test Results Using Bouwer and Rice Method

Monitoring Well ID	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MW-11 (QA-QC)	MW-13	MW-14	MW-15	MW-15 (QA/QC)
Well Details and Method Parameters																
Well Depth in Feet	**18.5**	**22.25**	**20.18**	**20.81**	**80.69**	**22.09**	**32.38**	**81.9**	**21.14**	**19.83**	**29.59**	**29.59**	**20.46**	**29.67**	**91.18**	**91.18**
Screen Length in Feet	**10.0**	**10.0**	**10.0**	**10.0**	**20.0**	**10.0**	**10.0**	**20.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**20.0**	**20.0**
Depth to Screen in Feet	**8.38**	**12.03**	**9.83**	**10.61**	**60.47**	**11.87**	**22.04**	**61.68**	**10.92**	**9.49**	**19.37**	**19.37**	**10.24**	**19.45**	**70.96**	**70.96**
Depth to Aquitard in Feet	**30.0**	**30.0**	**21.5**	**33.0**	**100.0**	**26.0**	**35.0**	**82.0**	**50.0**	**28.0**	**30.0**	**30.0**	**27.7**	**30.0**	**100.0**	**100.0**
Depth to Water in Feet	**9.78**	**10.90**	**10.04**	**8.78**	**10.44**	**11.60**	**12.46**	**12.54**	**11.00**	**9.45**	**9.08**	**9.14**	**11.15**	**11.01**	**11.48**	**11.48**
Depth to Sandpack in Feet	**8.4**	**9.5**	**7.3**	**7.5**	**57.5**	**9.4**	**19.0**	**58.7**	**8.4**	**7.0**	**16.4**	**16.4**	**7.2**	**16.5**	**68.0**	**68.0**
Slug Displacement (H_o) in Feet	**0.97**	**2.68**	**3.86**	**4.74**	**3.49**	**2.33**	**1.28**	**2.78**	**0.36**	**2.43**	**2.30**	**2.05**	**2.92**	**3.91**	**4.10**	**3.35**
Porosity (n)	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**
Radius of Casing (r_c) in Feet	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**	**0.083**
Radius of Borehole (r_w) in Feet	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.400**
Saturated Aquifer Thickness (H) in Feet	20.22	19.10	11.46	24.22	89.56	14.40	22.54	69.46	39.00	18.55	20.92	20.86	16.59	18.99	88.52	88.52
Saturated Well Thickness (Lw) in Feet	8.60	11.13	9.79	11.83	70.03	10.27	19.58	69.14	9.92	10.04	20.29	20.23	9.09	18.44	79.48	79.48
Effective Radius (r_{eff}) in Feet	0.275	0.275	0.275	0.275	0.083	0.275	0.083	0.083	0.275	0.275	0.083	0.083	0.275	0.083	0.083	0.083
Effective Screen Length (L_e) in Feet	8.6	10.0	9.8	10.0	20.0	10.0	10.0	20.0	9.9	10.0	10.0	10.0	9.1	10.0	20.0	20.0
Fully Submerged Sandpack	No	No	No	No	Yes	No	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes
Transiently Exposed Sandpack	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes	No	No	Yes	No	No	No
Transiently Exposed Screen	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes	No	No	Yes	No	No	No
Partially Submerged Screen	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	Yes	No	No	No
Normalized Head at t_1 (y_1) in Feet	**1.5602**	**0.4600**	**0.5023**	**0.4450**	**0.5582**	**0.7643**	**1.0644**	**4.3738**	**1.1411**	**0.7488**	**0.9965**	**0.9966**	**0.5943**	**0.5796**	**0.5458**	**0.6638**
Time - t_1 in Seconds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Normalized Head at t_2 (y_2) in Feet	**2.33E-232**	**1.19E-07**	**5.00E-11**	**2.71E-01**	**6.23E-02**	**3.4769E-58**	**1.10E-100**	**1.05E-184**	**1.03E-199**	**2.51E-38**	**4.41E-173**	**5.26E-131**	**1.95E-38**	**2.72E-03**	**8.37E-06**	**1.03E-05**
Time - t_2 in Seconds	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**
L_e/r_w	21.5	25	24.475	25	50	25	25	50	24.8	25	25	25	22.725	25	50	50
Coefficient A [a]	2.2	2.3	2.3	2.3	3.0	2.3	2.3	3.0	2.3	2.3	2.3	2.3	2.2	2.3	3.0	3.0
Coefficient B [a]	0.3	0.4	0.4	0.4	0.5	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5
Coefficient C [a]	1.6	1.8	1.7	1.8	2.6	1.8	1.8	2.6	1.7	1.8	1.8	1.8	1.7	1.8	2.6	2.6
Partially Penetrating Well																
$\ln(R_e/r_w)$ [b]	1.942	2.145	2.197	2.142	3.207	2.153	2.485	3.832	2.008	2.094	2.682	2.681	2.018	2.655	3.344	3.344
K in cm/sec	4.6E-01	1.3E-02	2.0E-02	4.1E-04	1.2E-04	1.1E-01	2.0E-02	2.9E-02	3.6E-01	7.0E-02	3.8E-02	2.8E-02	7.4E-02	5.0E-04	6.5E-04	6.5E-04
Fully Penetrating Well																
$\ln(R_e/r_w)$ [b]	2.304	2.494	2.410	2.532	3.760	2.444	2.834	3.753	2.421	2.430	2.854	2.853	2.349	2.798	3.833	3.833
K in cm/sec	5.5E-01	1.5E-02	2.2E-02	4.8E-04	1.5E-04	1.2E-01	2.3E-02	2.8E-02	4.3E-01	8.1E-02	4.0E-02	3.0E-02	8.6E-02	5.3E-04	7.5E-04	7.5E-04

Notes:

Bold values are entered manually and other values are calculated.

All depths are below measuring point and not below the ground surface

[a] A, B, and C coefficients are calculated using regression equations of Van Rooy (1988).

[b] R_e/r_w is the effective radial distance over which y is dissipated, divided by the radial distance of well development.

Shallow well

Intermediate depth well

Deep well

Attachment B-3

Butler Hydraulic Conductivity Method and Results

The Butler Method for Analysis of Slug Tests in Formations of High Hydraulic Conductivity

Slug tests in formations of high hydraulic conductivity (K) are often affected by mechanisms that are ignored in models developed for tests in less permeable formations. In situations where oscillatory data patterns are evident, graphical matching of theoretical type curves to plots of slug test response data enable estimation of hydraulic conductivity.

The method developed by Butler and Garnett (2000) is summarized below:

1. Pressure transducer readings are plotted versus the time since some arbitrary starting point. The time at which the test began and the pressure head corresponding to static conditions are identified from this plot. The static pressure head and the test start time are then subtracted from the head and time records respectively, to obtain a plot of the deviation of pressure head from static conditions (designated as H(t)) versus the time since test initiation. The deviation data are normalized using the change in water level (H_0) that initiated the test.

2. A graph of theoretical type curves is prepared. These type curves are in the form of plots of the normalized deviation of the water level from static conditions versus dimensionless time. The type curves are generated using the following equations:

$$W_d(t_d) = e^{\frac{-C_D}{2} t_D} \left[\cos(\omega_d t_d) + \frac{C_D}{2\omega_d} \sin(\omega_d t_d) \right], \; C_D < 2 \qquad (1)$$

$$W_d(t_d) = e^{-t_d} (1 + t_d), \; C_D = 2 \qquad (2)$$

$$W_d(t_d) = -\left(\frac{1}{\omega_d^+ - \omega_d^-} \right) \left[\omega_d^- e^{\omega_d^+ t_d} - \omega_d^+ e^{\omega_d^- t_d} \right], \; C_D > 2 \qquad (3)$$

Where:

C_D = dimensionless damping parameter;

g = gravitational acceleration;

H_0 = change in water level initiating a slug test (initial displacement);

L_e = effective length of water column inwell;

t_d = dimensionless time parameter, $(g/L_e)^{1/2}t$

t = time;

w = deviation of water level from static level in well;

w_d = normalized water level deviation (w/H_0);

ω_d = dimensionless frequency parameter $\left(=|1-(C_D/2)^2|^{1/2}\right)$;

$\omega_d^{\pm}$ = $-\frac{C_D}{2} \pm \omega_d$;

3. The type curves are superimposed on a plot of the test data. The dimensionless time axis is expanded or contracted until a reasonable match is obtained between a C_D type curve and the test data. Match points are then determined by reading the corresponding times from the real (t*) and dimensionless (t_d*) time axes.

4. The radial hydraulic conductivity (K_r) is estimated by substituting the well construction parameters, the C_D value, and the match-point ratio (t_d*/t*) into the appropriate equation:

   Unconfined – High-K Bouwer and Rice Model

$$K_r = \frac{t_d^* r_c^2 \ln\left[R_e / r_w\right]}{t^* 2bC_D} \qquad (4)$$

   Confined – High-K Horslev Model

$$K_r = \frac{t_d^* r_c^2 \ln\left[b/(2r_w) + (1+(b/(2r_w))^2)^{0.5}\right]}{t^* 2bC_D} \qquad (5)$$

   where:

   b = screen length;

   R_e = effective radius parameter of Bouwer and Rice (1976);

   r_c = effective radius of well casing (corrected for radius of transducer cable);

   r_w = radius of well screen or borehole.

No aquitard was observed to be present along the vertical section of sediments encountered throughout the screened interval of Monitoring Well MW-12 during installation of the well. Thus, the hydraulic conductivity for Monitoring Well MW-12 was evaluated using the unconfined case represented by equation (4).

The definition of dimensionless time following equation (3) includes a parameter designated as the effective length of the water column (L_e). L_e is calculated as part of the analysis process using the following equation:

$$Le = \left(\frac{t^*}{t_d^*}\right)^2 g \qquad (6)$$

Table 1 presents the applicable well construction details and method parameters, as well as the resulting calculated hydraulic conductivity for Monitoring Well MW-12.

References

Bouwer H., and R.C. Rice, 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, V.12 No. 3, 423-428, Water Resources Research.

Butler, James Jr., and Elizebeth J. Garnett, 2000. Simple Procedures for Analysis of Slug Tests in Formations of High Hydraulic conductivity using Spreadsheet and Scientific Graphics Software, Kansas Geological Survey Open File Report 2000-40, December 2000.

Table 1
Slug Test Results Using Butler Method

Test Well Specs - "d" not used in confined case

Depth to Bottom of Screen (from toc):	80.02	ft
Screen Length (b):	20	ft
Depth to Static Water Level (from toc):	9.5	ft
Top of Screen to Water Table (d):	50.3	ft
Radius of Well Screen (r_w):	0.083	ft
Nominal Radius of Well Casing (r_{nc}):	0.083	ft
Radius of Transducer Cable (r_{tc}):	0.010	ft
Effective Casing Radius ($r_c = (r_{nc}^2-r_{tc}^2)^{0.5}$):	0.083	ft
Modified Screen Radius (r_w^*):	0.083	ft
Aspect Ratio (b/r_w^*):	240.964	
Formation Thickness (B):	100	ft

		Best Fit		
Time		**Type Curve**		
Correlation Ratio		**C_D**		
t_d^*/t^*		0.545		
0.784				
computed from ratio	Le =	52.35	ft	
nominal	Le =	60.52	ft	
% difference		14%		
Modulation Factor =		1.275		
(frequency)				

Confined - High-K Hvorslev Model

$K_r = \frac{t_d^* r_c^2 \ln[b/(2r_w^*)+(1+(b/(2r_w^*))^2)^{0.5}]}{t^* \quad 2bC_D}$

Bracketted quantity 240.968

K_r =	**1.35E-03**	**ft/sec**		
	1.17E+02	**ft/day**	**3.55E+01**	**m/day**
	4.11E-02	**cm/sec**		

Unconfined - High-K Bouwer and Rice Model

$K_r = \frac{t_d^* r_c^2 \ln[R_e/r_w^*]}{t^* \quad 2bC_D}$

$\ln(R_e/r_w^*)$=	4.498		***A*** =	6.496
			B =	1.319
	first term	$1.1/(\ln((d+b)/r_w^*)$		
		0.163		
	second term		$(A + B^*(\ln[(B-(d+b))/r_w^*]))/(b/r_w^*)$	
			0.059	
	$\ln[(B-(d+b))/r_w^*]$		5.880	
			Cannot exceed 6.	
			See Butler (1997) - p.108.	

K_r =	**1.11E-03**	**ft/sec**		
	9.56E+01	**ft/day**	**2.91E+01**	**m/day**
	3.38E-02	**cm/sec**		

A = $1.4720+3.537E-2(b/r_w^*)-8.148E-5(b/r_w^*)^2+1.028E-7(b/r_w^*)^3-6.484E-11(b/r_w^*)^4+1.573E-14(b/r_w^*)^5$

B = $0.2372+5.151E-3(b/r_w^*)-2.682E-6(b/r_w^*)^2-3.491E-10(b/r_w^*)^3+4.738E-13(b/r_w^*)^4$

Test Time	Deviation From Static	Test Time	Normalized Head	Dimensionless Time	C_D = 0.545	Adjusted Time
0	-2.134	0	1.000	0	1	0
0.5	-1.527	0.5	0.716	0.1	0.995094	0.1275
1	-1.665	1	0.780	0.2	0.980771	0.2550
1.5	-1.038	1.5	0.486	0.3	0.957671	0.3825
2	-0.465	2	0.218	0.4	0.926483	0.5100
2.5	0.043	2.5	-0.020	0.5	0.88794	0.6375
3	0.415	3	-0.194	0.6	0.842807	0.7650
3.5	0.681	3.5	-0.319	0.7	0.791873	0.8925
4	0.787	4	-0.369	0.8	0.735939	1.0200
4.5	0.745	4.5	-0.349	0.9	0.675816	1.1475
5	0.626	5	-0.293	1	0.61231	1.2750
5.5	0.424	5.5	-0.199	1.1	0.546218	1.4025
6	0.197	6	-0.092	1.2	0.478321	1.5300
6.5	-0.022	6.5	0.010	1.3	0.409373	1.6575
7	-0.202	7	0.095	1.4	0.340101	1.7850
7.5	-0.335	7.5	0.157	1.5	0.271197	1.9125
8	-0.400	8	0.187	1.6	0.20331	2.0400
8.5	-0.409	8.5	0.192	1.7	0.137047	2.1675
9	-0.370	9	0.173	1.8	0.072966	2.2950
9.5	-0.294	9.5	0.138	1.9	0.011574	2.4225
10	-0.204	10	0.096	2	-0.046673	2.5500
10.5	-0.112	10.5	0.052	2.1	-0.101378	2.6775
11	-0.025	11	0.012	2.2	-0.152195	2.8050
11.5	0.042	11.5	-0.020	2.3	-0.198837	2.9325
12	0.081	12	-0.038	2.4	-0.241071	3.0600
12.5	0.094	12.5	-0.044	2.5	-0.27872	3.1875
13	0.093	13	-0.044	2.6	-0.311663	3.3150
13.5	0.070	13.5	-0.033	2.7	-0.339827	3.4425
14	0.036	14	-0.017	2.8	-0.363193	3.5700
14.5	-0.003	14.5	0.001	2.9	-0.381788	3.6975
15	-0.041	15	0.019	3	-0.395684	3.8250
15.5	-0.074	15.5	0.035	3.1	-0.404995	3.9525
16	-0.094	16	0.044	3.2	-0.409874	4.0800
16.5	-0.104	16.5	0.049	3.3	-0.410508	4.2075
17	-0.106	17	0.050	3.4	-0.407117	4.3350
17.5	-0.096	17.5	0.045	3.5	-0.399947	4.4625

Table 1
Slug Test Results Using Butler Method

	18	-0.084		18	0.039		3.6	-0.389268		4.5900												
	18.5	-0.068		18.5	0.032		3.7	-0.37537		4.7175												
	19	-0.056		19	0.026		3.8	-0.358559		4.8450												
	19.5	-0.041		19.5	0.019		3.9	-0.339153		4.9725												
	20	-0.025		20	0.012		4	-0.317478		5.1000												
	20.5	-0.022		20.5	0.010		4.1	-0.293866		5.2275												
	21	-0.016		21	0.007		4.2	-0.268648		5.3550												
	21.5	-0.020		21.5	0.009		4.3	-0.242156		5.4825												
	22	-0.023		22	0.011		4.4	-0.214714		5.6100												
	22.5	-0.026		22.5	0.012		4.5	-0.18664		5.7375												
	23	-0.036		23	0.017		4.6	-0.158239		5.8650												
	23.5	-0.038		23.5	0.018		4.7	-0.129807		5.9925												
	24	-0.045		24	0.021		4.8	-0.10162		6.1200												
	24.5	-0.048		24.5	0.022		4.9	-0.07394		6.2475												
	25	-0.049		25	0.023		5	-0.04701		6.3750												
	25.5	-0.051		25.5	0.024		5.1	-0.02105		6.5025												
	26	-0.051		26	0.024		5.2	0.003737		6.6300												
	26.5	-0.050		26.5	0.023		5.3	0.027173		6.7575												
	27	-0.046		27	0.022		5.4	0.049102		6.8850												
	27.5	-0.042		27.5	0.020		5.5	0.06939		7.0125												
	28	-0.038		28	0.018		5.6	0.087927		7.1400												
	28.5	-0.042		28.5	0.020		5.7	0.104626		7.2675												
	29	-0.034		29	0.016		5.8	0.119422		7.3950												
	29.5	-0.036		29.5	0.017		5.9	0.132272		7.5225												
	30	-0.033		30	0.015		6	0.143153		7.6500												
	30.5	-0.039		30.5	0.018		6.1	0.152066		7.7775												
	31	-0.037		31	0.017		6.2	0.159027		7.9050												
	31.5	-0.038		31.5	0.018		6.3	0.164073		8.0325												
	32	-0.038		32	0.018		6.4	0.167255		8.1600												
	32.5	-0.039		32.5	0.018		6.5	0.168642		8.2875												
	33	-0.044		33	0.021		6.6	0.168316		8.4150												
	33.5	-0.038		33.5	0.018		6.7	0.16637		8.5425												
	34	-0.042		34	0.020		6.8	0.16291		8.6700												
	34.5	-0.041		34.5	0.019		6.9	0.158049		8.7975												
	35	-0.041		35	0.019		7	0.151909		8.9250												
	35.5	-0.038		35.5	0.018		7.1	0.144617		9.0525												
	36	-0.039		36	0.018		7.2	0.136306		9.1800												
	36.5	-0.038		36.5	0.018		7.3	0.12711		9.3075												
	37	-0.038		37	0.018		7.4	0.117166		9.4350												
	37.5	-0.037		37.5	0.017		7.5	0.10661		9.5625												
	38	-0.037		38	0.017		7.6	0.095577		9.6900												
	38.5	-0.038		38.5	0.018		7.7	0.0842		9.8175												
	39	-0.038		39	0.018		7.8	0.072608		9.9450												
	39.5	-0.040		39.5	0.019		7.9	0.060924		10.0725												
	40	-0.037		40	0.017		8	0.049268		10.2000												
	40.5	-0.041		40.5	0.019		8.1	0.037751		10.3275												
	41	-0.040		41	0.019		8.2	0.026478		10.4550												
	41.5	-0.037		41.5	0.017		8.3	0.015545		10.5825												
	42	-0.040		42	0.019		8.4	0.005041		10.7100												
	42.5	-0.041		42.5	0.019		8.5	-0.004955		10.8375												
	43	-0.042		43	0.020		8.6	-0.014373		10.9650												
	43.5	-0.036		43.5	0.017		8.7	-0.023151		11.0925												
	44	-0.040		44	0.019		8.8	-0.031239		11.2200												
	44.5	-0.035		44.5	0.016		8.9	-0.038594		11.3475												
	45	-0.041		45	0.019		9	-0.045183		11.4750												
	45.5	-0.039		45.5	0.018		9.1	-0.050983		11.6025												
	46	-0.041		46	0.019		9.2	-0.055981		11.7300												
	46.5	-0.039		46.5	0.018		9.3	-0.060168		11.8575												

Table 1
Slug Test Results Using Butler Method

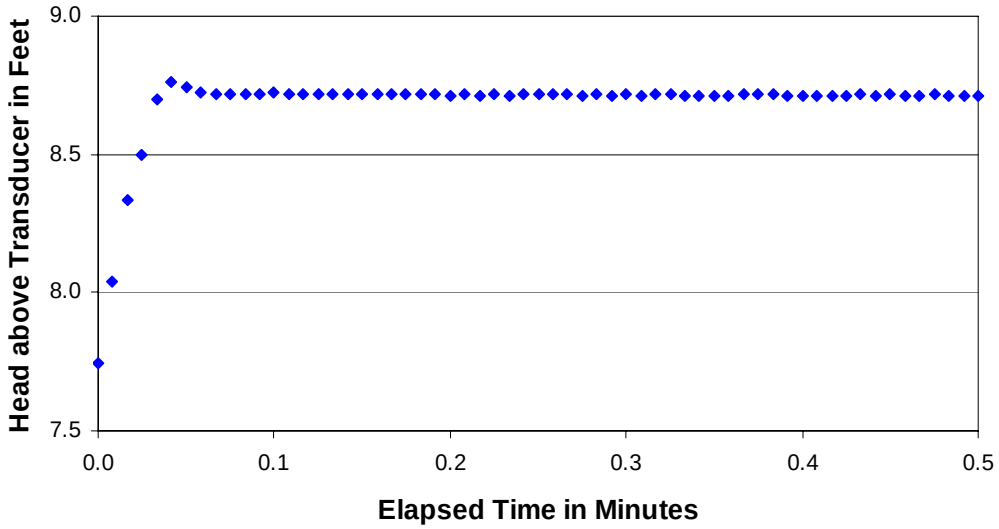
	47	-0.039		47	0.018		9.4	-0.063549		11.9850												
	47.5	-0.040		47.5	0.019		9.5	-0.066132		12.1125												
	48	-0.040		48	0.019		9.6	-0.067935		12.2400												
	48.5	-0.039		48.5	0.018		9.7	-0.068982		12.3675												
	49	-0.036		49	0.017		9.8	-0.069302		12.4950												
	49.5	-0.025		49.5	0.012		9.9	-0.068932		12.6225												
	50	-0.039		50	0.018		10	-0.067911		12.7500												
	50.5	-0.039		50.5	0.018		10.1	-0.066283		12.8775												
	51	-0.040		51	0.019		10.2	-0.064098		13.0050												
	51.5	-0.038		51.5	0.018		10.3	-0.061405		13.1325												
	52	-0.039		52	0.018		10.4	-0.058258		13.2600												
	52.5	-0.040		52.5	0.019		10.5	-0.054711		13.3875												
	53	-0.038		53	0.018		10.6	-0.05082		13.5150												
	53.5	-0.037		53.5	0.017		10.7	-0.046642		13.6425												
	54	-0.040		54	0.019		10.8	-0.042231		13.7700												
	54.5	-0.037		54.5	0.017		10.9	-0.037644		13.8975												
	55	-0.039		55	0.018		11	-0.032934		14.0250												
	55.5	-0.037		55.5	0.017		11.1	-0.028154		14.1525												
	56	-0.037		56	0.017		11.2	-0.023353		14.2800												
	56.5	-0.038		56.5	0.018		11.3	-0.01858		14.4075												
	57	-0.037		57	0.017		11.4	-0.01388		14.5350												
	57.5	-0.038		57.5	0.018		11.5	-0.009294		14.6625												
	58	-0.037		58	0.017		11.6	-0.00486		14.7900												
	58.5	-0.040		58.5	0.019		11.7	-0.000615		14.9175												
	59	-0.038		59	0.018		11.8	0.003411		15.0450												
	59.5	-0.038		59.5	0.018		11.9	0.007191		15.1725												
	60	-0.038		60	0.018		12	0.0107		15.3000												
	60.5	-0.037		60.5	0.017		12.1	0.013919		15.4275												
	61	-0.037		61	0.017		12.2	0.016832		15.5550												
	61.5	-0.037		61.5	0.017		12.3	0.019426		15.6825												
	62	-0.036		62	0.017		12.4	0.021695		15.8100												
	62.5	-0.036		62.5	0.017		12.5	0.023631		15.9375												
	63	-0.037		63	0.017		12.6	0.025236		16.0650												
	63.5	-0.039		63.5	0.018		12.7	0.02651		16.1925												
	64	-0.036		64	0.017		12.8	0.027458		16.3200												
	64.5	-0.038		64.5	0.018		12.9	0.028089		16.4475												
	65	-0.032		65	0.015		13	0.028414		16.5750												
	65.5	-0.040		65.5	0.019		13.1	0.028445		16.7025												
	66	-0.034		66	0.016		13.2	0.028197		16.8300												
	66.5	-0.039		66.5	0.018		13.3	0.027689		16.9575												
	67	-0.037		67	0.017		13.4	0.026939		17.0850												
	67.5	-0.038		67.5	0.018		13.5	0.025966		17.2125												
	68	-0.037		68	0.017		13.6	0.024792		17.3400												
	68.5	-0.036		68.5	0.017		13.7	0.02344		17.4675												
	69	-0.039		69	0.018		13.8	0.021931		17.5950												
	69.5	-0.035		69.5	0.016		13.9	0.020289		17.7225												
	70	-0.035		70	0.016		14	0.018537		17.8500												
	70.5	-0.034		70.5	0.016		14.1	0.016697		17.9775												
	71	-0.038		71	0.018		14.2	0.014793		18.1050												

Attachment B-4

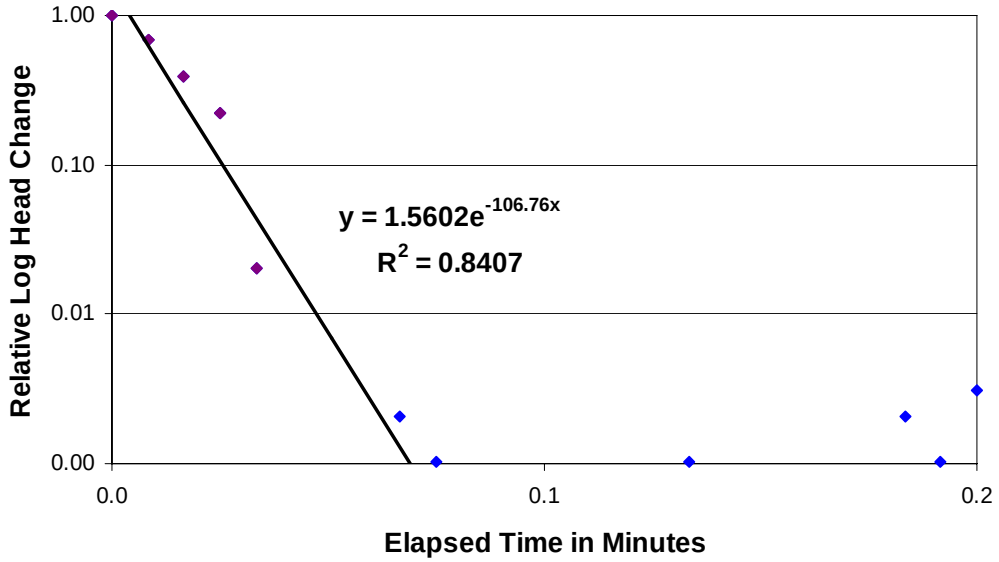
Slug Test Hydrographs and Hydraulic Conductivity Plots

Slug Test Analysis for Well MW-01
St. Paul CDF

Slug Out Hydrograph

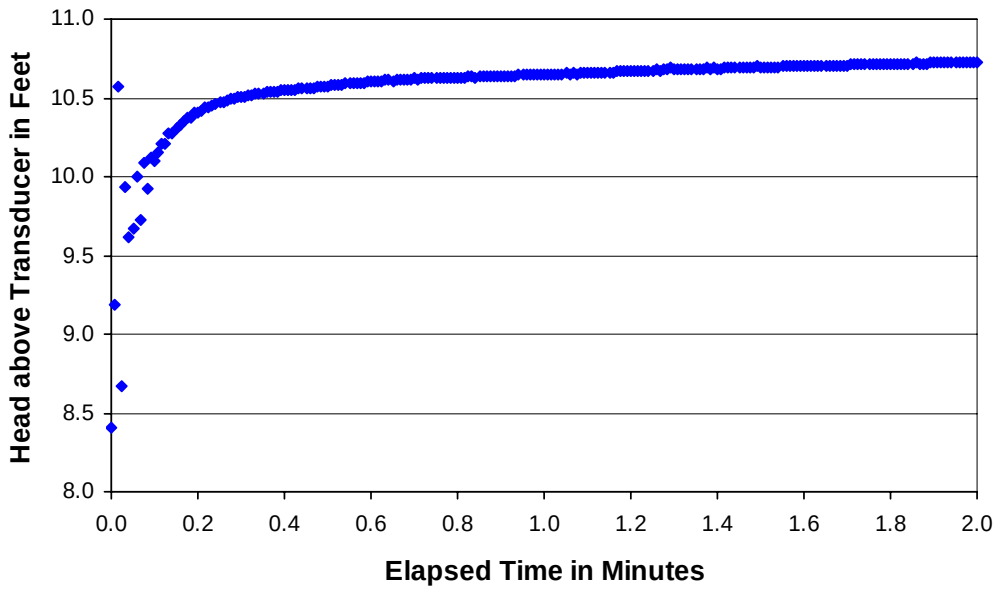


Regression Fit

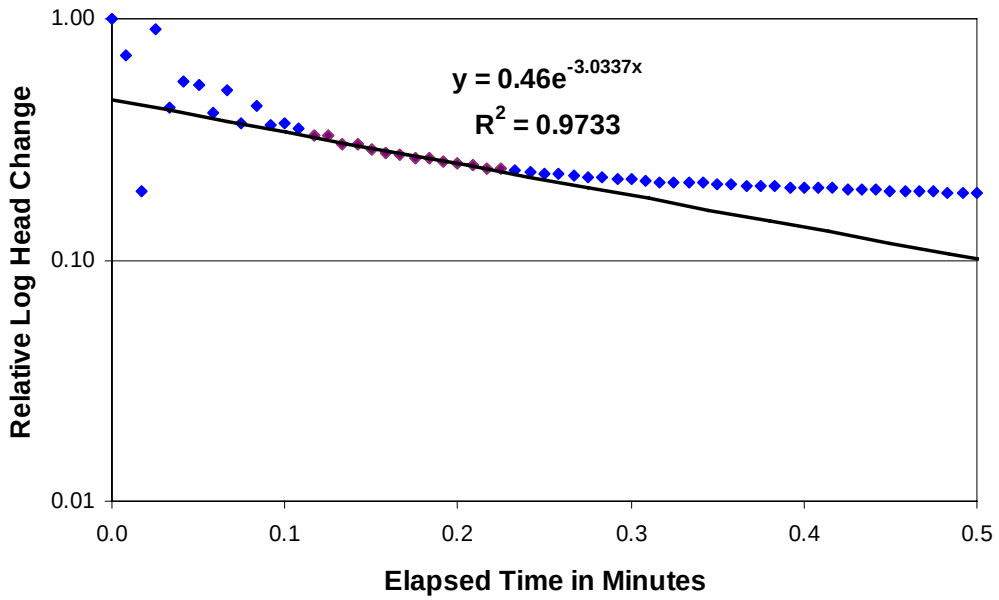


Slug Test Analysis for Well MW-02
St. Paul CDF

Slug Out Hydrograph

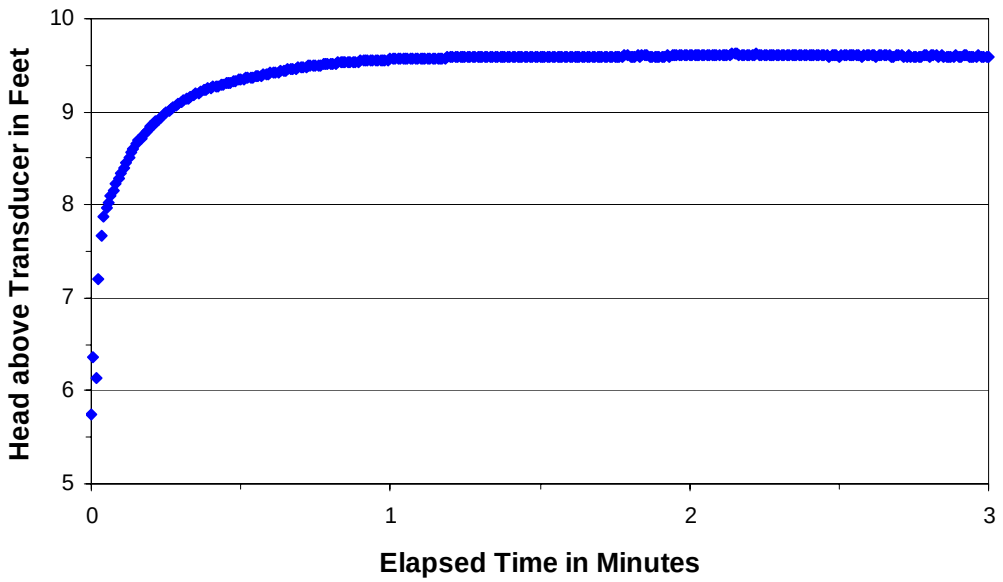


Regression Fit

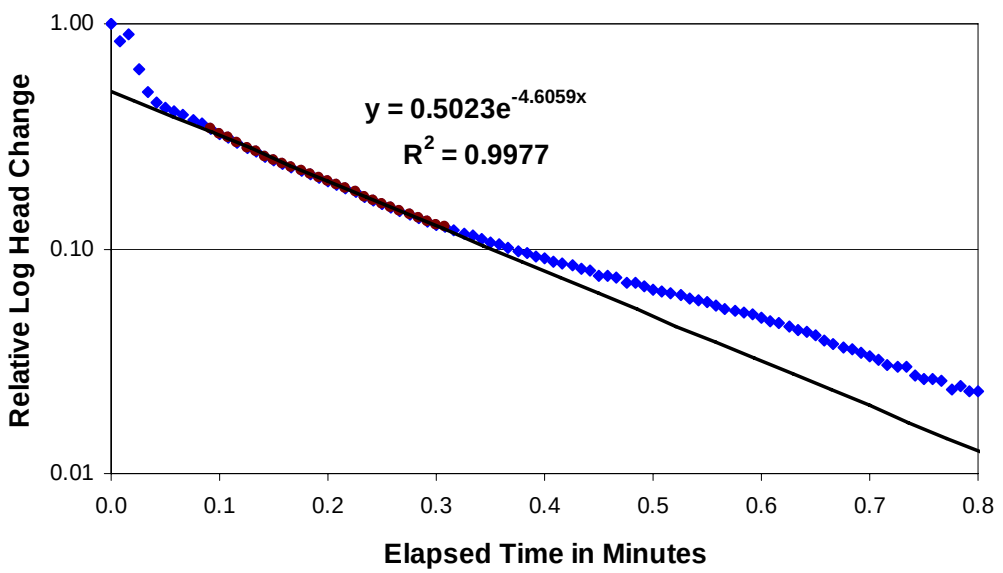


Slug Test Analysis for Well MW-03
St. Paul CDF

Slug Out Hydrograph

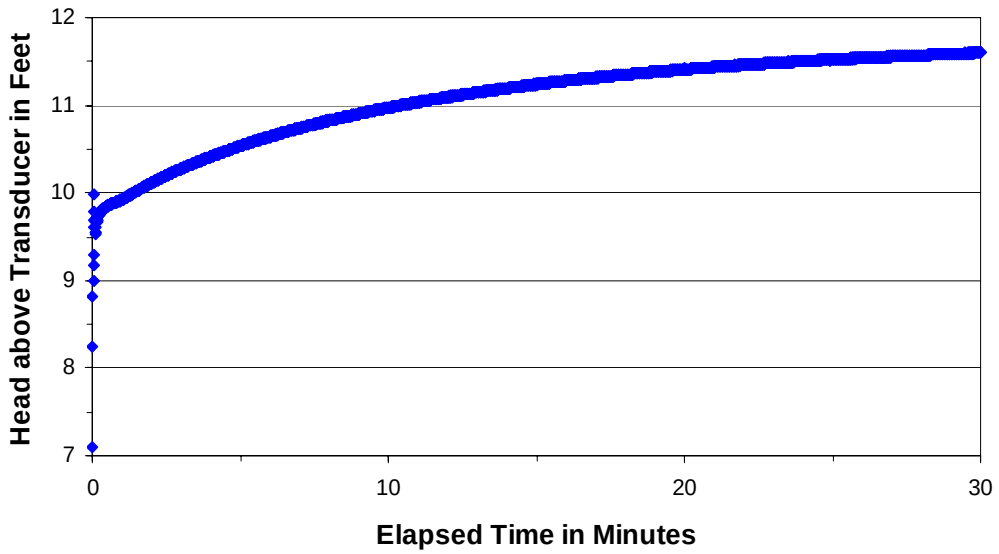


Regression Fit

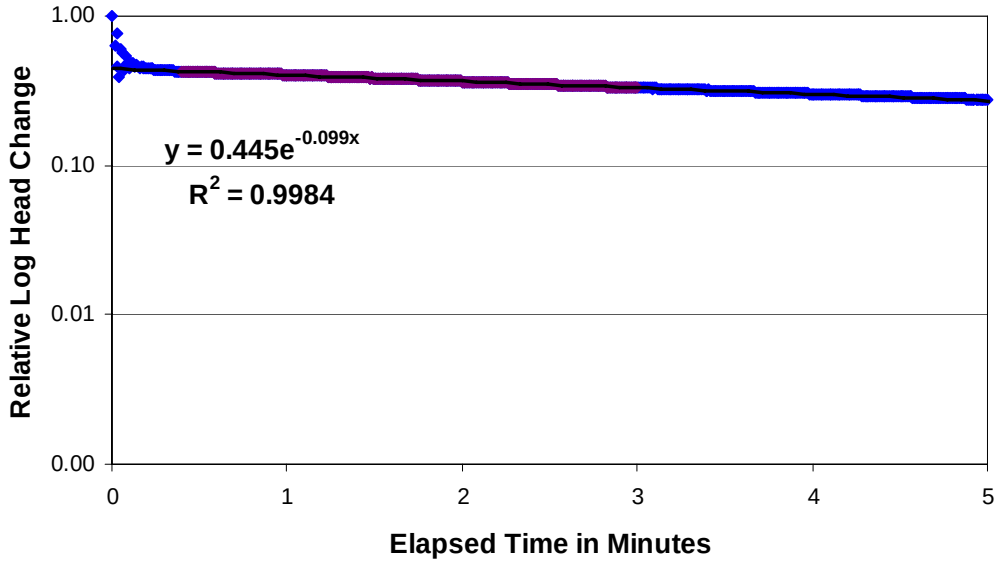


Slug Test Analysis for Well MW-04
St. Paul CDF

Slug Out Hydrograph

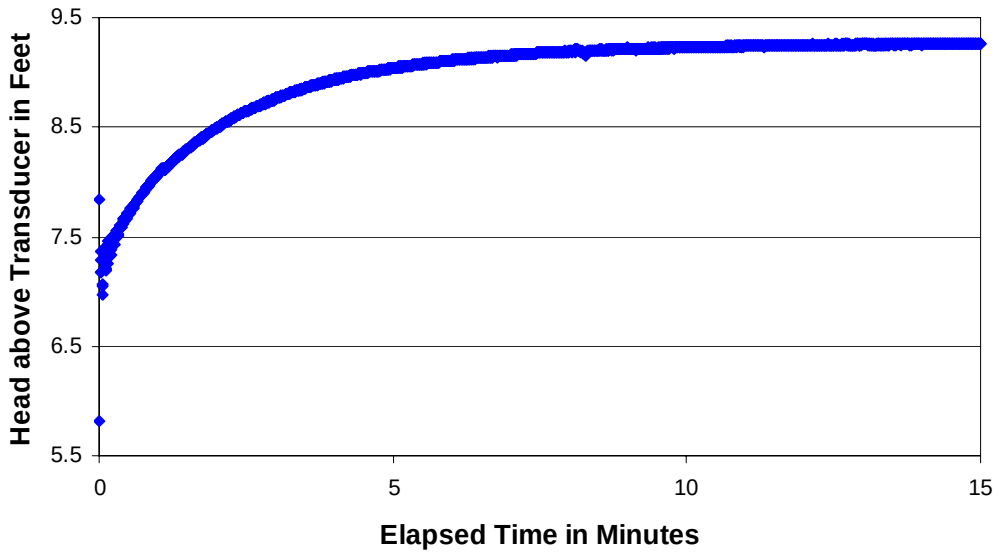


Regression Fit

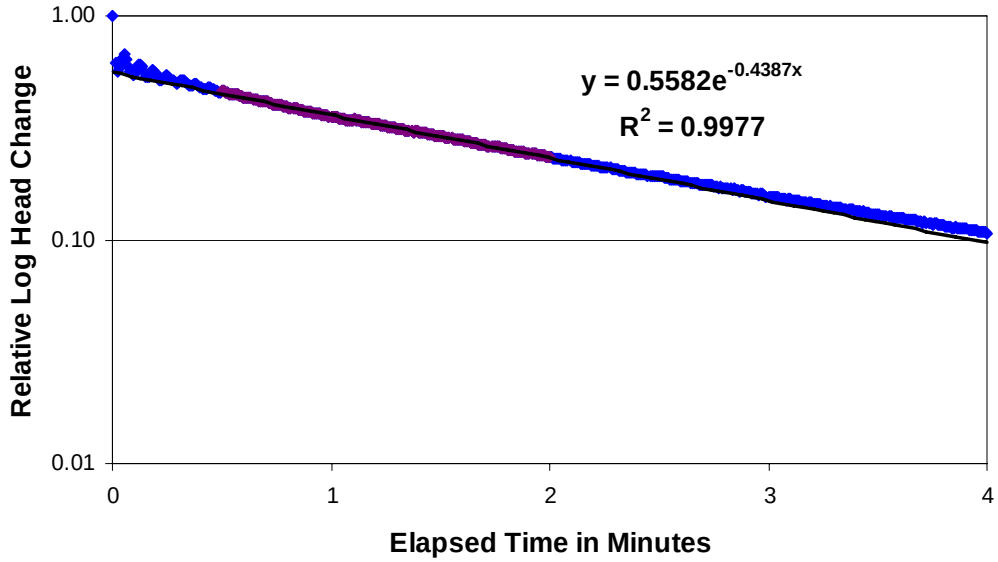


Slug Test Analysis for Well MW-05
St. Paul CDF

Slug Out Hydrograph

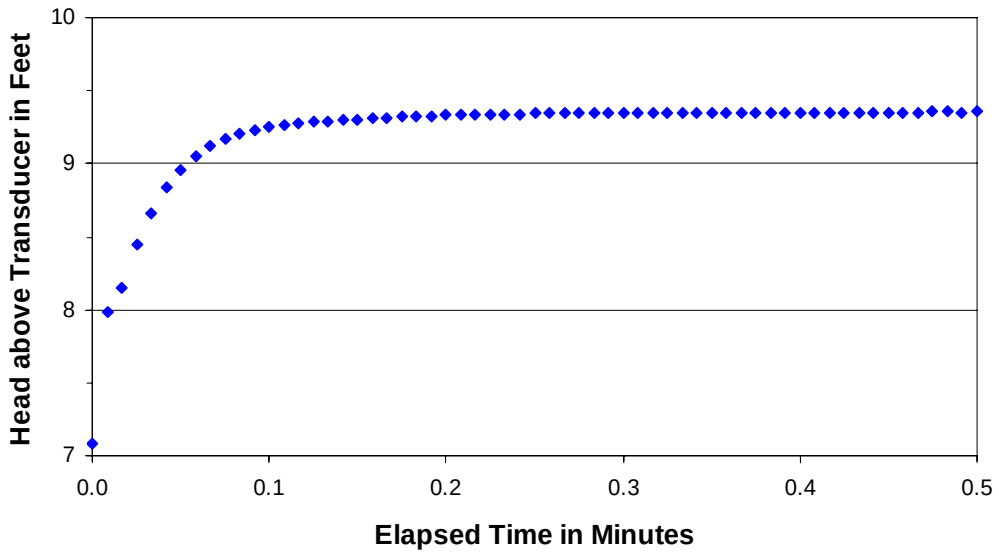


Regression Fit

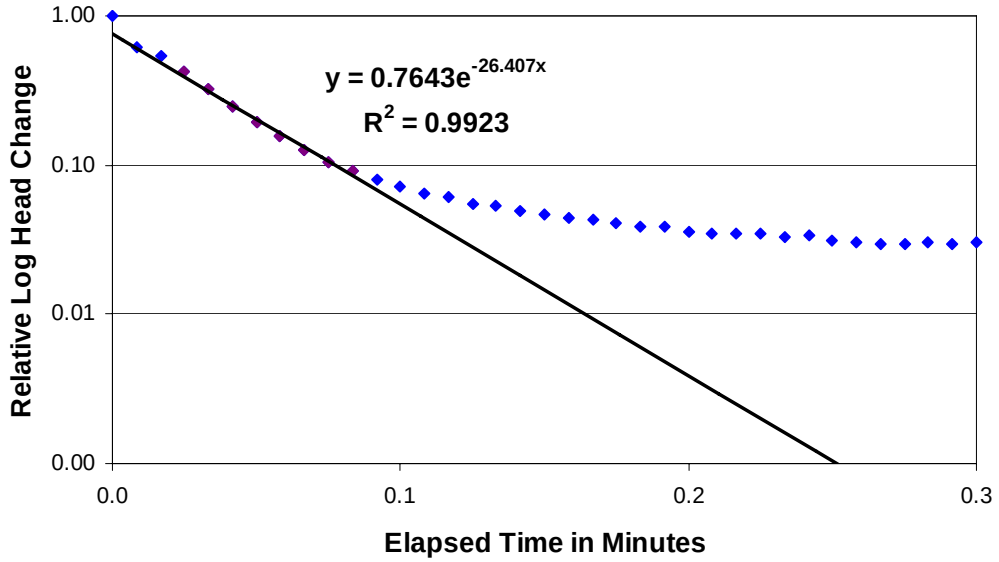


Slug Test Analysis for Well MW-06
St. Paul CDF

Slug Out Hydrograph

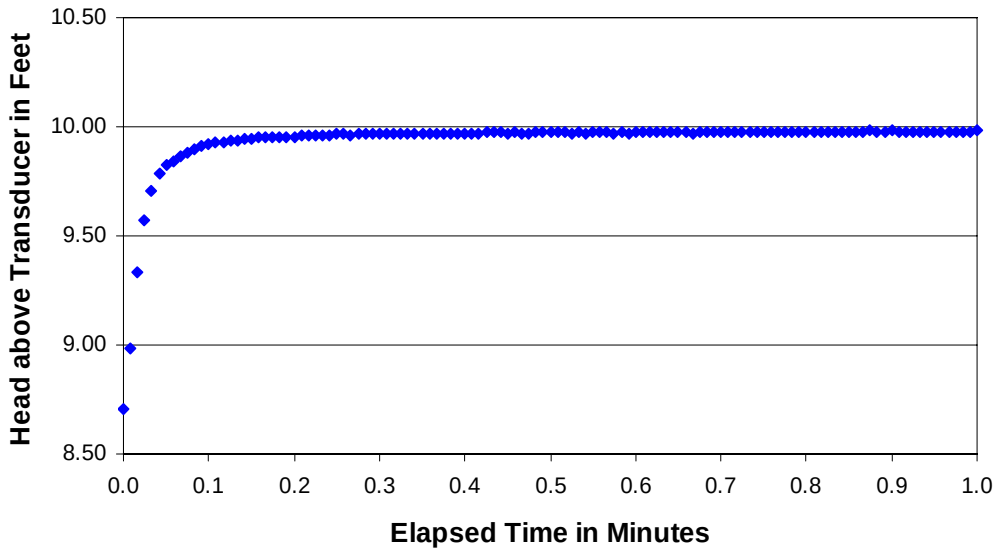


Regression Fit

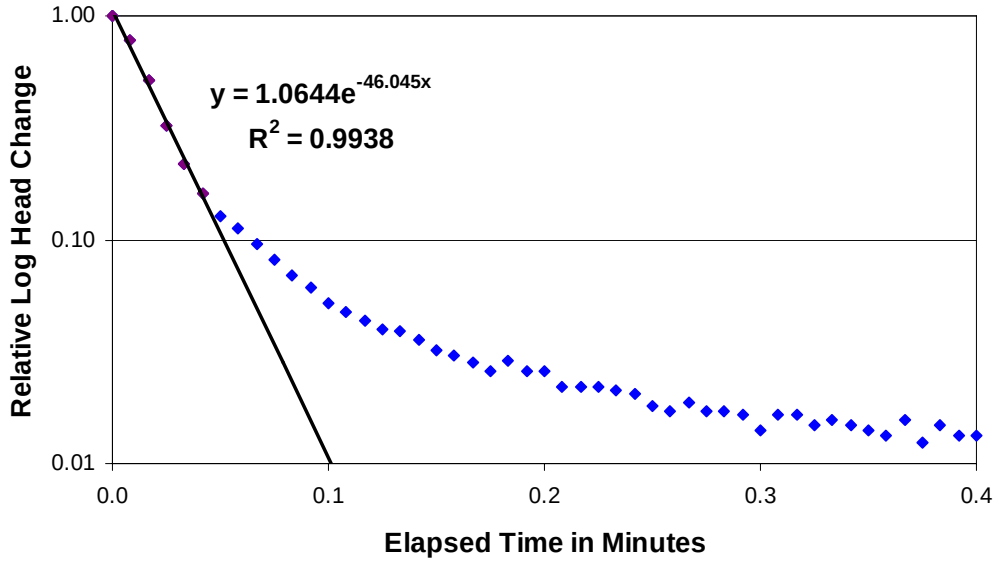


Slug Test Analysis for Well MW-07
St. Paul CDF

Slug Out Hydrograph

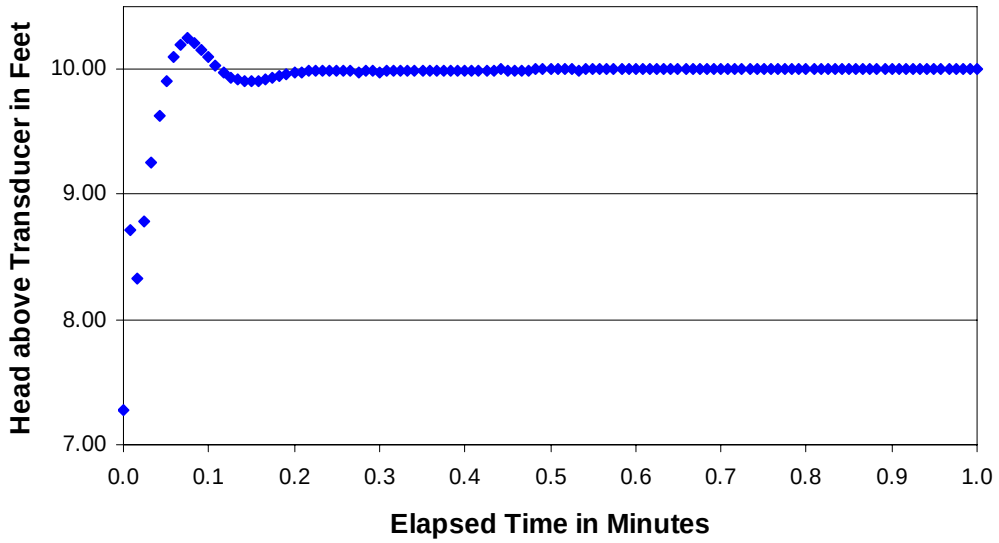


Regression Fit

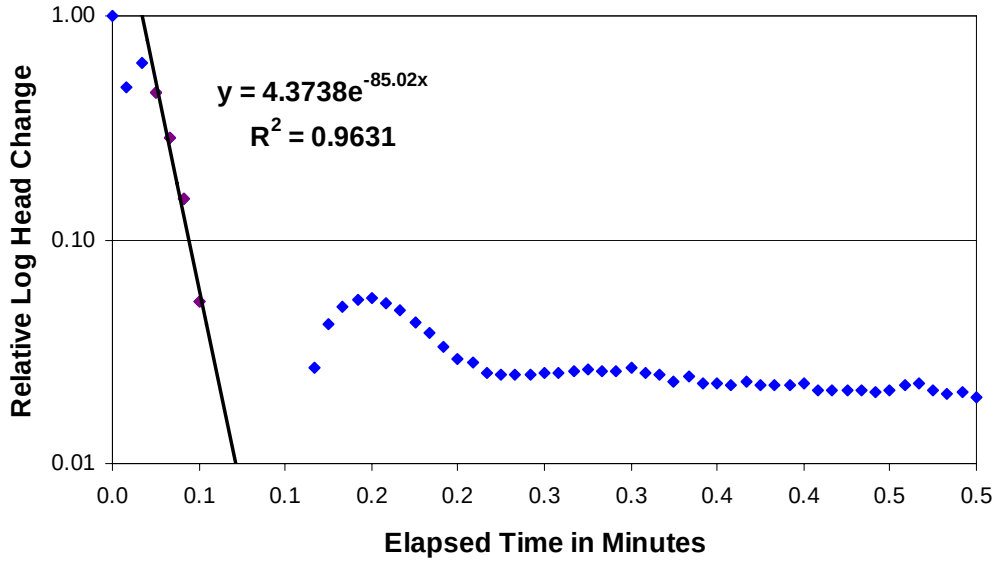


Slug Test Analysis for Well MW-08
St. Paul CDF

Slug Out Hydrograph

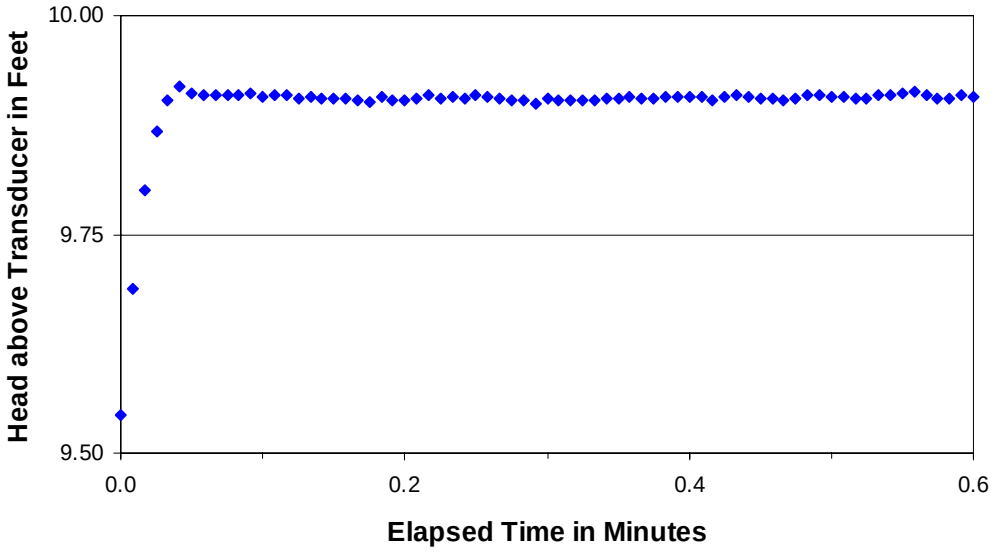


Regression Fit

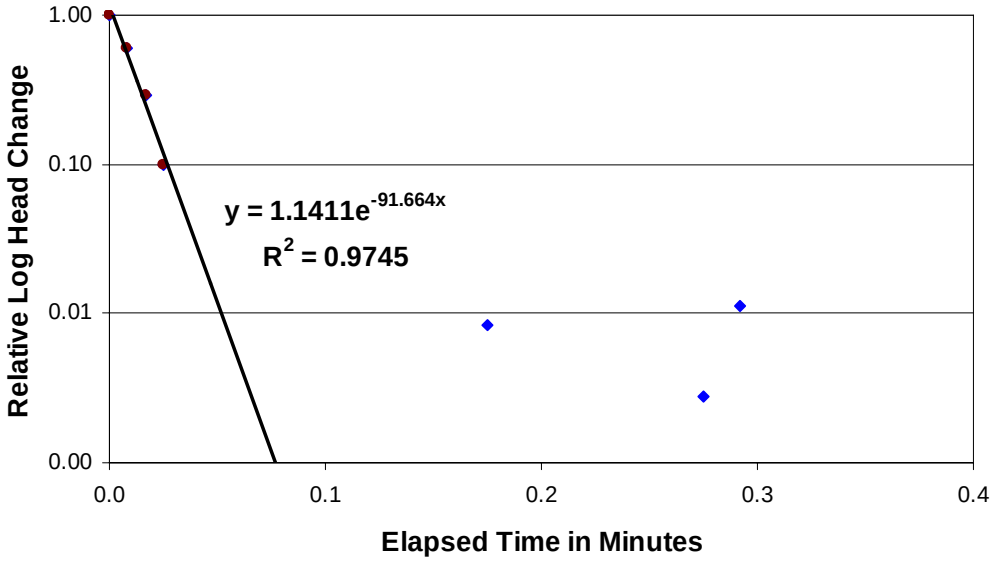


Slug Test Analysis for Well MW-09
St. Paul CDF

Slug Out Hydrograph

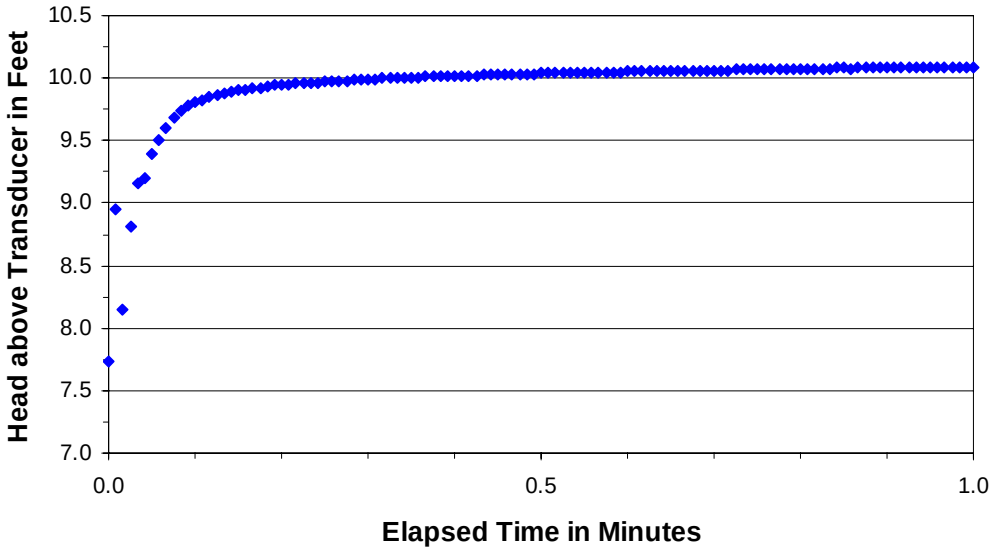


Regression Fit

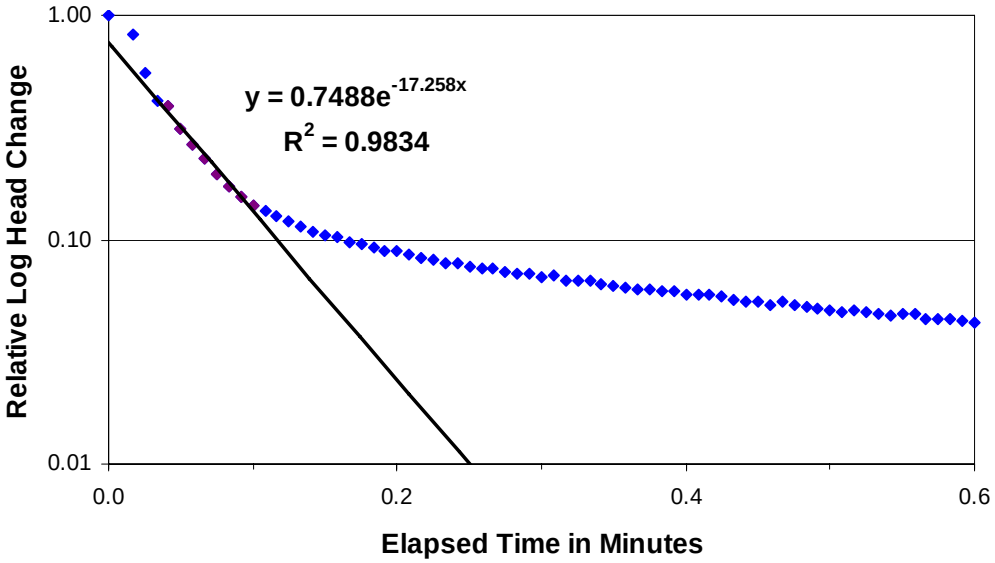


Slug Test Analysis for Well MW-10
St. Paul CDF

Slug Out Hydrograph

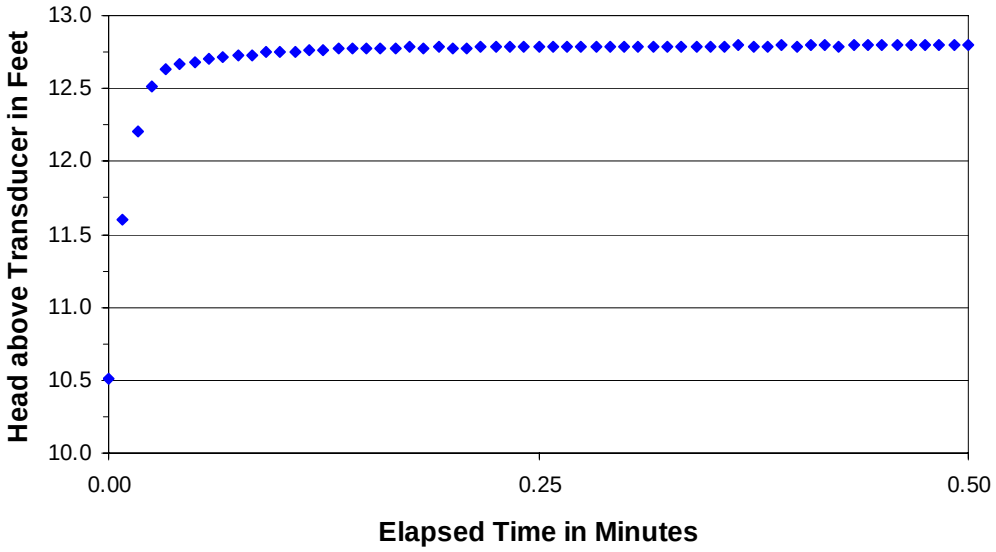


Regression Fit

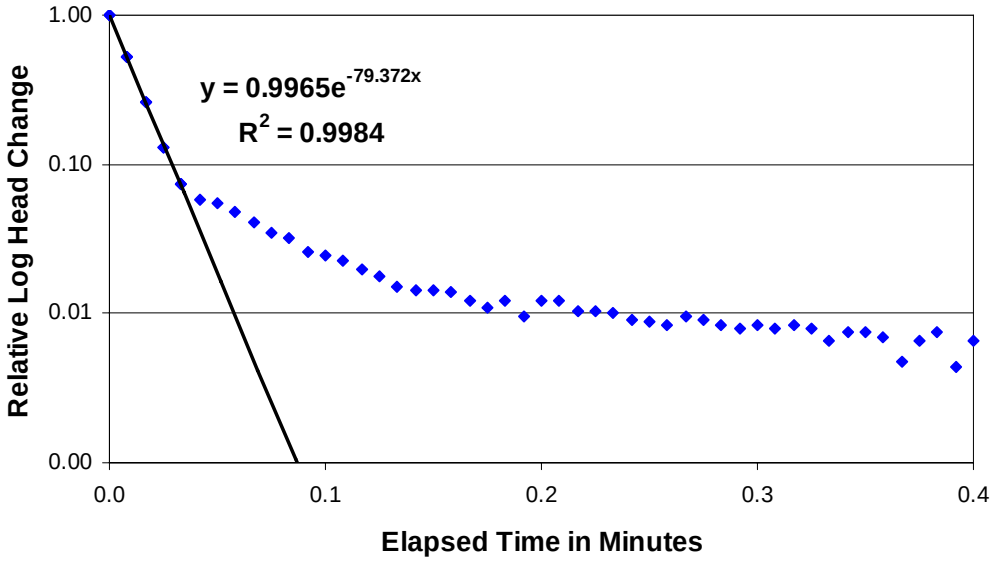


Slug Test Analysis for Well MW-11
St. Paul CDF

Slug Out Hydrograph

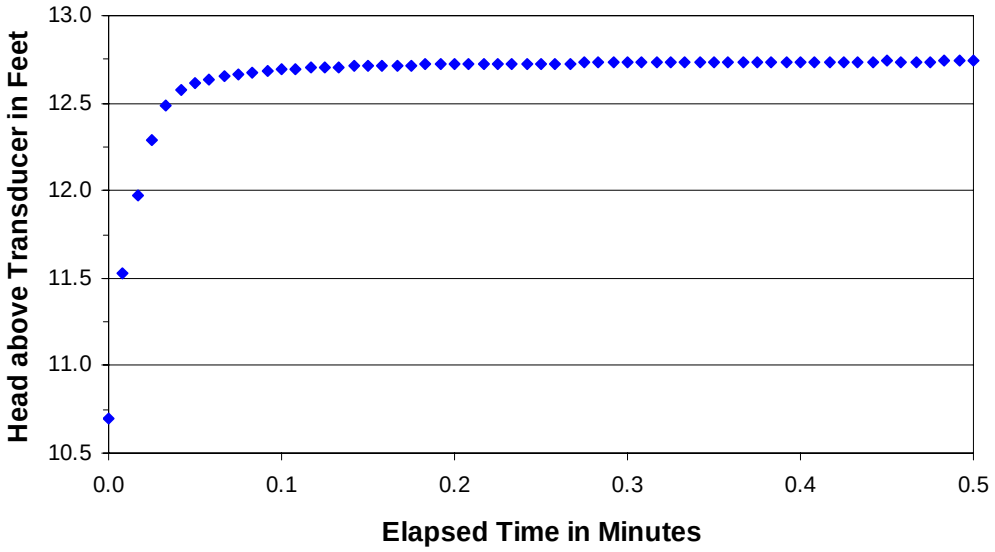


Regression Fit

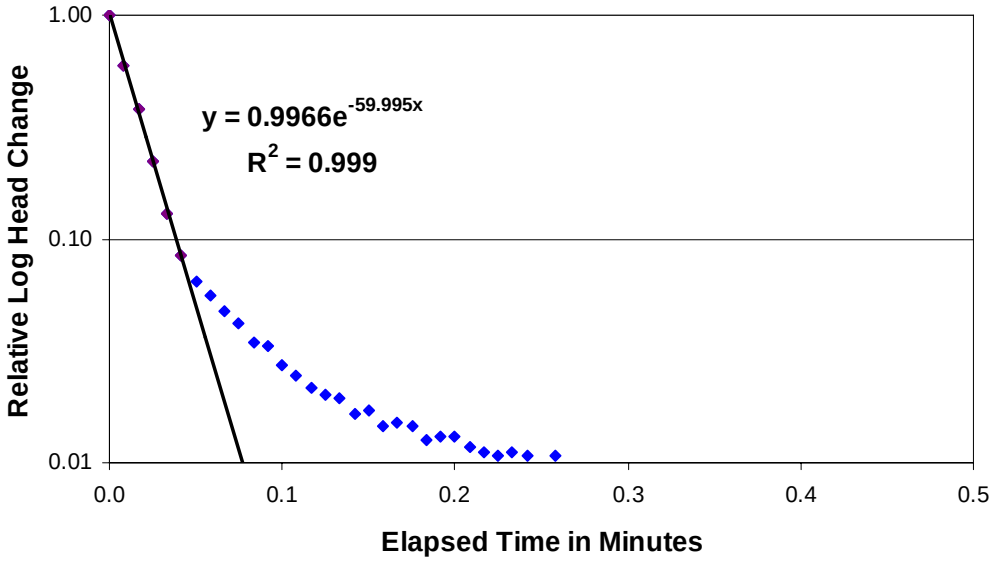


Slug Test Analysis for Well MW-11 (QA-QC)
St. Paul CDF

Slug Out Hydrograph

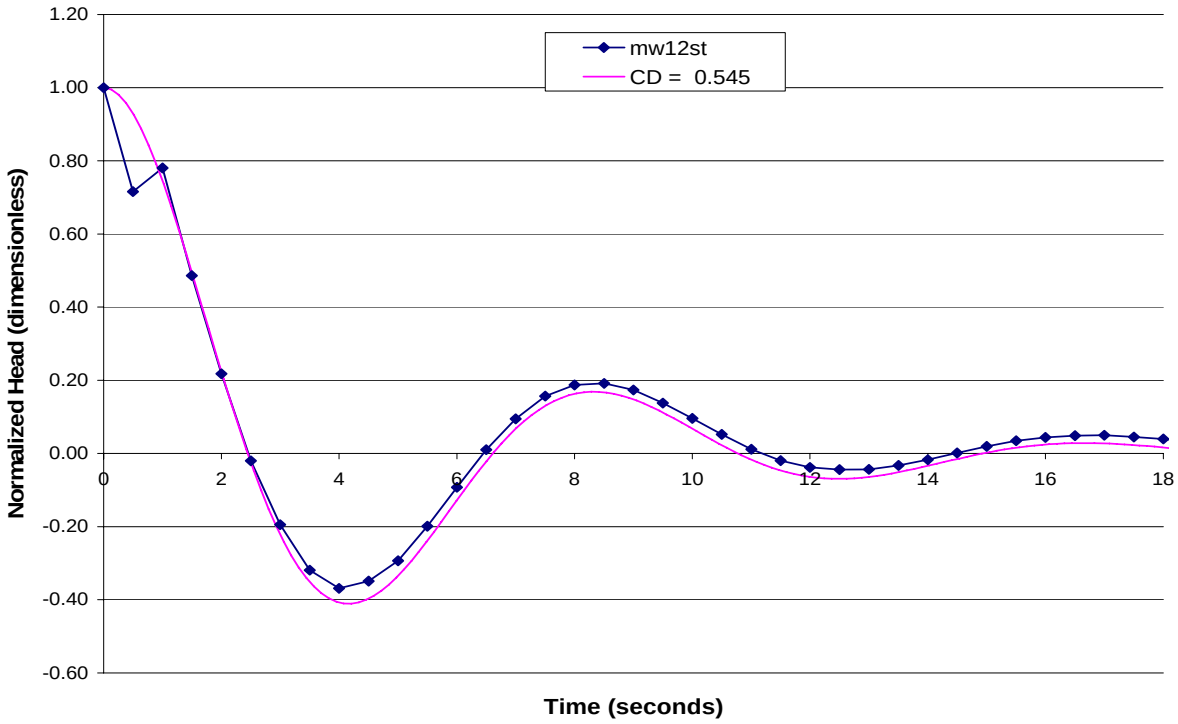


Regression Fit



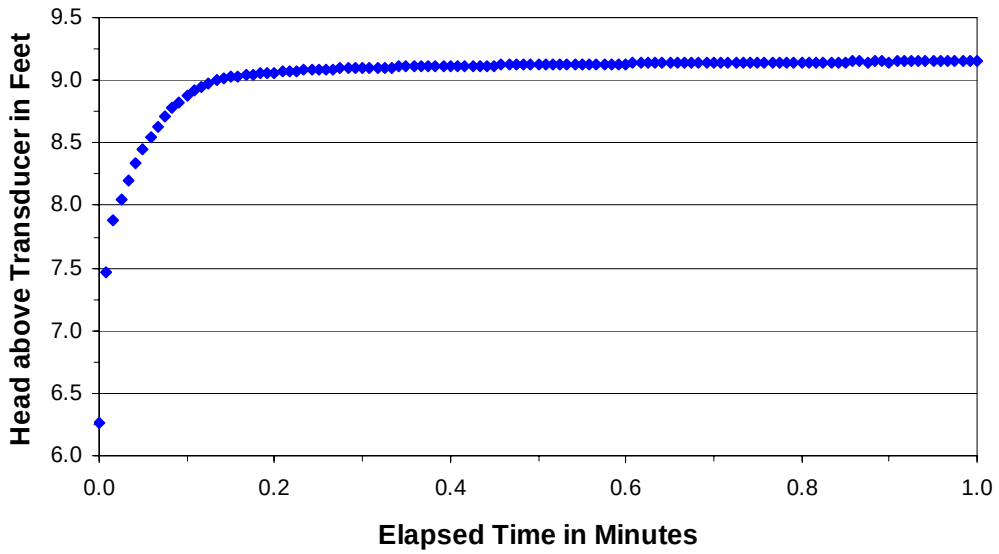
Slug Test Analysis for Well MW-12
St. Paul CDF

Curve Matching

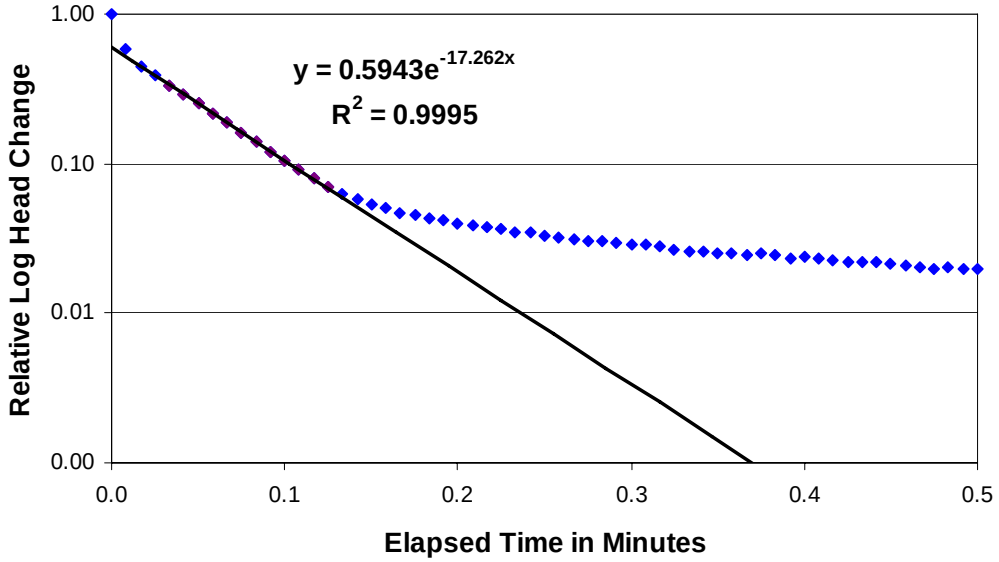


Slug Test Analysis for Well MW-13
St. Paul CDF

Slug Out Hydrograph

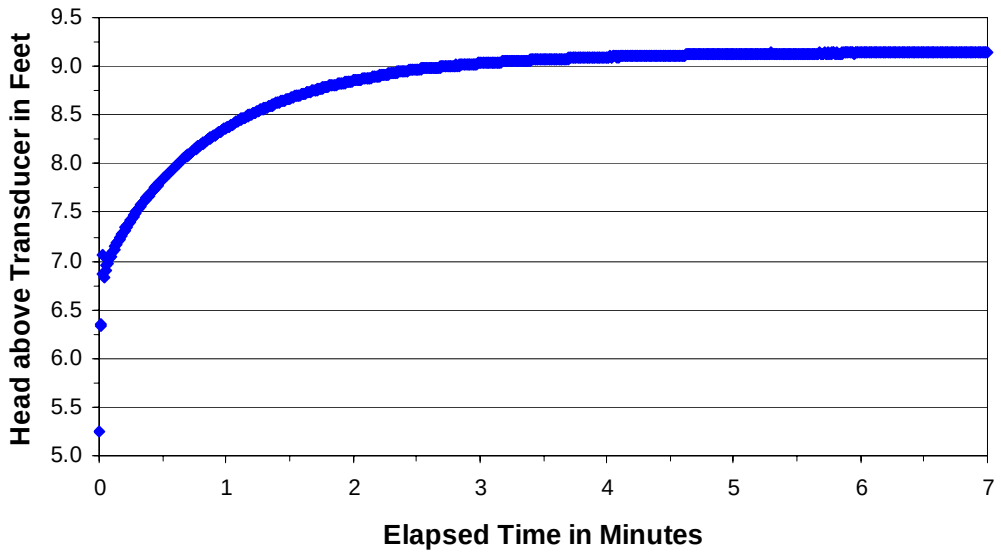


Regression Fit

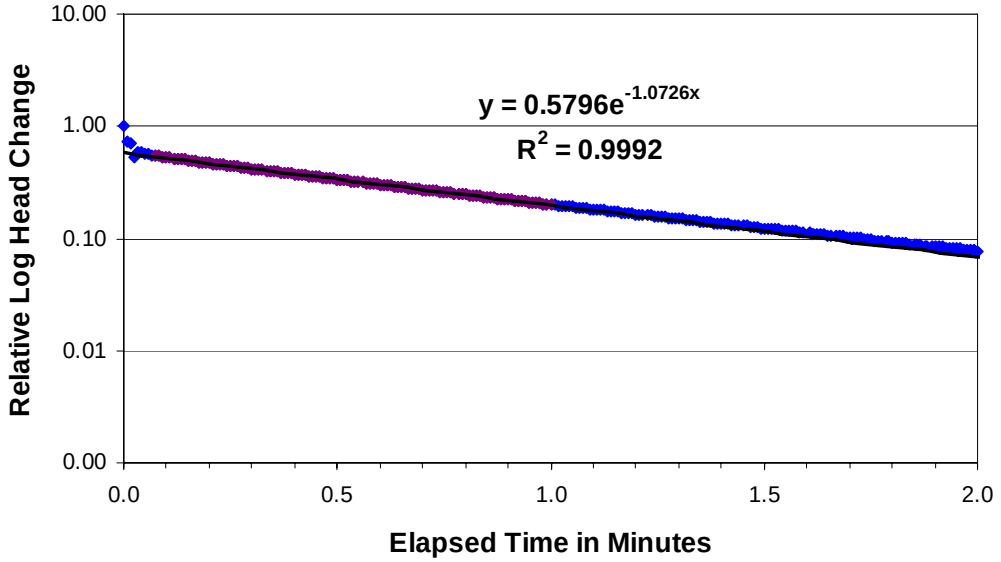


Slug Test Analysis for Well MW-14
St. Paul CDF

Slug Out Hydrograph

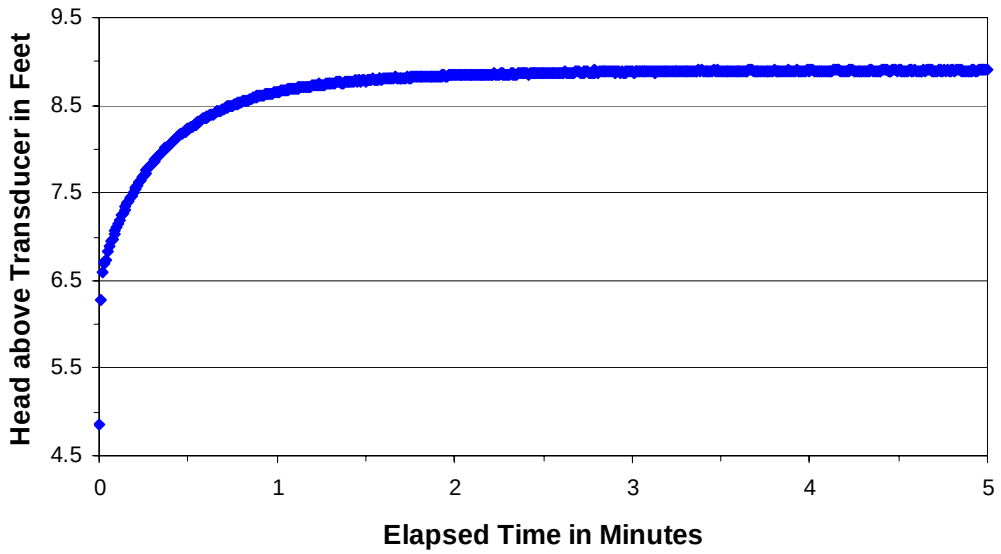


Regression Fit

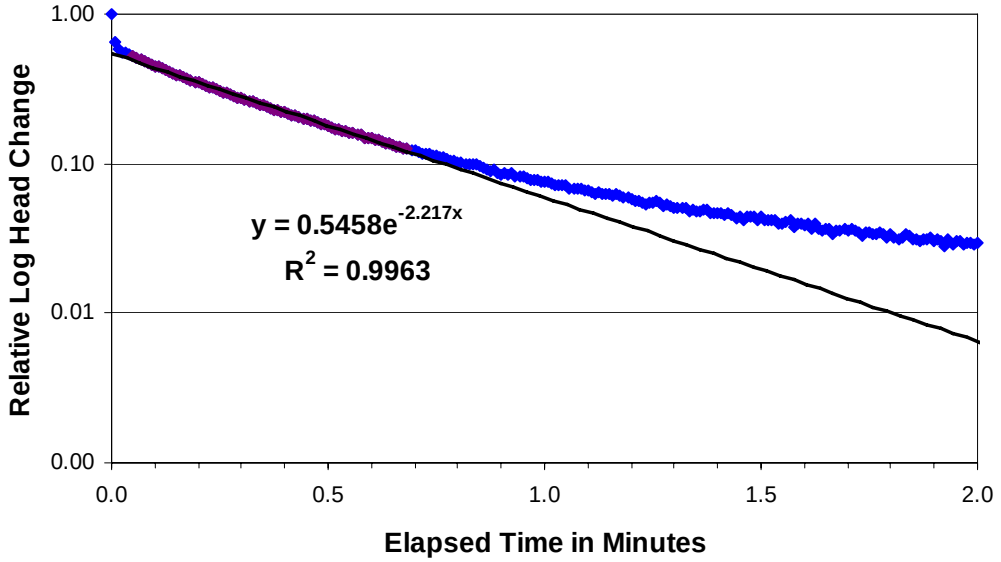


Slug Test Analysis for Well MW-15
St. Paul CDF

Slug Out Hydrograph

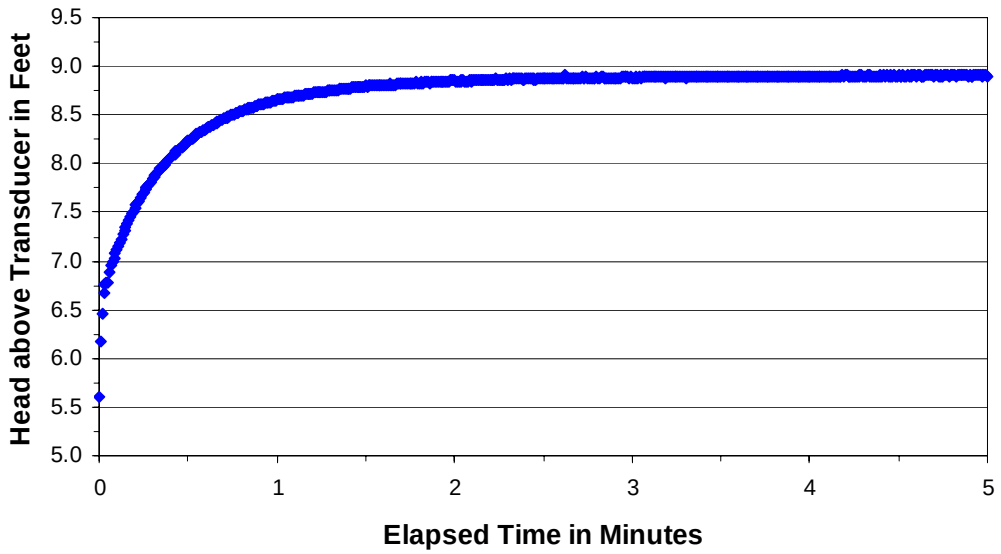


Regression Fit

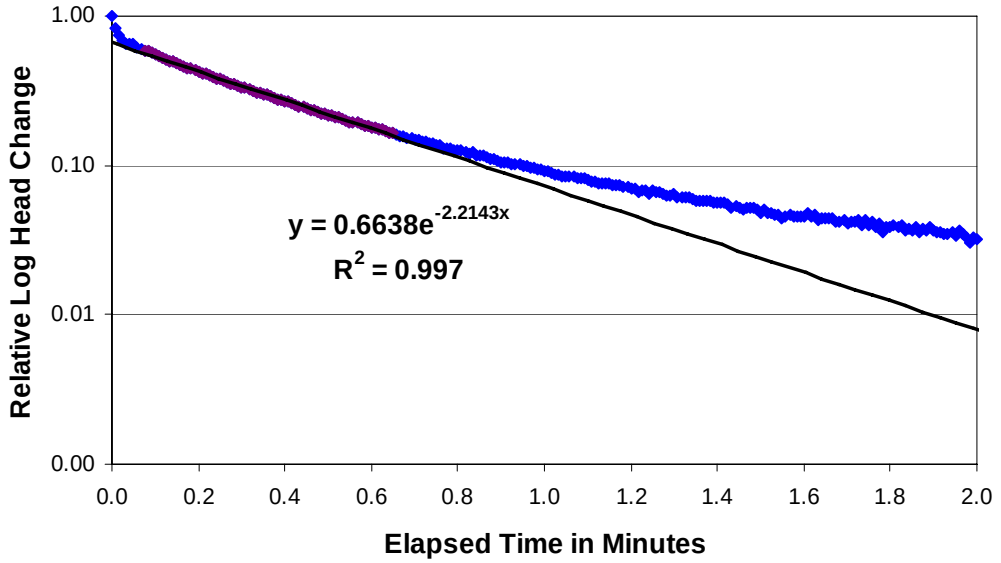


Slug Test Analysis for Well MW-15 (QA-QC)
St. Paul CDF

Slug Out Hydrograph



Regression Fit



APPENDIX C

TIDAL STUDY TEST DATA, METHODOLOGY, AND RESULTS

Attachment C-1

Tidal Study Data

Note: The tidal study data is provided on the CD in Attachment B-1.

Attachment C-2

Tidal Study Methodology

Tidal Study Analysis Methods

A 72-hour tidal study was completed to assess tidal effects on groundwater levels in the 15 monitoring wells installed in and around the St. Paul Waterway Confined Disposal Facility (CDF). The tidal study was performed on October 3 through October 6, 2006. Groundwater levels were recorded at 15-minute intervals at each well location and surface water levels were monitored and recorded at a tide gauge established in the Middle Waterway and a still well established in the surface water swale located on the eastern boundary of the CDF using a network of pressure transducers and data loggers. The data loggers within the transducers recorded the water level in each monitoring well and surface water monitoring location every 15 minutes from 10:30 on October 3 to 10:30 on October 6 resulting in 288 measurements of the elevation of the water surface at each location.

The pressure transducers used in the tidal study measure and record the pressure resulting from the weight of the column of water (i.e., hydraulic head) above the transducer. The data loggers within the pressure transducers record the changes in pressure that are the result of the change in the weight of the water column over time, in response to tidal fluctuations. The internal data loggers are programmed to automatically convert the pressure readings (i.e., weight of the water column) to the height of the water column, in feet, above the transducer.

Measurement of the depth to the water surface from the surveyed top of the well casing, for groundwater wells, and top of the surveyed still well casing and tide gauge, for surface water monitoring locations, were performed four or five times at each location and used to convert the relative measurements recorded by the transducers to elevations in feet Mean Low Low Water (MLLW). The depth to the surface of the water (i.e., groundwater and surface water) were measured manually using a water level indicator. The height of the water column being read by the transducer was recorded concurrently with the depth to the surface of the water and was used to correlate the measurement of the height of the water column to elevation at the surface of the water in feet MLLW. The water level measurements and the average and standard deviation of the differences in measurements are presented in Table 1.

For an unknown reason, all of the transducers recorded multiple water elevations for the same time intervals for times between 2:00 and 2:45 on October 5, 2006. The duplication was repeated in every transducer, and is likely a programming error in the software used to transfer the data from the transducer to an electronic file for data evaluation. However, the measurement duplication does not impact the trends observed in the groundwater levels and the overall mean groundwater elevation.

Mean groundwater and surface water elevations were calculated using the method described by Serfes (1991). This method uses the 72-hour set of hourly observed water level elevations and filters out the dominant tidal fluctuations to determine a mean water level elevation. To calculate a mean groundwater elevation, a sequence of 48 means is calculated from the hourly groundwater elevations using moving averages. A second sequence of 25 means is calculated from the first series of means using the same moving average method. The mean of the second set of sequence of moving averages is then calculated yielding the overall mean water level elevation.

The method is performed mathematically by designating the consecutive hourly water levels as O(1), O(2), O(3).....,O(71), then calculating the first sequence of moving means (X_i) with the following formula:

$$X_i = \sum_{K=0}^{23} \frac{O(K+i)}{24} \text{ where } i = 1,2,3,...48;$$

and then the second sequence of moving means (Yj) is the calculated with the following formula and the first series of moving means:

$$Y_i = \sum_{i=0}^{23} \frac{X(i+j)}{24} \text{ where } j = 1,2,3,..25.$$

Finally, the mean groundwater elevation (M) is calculated as the arithmetic mean of the second sequence of moving means:

$$M = \sum_{j=1}^{23} \frac{Yj}{25}$$

The mean water level elevations were used to identify groundwater gradients and flow directions in and adjacent to the St. Paul CDF.

References:

Serfes, M.E. 1991. *Determining the Mean Hydraulic Gradient of Ground Water Affected by Tidal Fluctuations.* Ground Water 29(4): 549-555.

Table 1
Conversion of Water Level Measurements to Elevations Relative to Mean Low Low Water

Transducer Location	Top of Casing Elevation (ft MLLW)	Measurement Timing		Depth to Water Surface (ft TOC)	Height of Water Above Transducer (ft)	Calculated Transducer Elevation[1] (ft MLLW)	Measurement Statistics	
		Date	Time				Mean Transducer Elevation (ft MLLW)	Standard Deviation
MW-01	17.99	10/2/2006	17:58	7.88	10.65	-0.54	-0.52	0.11
		10/3/2006	11:17	11.98	6.44	-0.43		
		10/4/2006	15:28	7.57	11.04	-0.62		
		10/5/2006	15:56	6.28	12.35	-0.64		
		10/6/2006	12:48	11.23	7.13	-0.37		
MW-02	19.65	10/2/2006	17:07	9.13	13.12	-2.60	-2.55	0.05
		10/3/2006	11:21	12.05	10.13	-2.53		
		10/4/2006	15:22	9.13	13.12	-2.60		
		10/5/2006	15:59	8.30	13.89	-2.54		
		10/6/2006	12:40	11.54	10.57	-2.46		
MW-03	20.07	10/2/2006	13:59	10.00	9.94	0.13	0.04	0.04
		10/3/2006	12:15	10.11	9.94	0.02		
		10/4/2006	16:18	9.99	10.07	0.01		
		10/5/2006	16:46	9.85	10.19	0.03		
		10/6/2006	14:17	9.94	10.10	0.03		
MW-04	18.55	10/2/2006	17:43	8.83	11.97	-2.26	-2.25	0.01
		10/3/2006	11:12	9.11	11.69	-2.25		
		10/4/2006	15:32	9.04	11.78	-2.27		
		10/5/2006	16:10	8.91	11.89	-2.25		
		10/6/2006	12:57	9.00	11.78	-2.23		
MW-05	18.60	10/2/2006	17:49	10.34	23.46	-15.20	-15.22	0.03
		10/3/2006	11:09	10.75	23.06	-15.21		
		10/4/2006	15:33	10.54	23.31	-15.25		
		10/5/2006	16:12	10.39	23.47	-15.26		
		10/6/2006	13:01	10.60	23.20	-15.20		
MW-06	21.08	10/2/2006	16:25	10.11	12.06	-1.10	-1.14	0.22
		10/3/2006	11:31	14.79	7.77	-1.48		
		10/4/2006	15:14	10.17	12.07	-1.16		
		10/5/2006	16:02	9.14	13.07	-1.13		
		10/6/2006	12:33	13.90	7.98	-0.80		

Table 1
Conversion of Water Level Measurements to Elevations Relative to Mean Low Low Water

Transducer Location	Top of Casing Elevation (ft MLLW)	Measurement Timing		Depth to Water Surface (ft TOC)	Height of Water Above Transducer (ft)	Calculated Transducer Elevation[1] (ft MLLW)	Measurement Statistics	
		Date	Time				Mean Transducer Elevation (ft MLLW)	Standard Deviation
MW-07	20.36	10/2/2006	16:30	10.37	22.14	-12.15	-12.13	0.05
		10/3/2006	11:35	14.39	18.04	-12.07		
		10/4/2006	15:18	10.56	21.99	-12.19		
		10/5/2006	16:05	9.93	22.59	-12.16		
		10/6/2006	12:25	14.91	17.54	-12.09		
MW-08	20.97	10/2/2006	16:36	11.17	27.22	-17.42	-17.41	0.06
		10/3/2006	11:26	14.54	23.85	-17.42		
		10/4/2006	15:11	11.72	26.72	-17.47		
		10/5/2006	16:04	11.14	27.27	-17.44		
		10/6/2006	12:17	14.60	23.66	-17.29		
MW-09	21.37	10/2/2006	17:34	10.66	10.58	0.13	0.18	0.06
		10/3/2006	11:05	13.91	7.24	0.22		
		10/4/2006	15:38	11.14	10.12	0.11		
		10/5/2006	16:15	10.78	10.42	0.17		
		10/6/2006	13:18	13.75	7.34	0.28		
MW-10	18.41	10/2/2006	17:00	9.08	10.66	-1.33	-1.31	0.03
		10/3/2006	11:42	11.35	8.35	-1.29		
		10/4/2006	14:59	9.48	10.28	-1.35		
		10/5/2006	15:47	8.99	10.72	-1.30		
		10/6/2006	11:46	11.53	8.14	-1.26		
MW-11	18.39	10/2/2006	15:49	8.34	21.40	-11.35	-11.23	0.07
		10/3/2006	11:44	12.16	17.39	-11.16		
		10/4/2006	14:56	8.75	20.88	-11.24		
		10/5/2006	15:50	8.12	21.52	-11.25		
		10/6/2006	11:56	13.35	16.21	-11.17		
MW-12	18.47	10/2/2006	15:47	9.19	22.03	-12.74	-12.75	0.01
		10/3/2006	11:47	11.51	19.69	-12.73		
		10/4/2006	14:54	9.76	21.47	-12.76		
		10/5/2006	15:51	9.28	21.95	-12.76		
		10/6/2006	12:09	11.66	19.57	-12.76		

Table 1
Conversion of Water Level Measurements to Elevations Relative to Mean Low Low Water

Transducer Location	Top of Casing Elevation (ft MLLW)	Measurement Timing		Depth to Water Surface (ft TOC)	Height of Water Above Transducer (ft)	Calculated Transducer Elevation[1] (ft MLLW)	Measurement Statistics	
		Date	Time				Mean Transducer Elevation (ft MLLW)	Standard Deviation
MW-13	20.16	10/2/2006	17:18	11.16	9.27	-0.27	-0.25	0.03
		10/3/2006	10:54	11.22	9.20	-0.26		
		10/4/2006	15:55	11.25	9.18	-0.27		
		10/5/2006	16:25	11.22	9.21	-0.27		
		10/6/2006	13:36	11.22	9.13	-0.19		
MW-14	20.13	10/2/2006	17:22	11.05	18.53	-9.45	-9.45	0.05
		10/3/2006	10:40	11.19	18.42	-9.48		
		10/4/2006	15:53	11.15	18.47	-9.49		
		10/5/2006	16:27	11.11	18.48	-9.46		
		10/6/2006	13:38	11.19	18.30	-9.36		
MW-15	20.28	10/3/2006	10:30	13.28	10.49	-3.49	-3.50	0.01
		10/4/2006	15:58	11.69	12.11	-3.52		
		10/5/2006	16:34	11.45	12.32	-3.49		
		10/6/2006	13:53	12.68	11.11	-3.51		
Tide Gauge	15.40	10/2/2006	15:22	3.63	12.22	-0.45	-0.47	0.05
		10/3/2006	11:59	8.30	7.65	-0.55		
		10/4/2006	15:04	3.36	12.51	-0.47		
		10/5/2006	15:43	2.80	13.09	-0.49		
		10/6/2006	14:55	4.69	11.11	-0.40		
Still Well	15.13	10/2/2006	18:13	4.86	4.23	6.04	6.03	0.03
		10/3/2006	11:00	7.63	1.46	6.04		
		10/4/2006	15:46	4.69	4.47	5.97		
		10/5/2006	16:22	4.37	4.74	6.02		
		10/6/2006	13:27	7.52	1.54	6.07		

Note:

1 The transducer elevation was calculated by subtracting the sum of the depth to water and height of water above the tranducer from the top of the casing elevation.

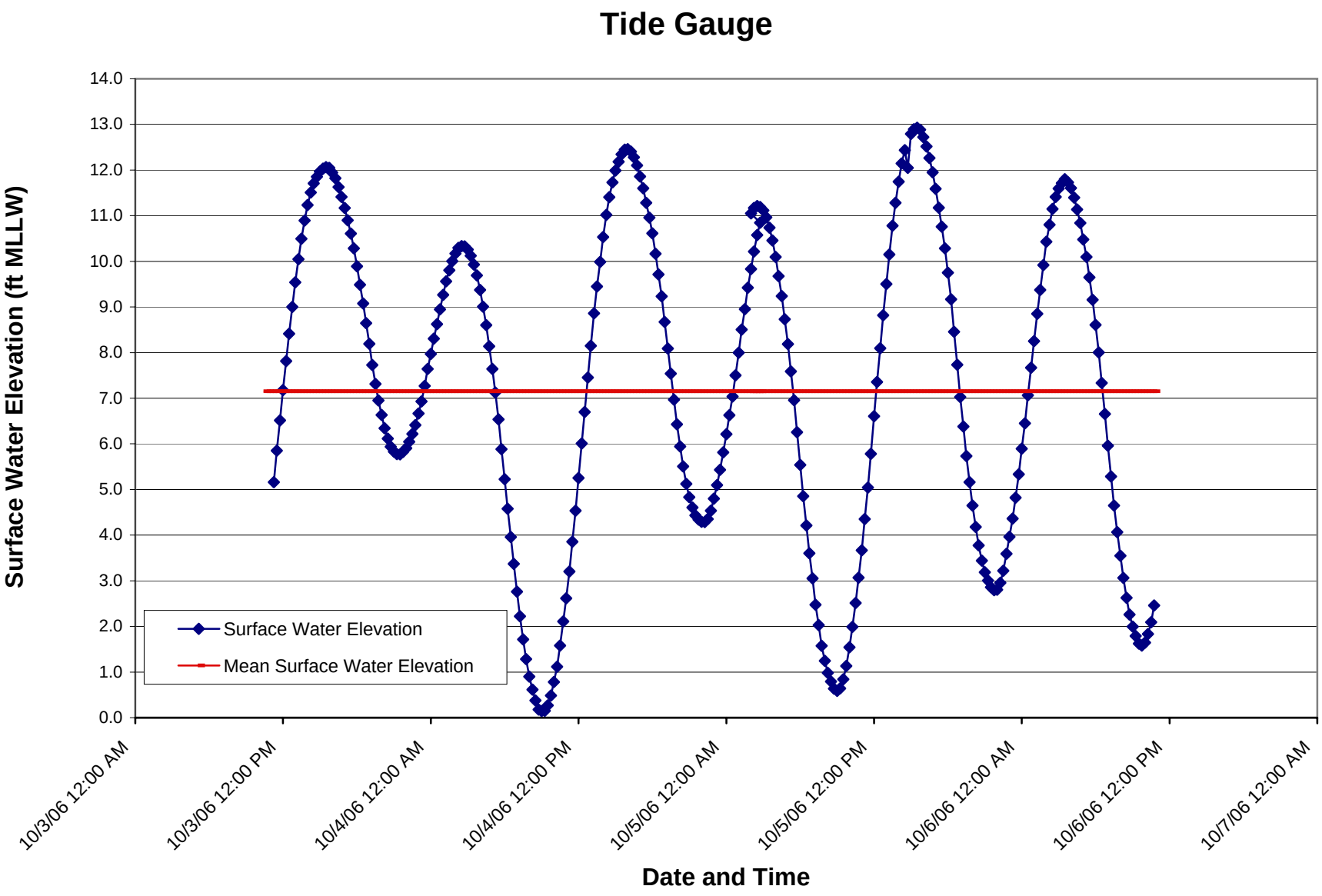
ft MLLW Elevation is feet Mean Lower Low Water (MLLW)

ft TOC Feet from the top of casing

ft Feet

Attachment C-3

Tidal Study Hydrographs


Tide Gauge
Surface Water Elevation (ft MLLW)
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12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Surface Water Elevation
Mean Surface Water Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
10/5/06 12:00 AM
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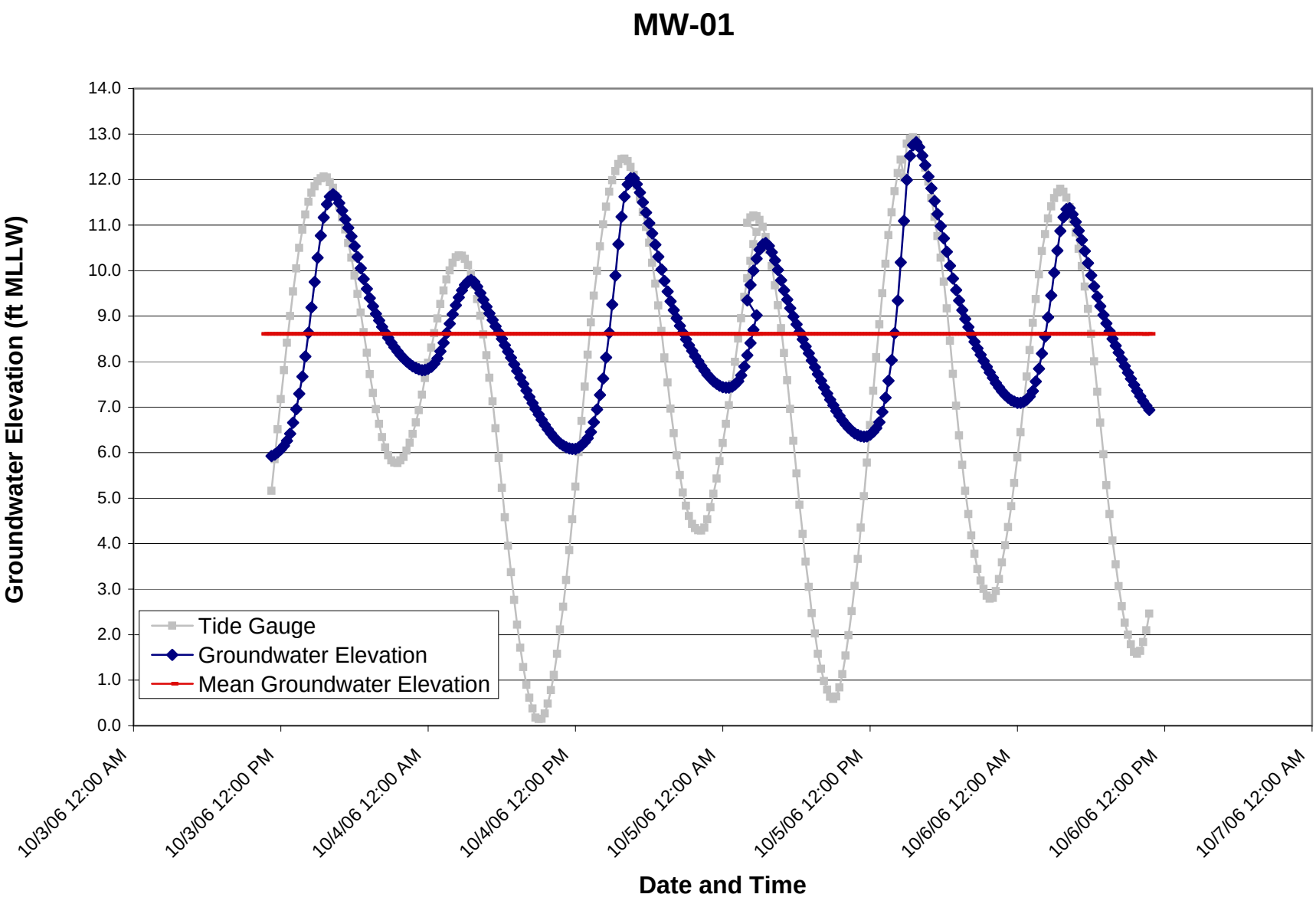
10/7/06 12:00 AM
Date and Time


MW-01
Groundwater Elevation (ft MLLW)
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12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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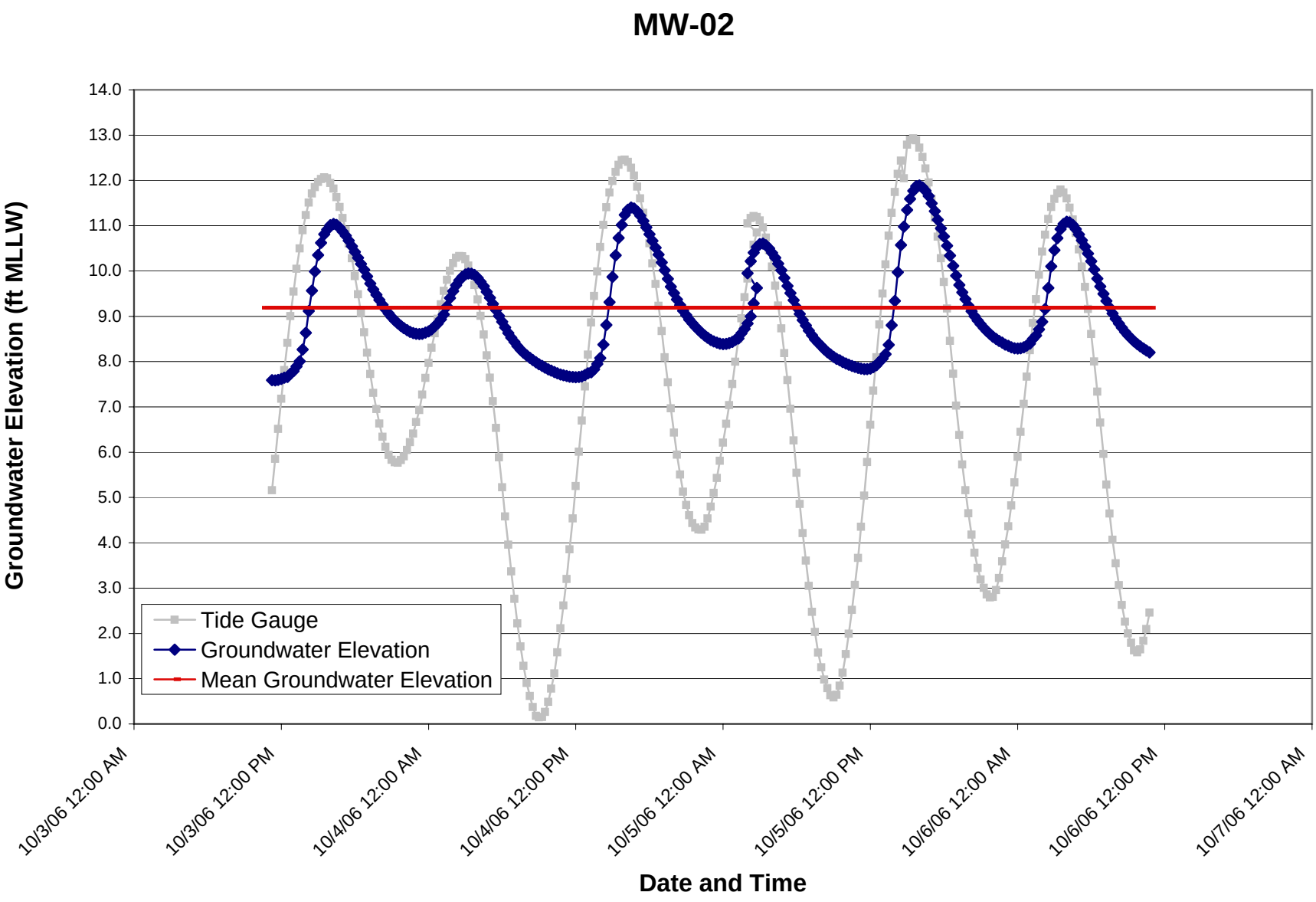
10/7/06 12:00 AM
Date and Time


MW-02
Groundwater Elevation (ft MLLW)
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12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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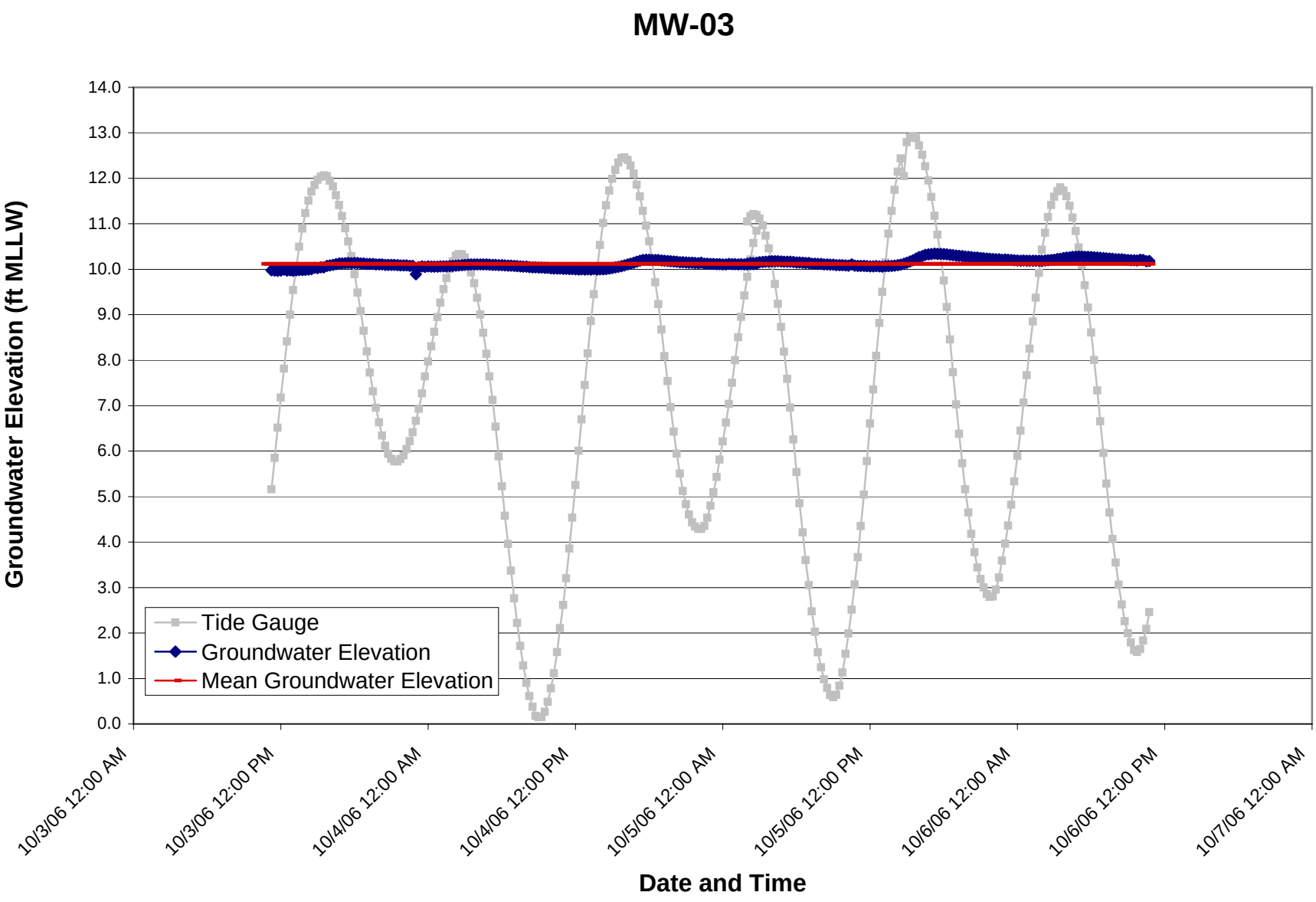
10/7/06 12:00 AM
Date and Time


MW-03
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12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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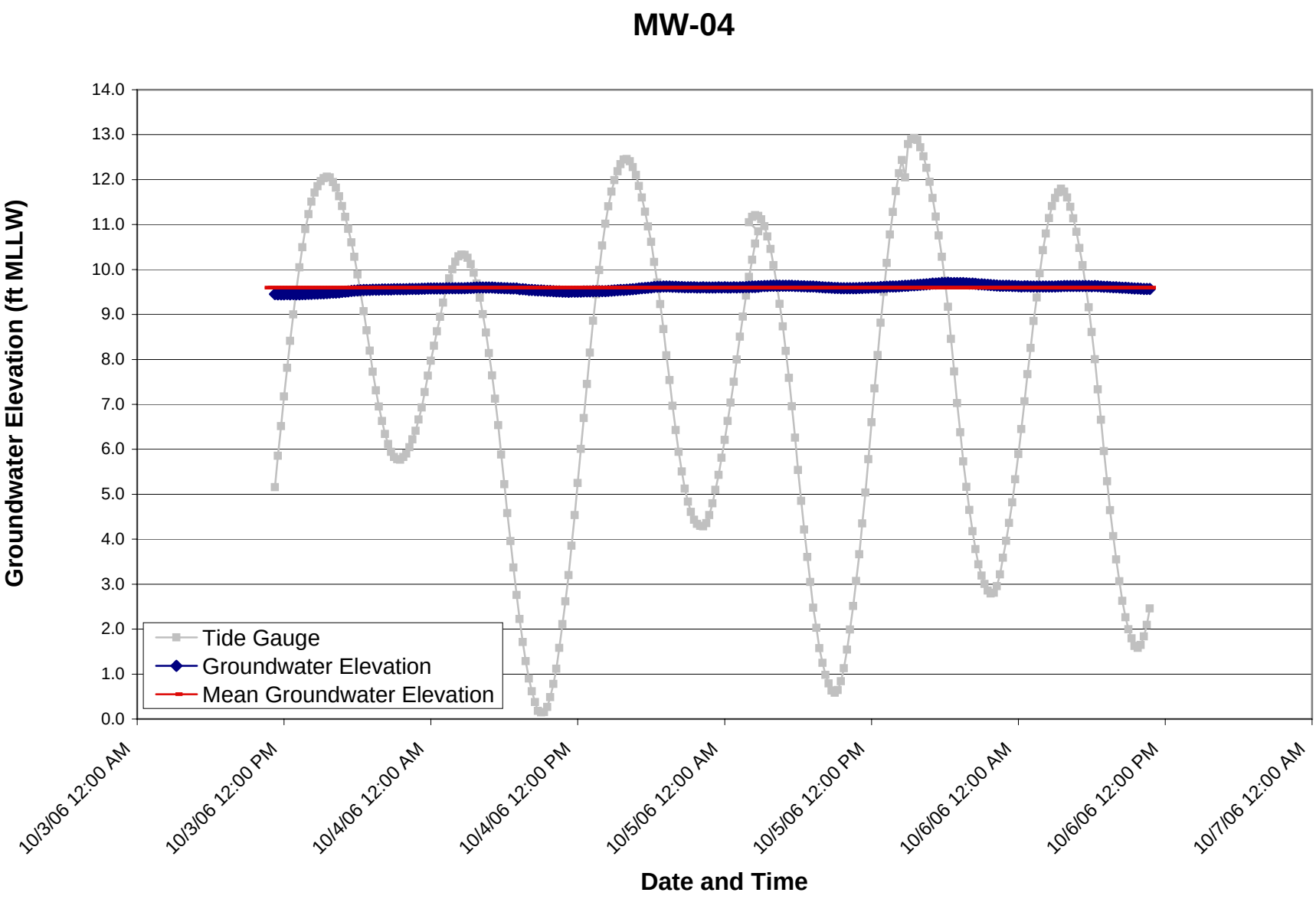
10/7/06 12:00 AM
Date and Time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12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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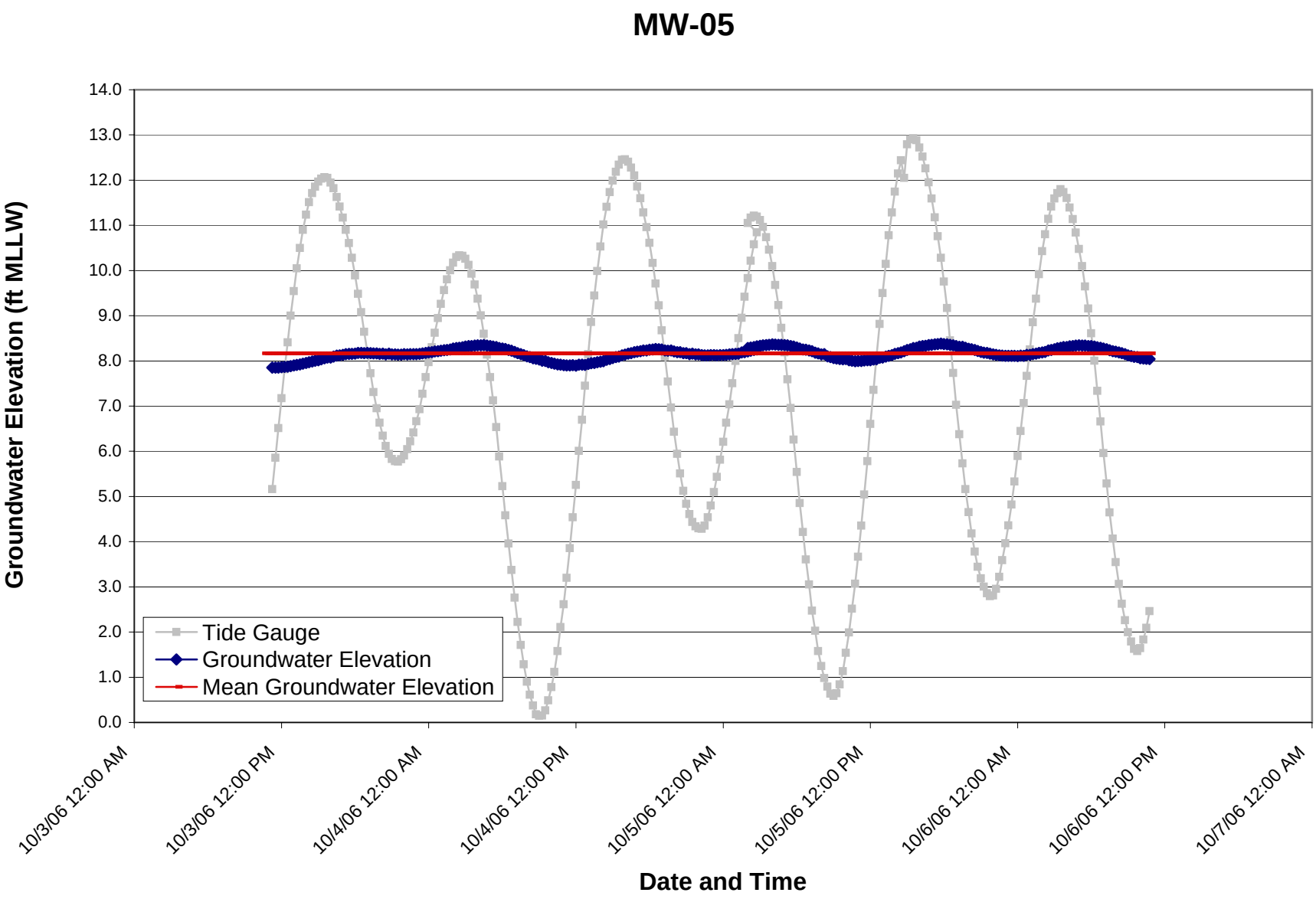
10/7/06 12:00 AM
Date and Time


MW-05
Groundwater Elevation (ft MLLW)
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12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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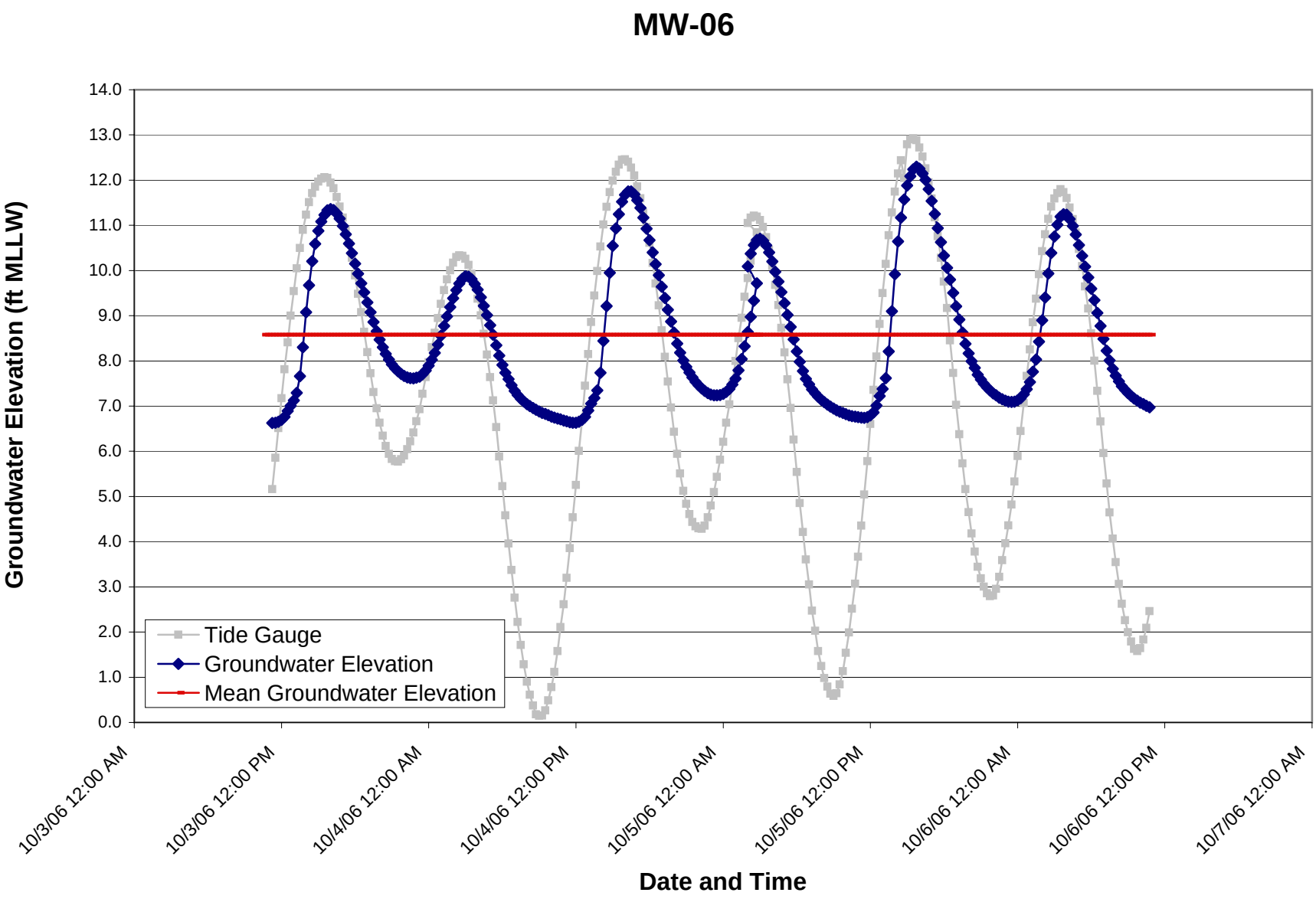
10/7/06 12:00 AM
Date and Time


MW-06
Groundwater Elevation (ft MLLW)
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12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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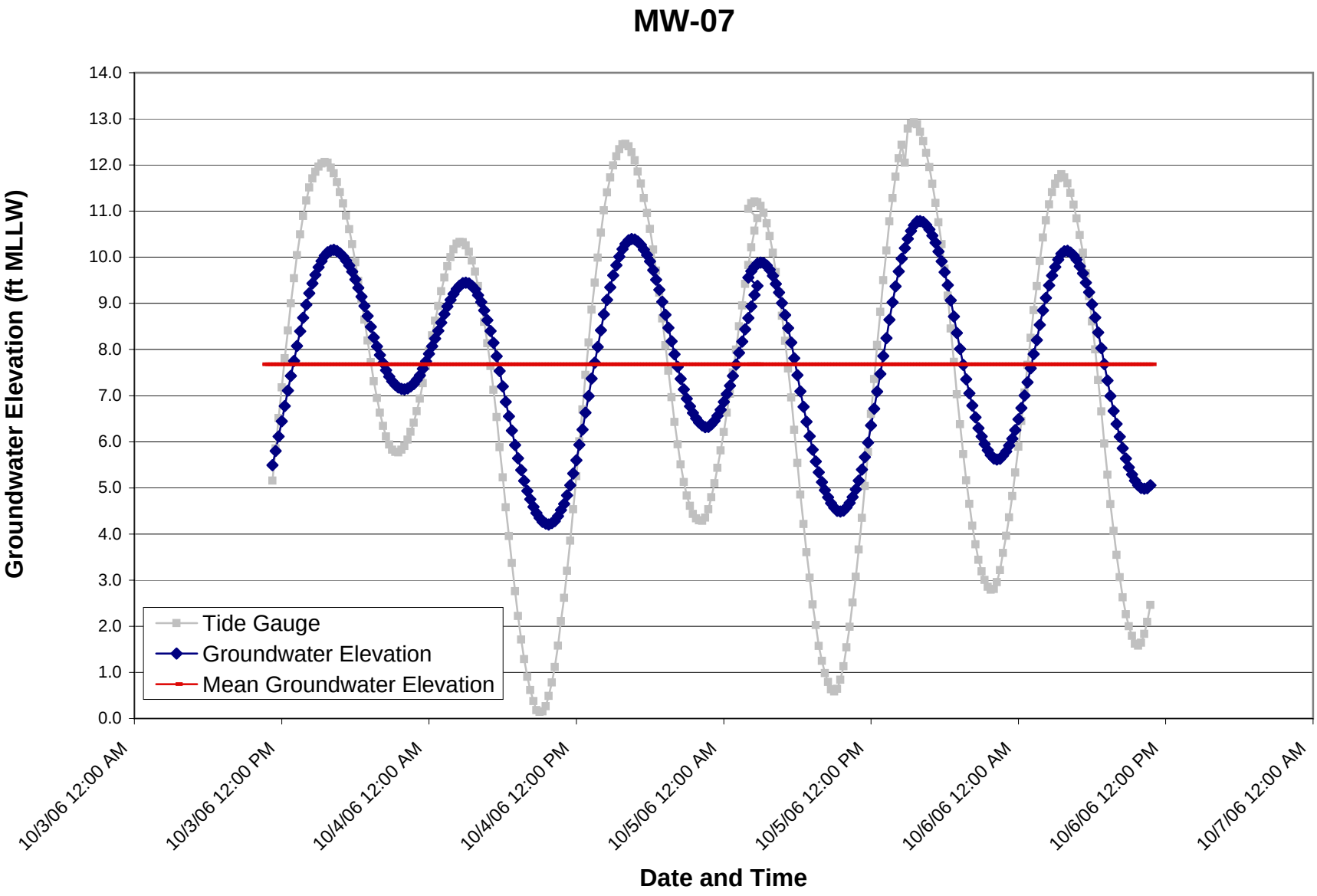
10/7/06 12:00 AM
Date and Time


MW-07
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12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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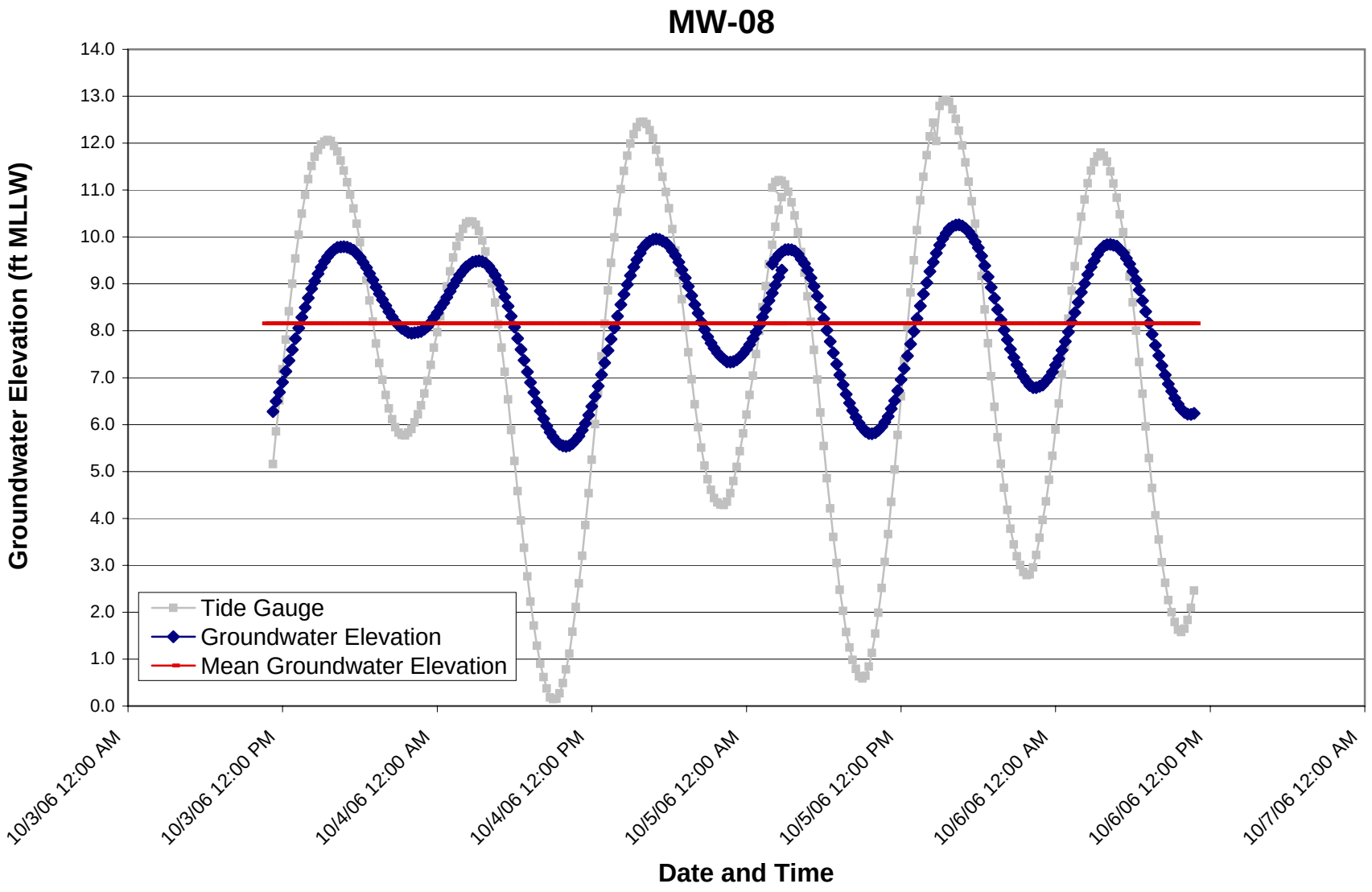
10/7/06 12:00 AM
Date and Time


MW-08
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10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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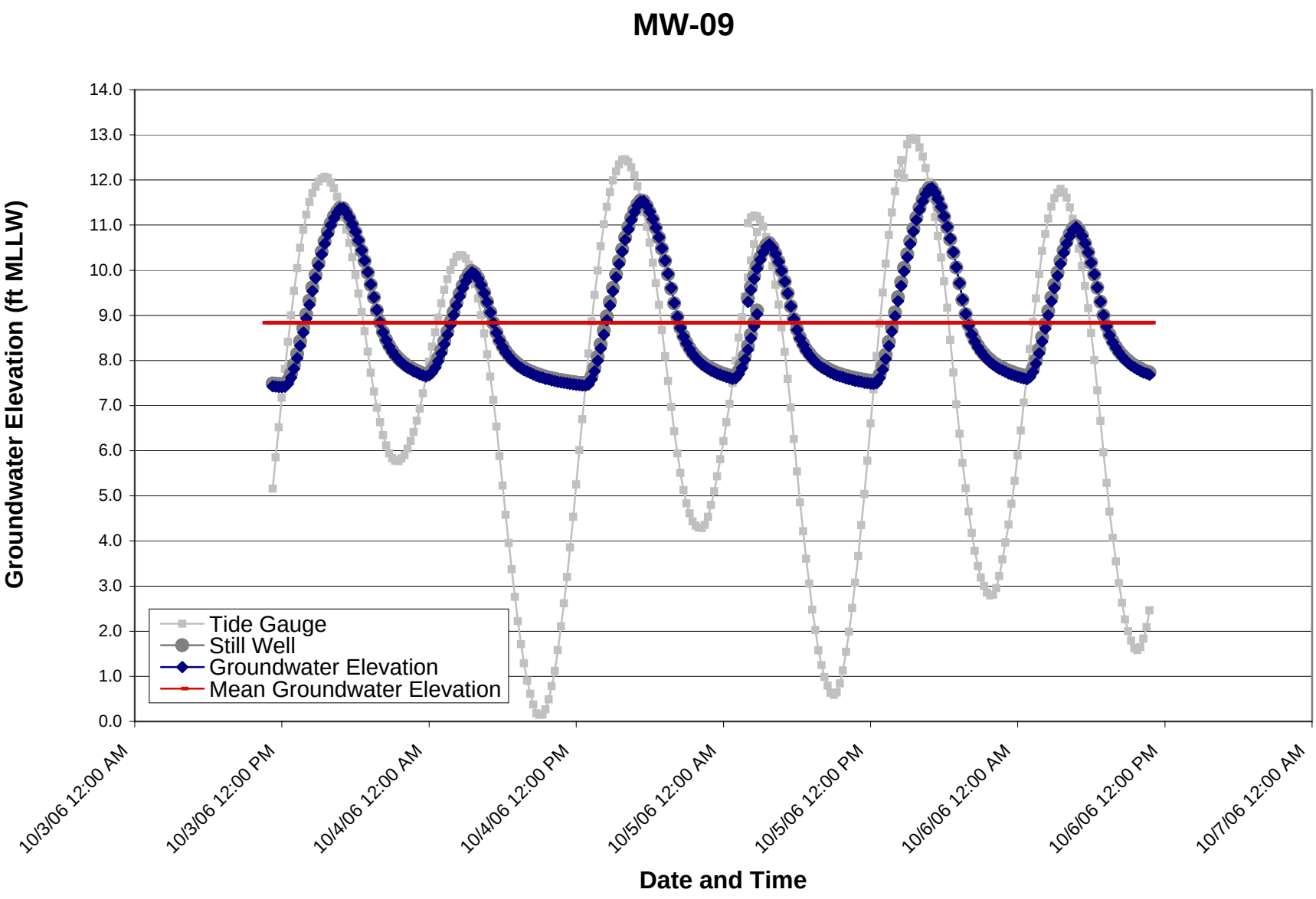
10/7/06 12:00 AM
Date and Time


MW-09
Groundwater Elevation (ft MLLW)
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12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Still Well
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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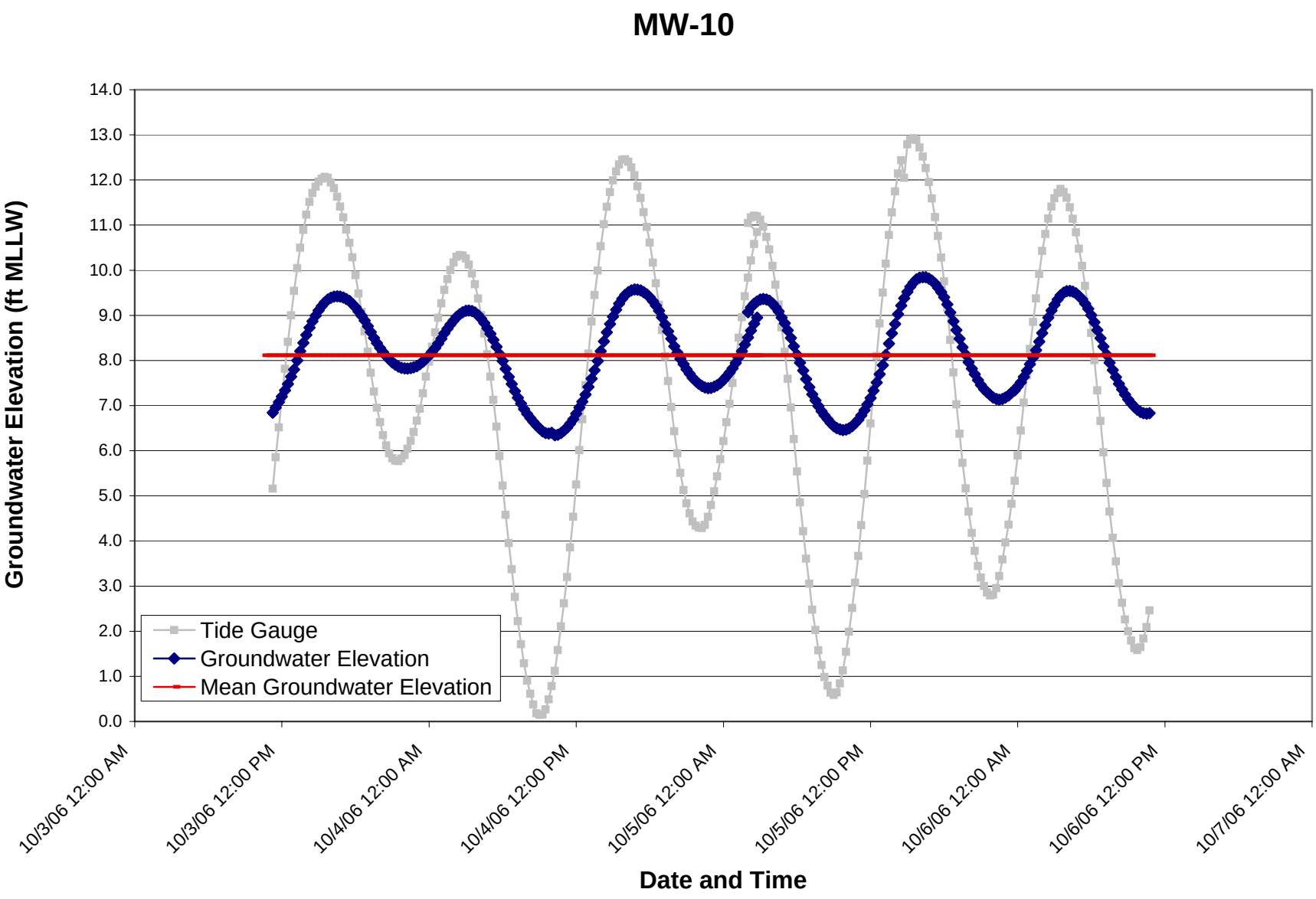
10/7/06 12:00 AM
Date and Time


MW-10
Groundwater Elevation (ft MLLW)
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10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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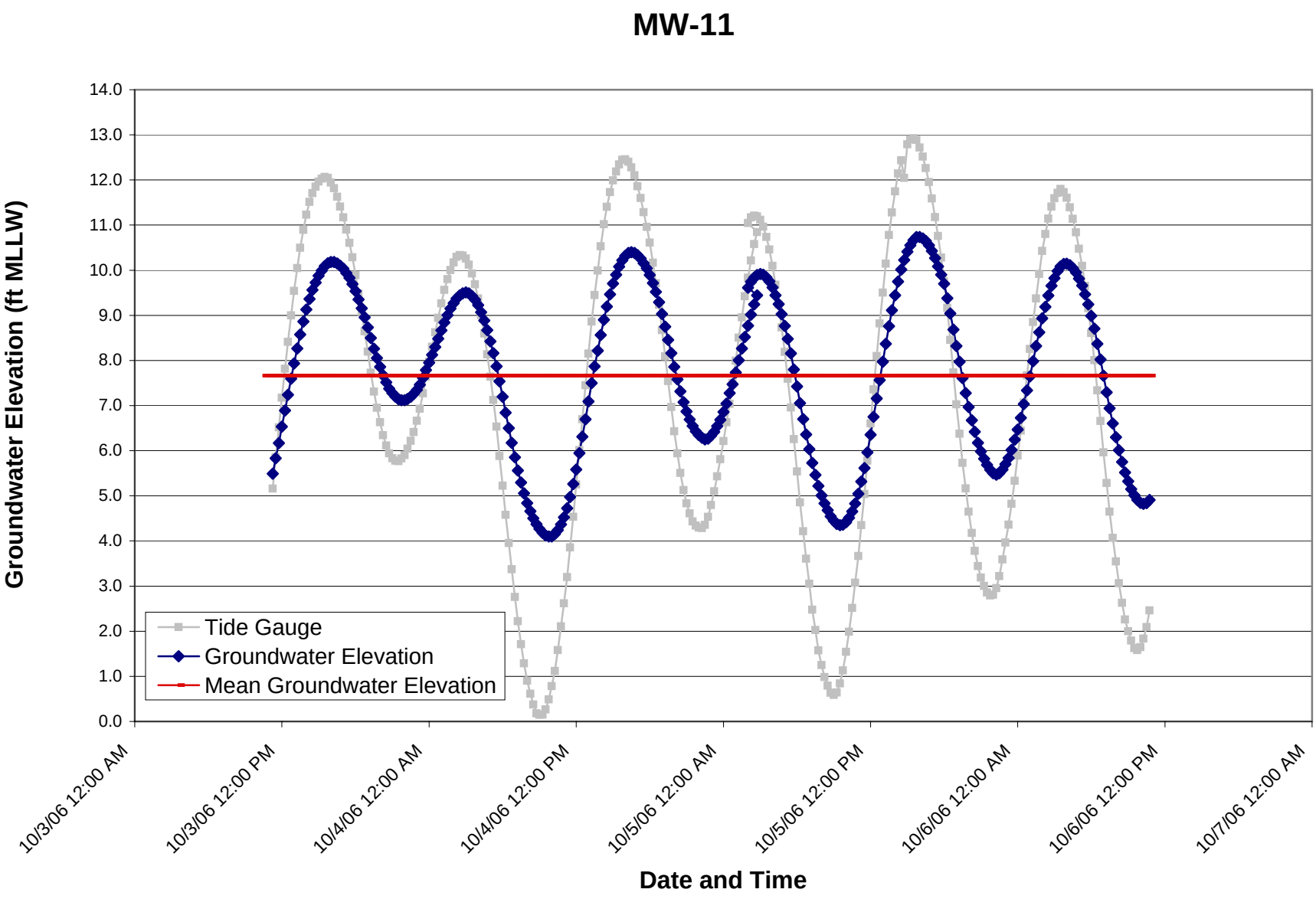
10/7/06 12:00 AM
Date and Time


MW-11
Groundwater Elevation (ft MLLW)
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7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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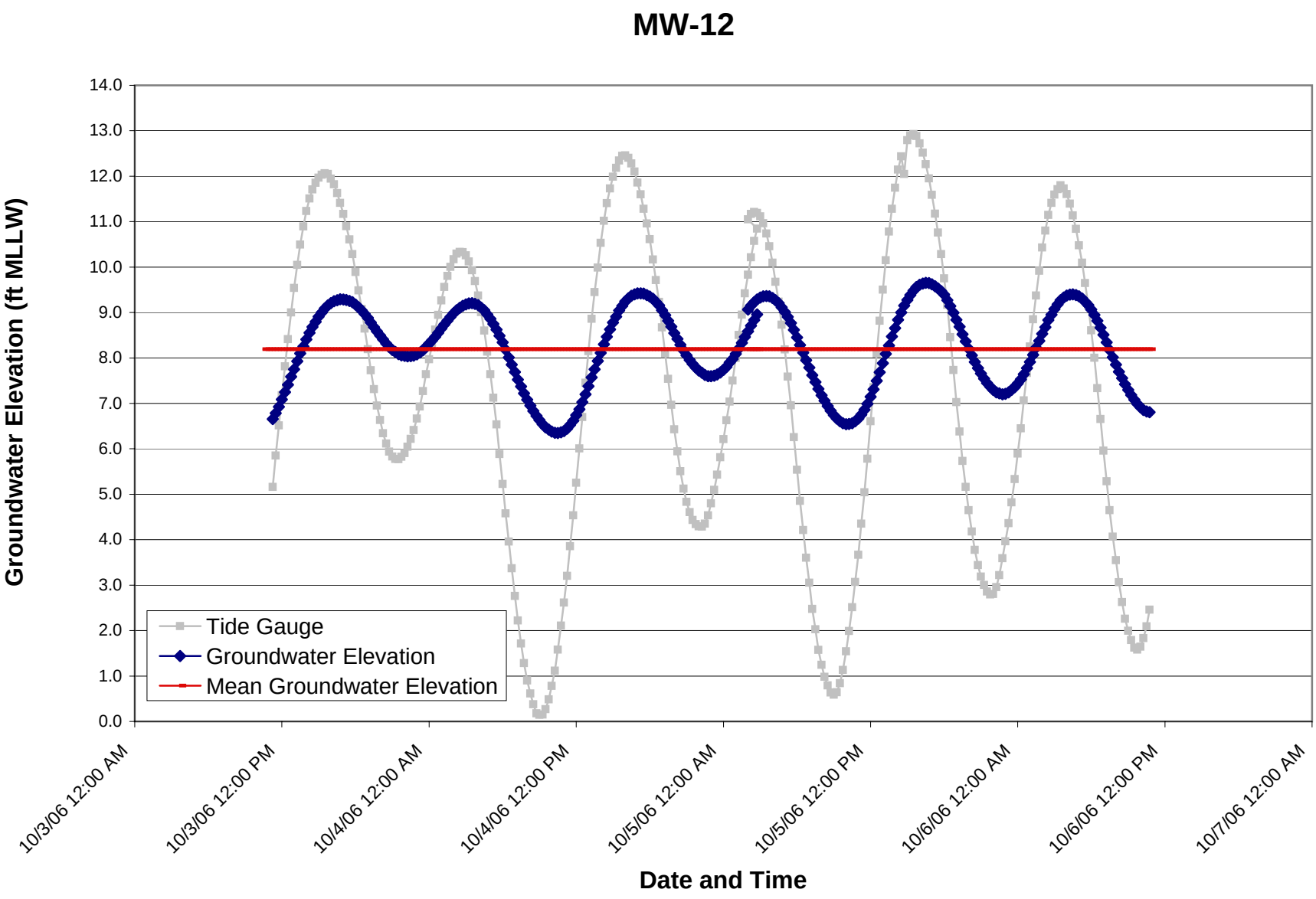
10/7/06 12:00 AM
Date and Time


MW-12
Groundwater Elevation (ft MLLW)
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12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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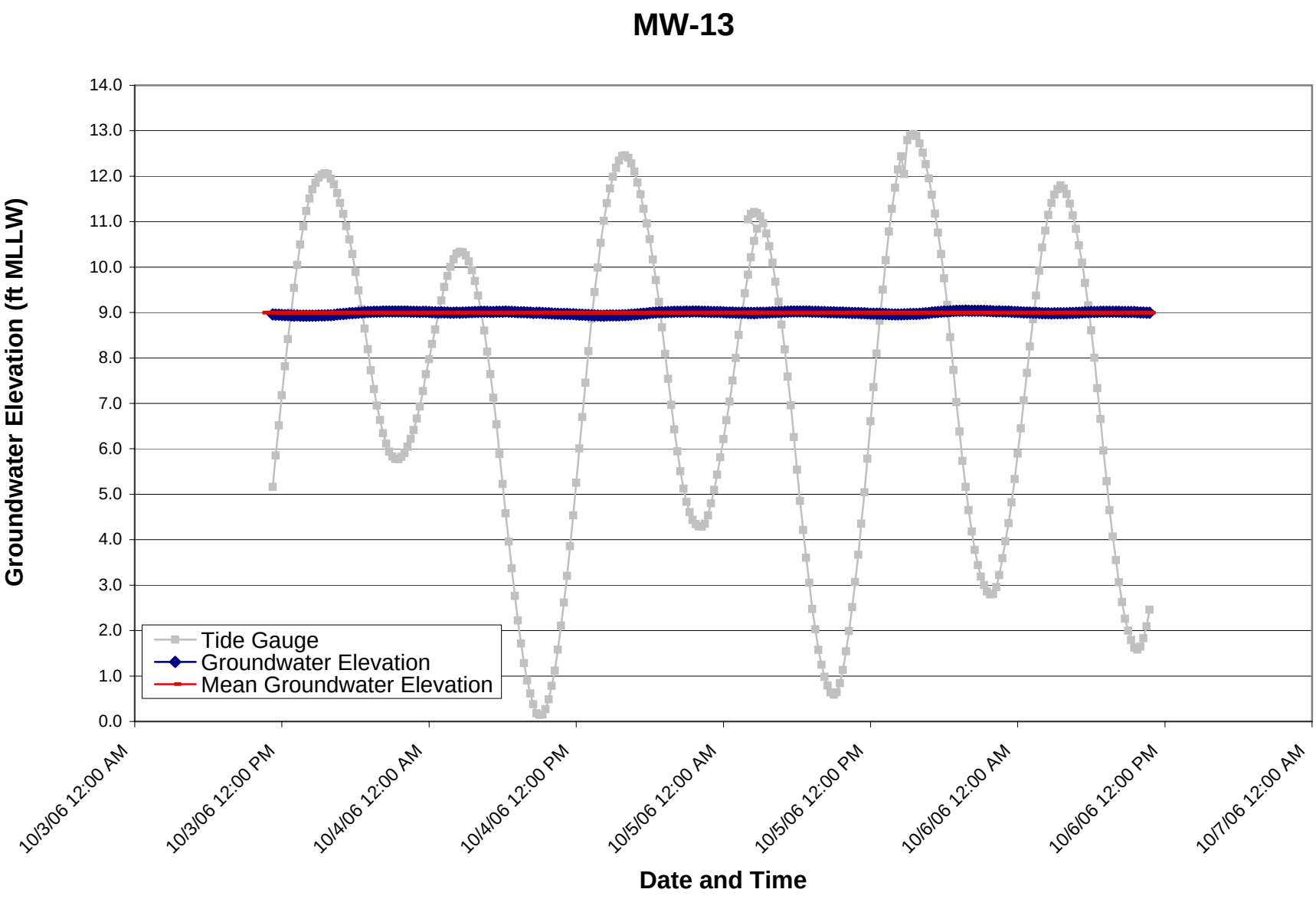
10/7/06 12:00 AM
Date and Time


MW-13
Groundwater Elevation (ft MLLW)
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12.0
11.0
10.0
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8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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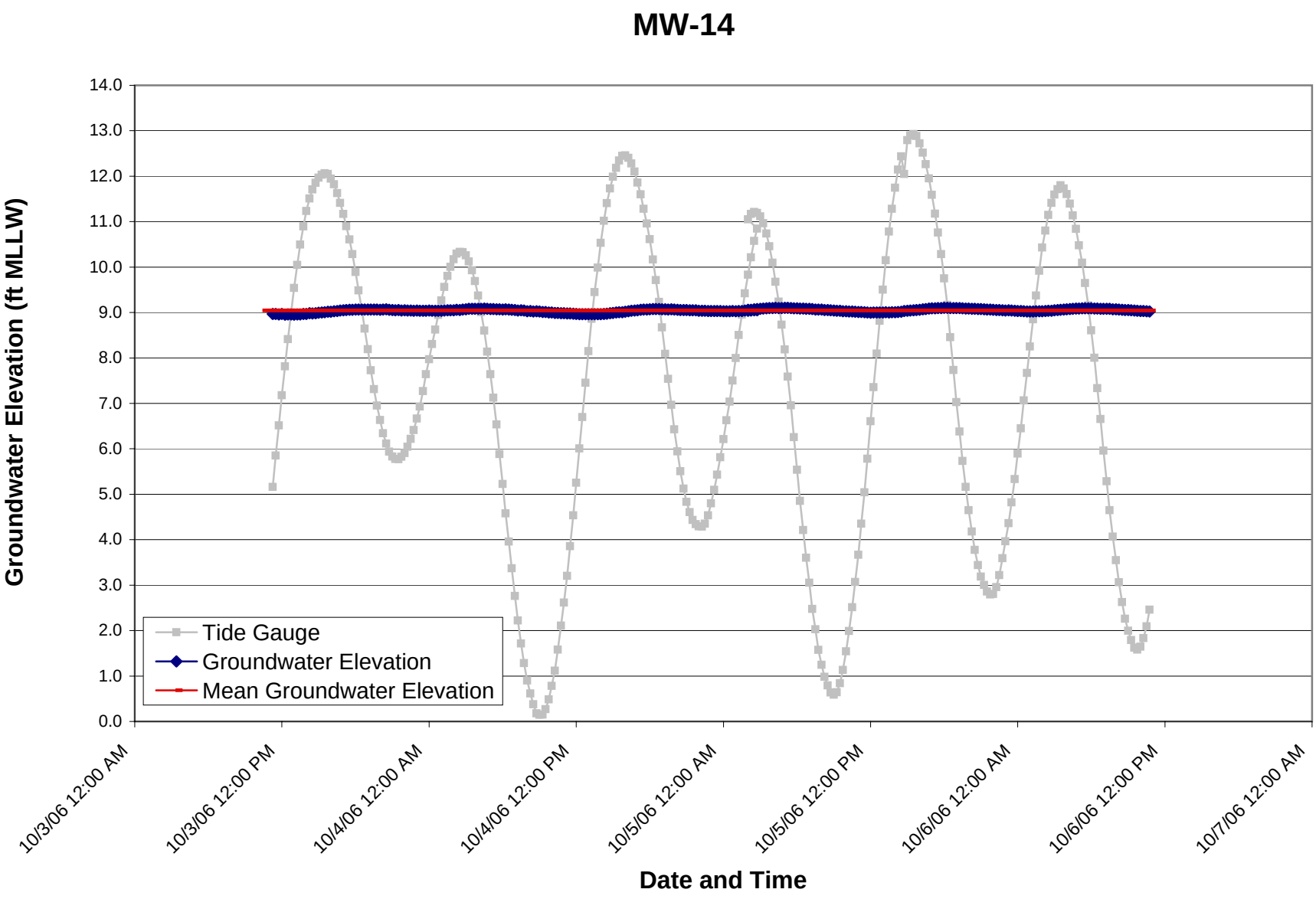
10/7/06 12:00 AM
Date and Time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Groundwater Elevation (ft MLLW)
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6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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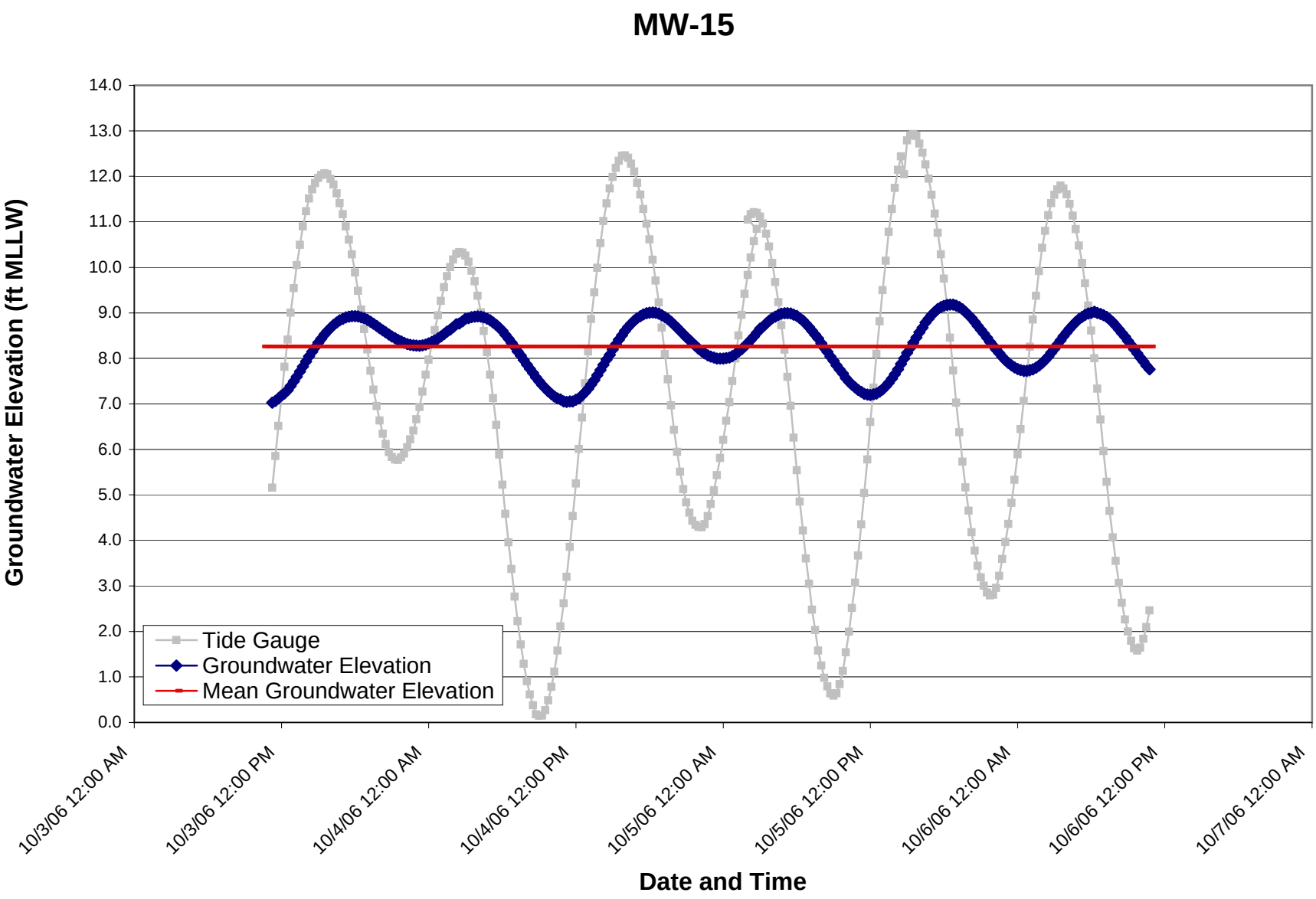
10/7/06 12:00 AM
Date and Time


MW-15
Groundwater Elevation (ft MLLW)
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8.0
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6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Groundwater Elevation
Mean Groundwater Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
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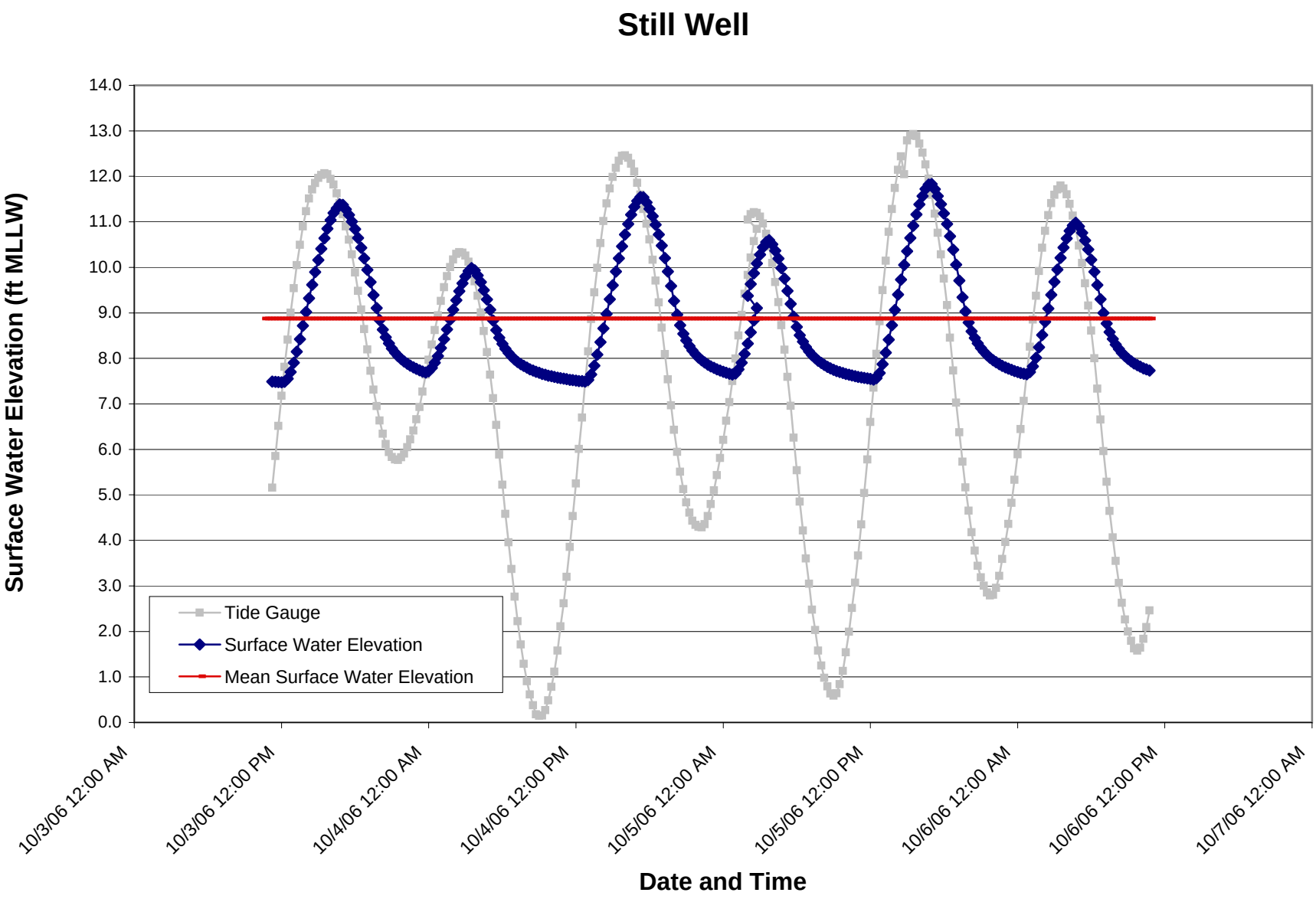
10/7/06 12:00 AM
Date and Time


Still Well
Surface Water Elevation (ft MLLW)
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Tide Gauge
Surface Water Elevation
Mean Surface Water Elevation
10/3/06 12:00 AM
10/3/06 12:00 PM
10/4/06 12:00 AM
10/4/06 12:00 PM
10/5/06 12:00 AM
10/5/06 12:00 PM
10/6/06 12:00 AM
10/6/06 12:00 PM
10/7/06 12:00 AM
Date and Time

Attachment D-2

Identification of Wells to be Monitored to Establish Baseline at CDF

(on enclosed CD)

City of Tacoma
Public Works Department

Technical Memorandum

TO: Piper Peterson Lee, U.S. Environmental Protection Agency

FROM: Mary Henley, P.E., Project Manager, City of Tacoma

SUBJECT: Identification of Wells to be Monitored to Establish Baseline at CDF

DATE: November 21, 2006

This memorandum presents a proposal to the United States Environmental Protection Agency (EPA) for wells to be monitored for establishment of baseline groundwater quality at the St. Paul Waterway Confined Disposal Facility (CDF). Investigation of the hydrogeologic conditions and monitoring to establish baseline groundwater quality is being performed as part of the EPA-approved Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006).

Baseline groundwater quality monitoring at the CDF includes quarterly groundwater sampling and analysis over a two-year period. As specified in the OMMP, the wells to be included in baseline groundwater monitoring are to be selected based on the post-construction hydrogeologic conditions at the CDF. Selection of wells for use in baseline groundwater monitoring at the CDF is the second step required by the OMMP for this aspect of the project. The initial step was to complete a post-construction hydrogeological investigation of the CDF. Results of the hydrogeological investigation are presented in the Post-Construction Hydrogeological Conditions Report. The findings and conclusions from the hydrogeological investigation are summarized in the following section and provide the basis for the proposed monitoring well network to be used to establish baseline groundwater quality at the CDF.

Summary of CDF Hydrological Conditions

The following hydrogeological conditions and potential contaminant transport mechanisms are identified in the Post-Construction Hydrogeological Conditions Report:

- Shallow groundwater, downgradient of the dredged sediment recently placed in the CDF is most likely to be impacted by saltwater washout effects and to transport contaminants from the CDF. Modeling performed as part of the design, identified that contaminant release is most likely to occur where less-saline groundwater and stormwater infiltration come in contact with confined, contaminated dredged materials and then flows away from (i.e., downgradient from) the CDF. Hydrogeological investigations indicate that shallow groundwater generally flows to the west toward the outer St. Paul and Middle Waterways.

- Intermediate depth groundwater, downgradient of the CDF, also has the potential to transport contamination from the confined, contaminated dredged materials. Evaluation of vertical groundwater gradients shows that shallow and deep groundwater flowing through the CDF converge at the intermediate depth horizon. Therefore, groundwater from all depths that has been in contact with the contaminated dredged material has the potential to flow from the CDF within the intermediate depth horizon. Hydrogeological investigations indicate that intermediate depth groundwater flows to the west toward the Middle Waterway.

Recommended Wells for Baseline Groundwater Quality Monitoring

Based on the findings of the CDF hydrogeological conditions investigation, the following monitoring wells are recommended for sampling to establish baseline groundwater quality at the CDF:

- Shallow depth monitoring wells MW-01, MW-02, MW-06, and MW-10 located downgradient of dredged sediment placed in the CDF (Figure 1). These wells are recommended to identify contaminant levels that may result from salt washout by shallow groundwater that encounters the dredged material confined within the CDF and is then discharged downgradient.

- Intermediate depth monitoring wells MW-07 and MW-11 also located downgradient of dredged sediment placed in the CDF. These wells are recommended to identify contaminant levels that may result from shallow, intermediate, and deep groundwater that encounters the dredged material within the CDF and converges at the intermediate depth as it discharges downgradient.

- Monitoring Wells MW-04 and MW-05, installed within the CDF. These wells are recommended to identify contaminant levels in groundwater while it is within the dredged material confined in the CDF.

On approval of the well network by EPA, baseline quarterly groundwater monitoring activities will be initiated in accordance with the OMMP. EPA approval is desired before January 2007, to allow performance of the initial quarter of baseline monitoring during the winter wet season. Constituents to be analyzed during this two year baseline monitoring effort, along with sampling and analysis procedures are outlined in the OMMP.

If you have any questions concerning the monitoring wells selected for baseline groundwater quality monitoring please give me a call at 253-502-2113.

Attachment – Figure 1 Baseline Groundwater Monitoring Locations

Tacoma

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Thea Foss and Wheeler-Osgood Waterways
Baseline Groundwater Monitoring

Figure 1
Baseline Groundwater Monitoring Locations

DATE: 11/21/2006 9:56:11 AM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\St Paul CDF GW\Baseline GW Memorandum Figures\Figure 1 (Baseline Groundwater Monitoring Locations).mxd

Attachment D-3

Response to Comments

(on enclosed CD)

January 16, 2007

Piper Peterson Lee
US EPA, Region 10
1200 Sixth Avenue
Seattle, WA 98101

Subject: Thea Foss and Wheeler-Osgood Waterways Remediation Project
Operations, Maintenance, and Monitoring Plan

Dear Ms. Peterson Lee:

Enclosed are the response to EPA comments on the Post-Construction Hydrogeologic Conditions Report for the St. Paul Waterway Confined Disposal Facility and the Technical Memorandum for Identification of Wells to be Monitored to Establish Baseline at the CDF. The comments were provided to the City in an email dated December 20, 2006. Each comment is presented followed by the response to the comment.

Please give me a call if you have any questions concerning the response to comments.

Sincerely,

Mary Henley, P.E.
Project Manager

MLH:sh (Response to EPA – Corps Comments on Baseline Well Selection – Hydrogeo Report.doc

Enclosures

cc: Kym Takasaki, ACOE
Leslie Ann Rose, CHB

File: Foss OMMP

RESPONSE TO COMMENTS ON THE POST-CONSTRUCTION HYDROGEOLOGIC CONDITIONS REPORT

Comment No. 1. General Comments on Methods. Overall report is well-written, and methods for collecting and analyzing slug test data and tidal data are widely-recognized and appropriate. Based on information presented it is uncertain whether some of the wells were developed adequately or if the wells were designed appropriately. The large amount of fine sand and silt removed from the base of the wells indicates that smaller screen-slot size and filter pack sand may have been more appropriate. We anticipate that future development prior to sampling (maybe with a larger pump) will help reduce the turbidity observed in some of the site wells.

Response: *Post-development turbidity levels were relatively low in most of the monitoring wells installed to monitor the CDF indicating that the wells were designed appropriately. Development was performed in accordance with standard protocols as outlined in the OMMP until the measured turbidity had stabilized and significant reductions in turbidity were no longer observed between successive measurements. Although moderate turbidity levels were measured in several wells at the completion of development, additional development including purging the wells utilizing a larger pump and higher pumping rates is not expected to significantly reduce turbidity further in the wells. Low-flow sampling methods will be used to collect groundwater samples from the wells selected for baseline monitoring at the site. It is anticipated that the use of low-flow sampling will result in further reduction in measured turbidity levels in the groundwater that is collected for analysis. If there is difficulty achieving low turbidity levels during quarterly sampling, the City will consider further development to resolve the issue.*

Comment No. 2. Section 3.3, Groundwater Response to Tidal Fluctuations – For completeness, it would be appropriate to state whether there was any precipitation observed at/near the site during the tidal monitoring study that would have affected groundwater levels. Based on a search of Sea-Tac Airport precipitation data, only 0.02 inches of rain fell during the monitoring period there, which would likely have negligible affect on groundwater levels. Additionally, state whether any known nearby industrial wells or other operations occurred during the testing which might affect local groundwater.

Response: *Weather data from weather stations in the vicinity of the CDF (i.e., Fort Lewis and Tacoma Narrows Airport) during the time period of the tidal study (i.e., October 3, 2006 through October 6, 2006) indicates that approximately 0.15 inches of precipitation fell on the final day of the tidal study. The City does not believe that this amount of rain at the end of the tidal study had a discernable affect on groundwater levels.*

Representatives of Simpson who operate the facilities surrounding the CDF were contacted concerning the presence of operations or industrial wells in the vicinity of the CDF. No industrial wells (i.e., extraction or injection wells) or other operations were identified at Simpson's facilities that would have affected local groundwater flow during the testing.

Comment No. 3. Section 3.4, Mean Groundwater Elevation, Gradients, and Flow Direction – Obviously seasonal changes in average groundwater gradient were not considered in this investigation due to its short duration. However, for completeness it would be appropriate to state this and possibly relate any information on seasonality gleaned from other studies within nearby Tacoma waterways if changes in flow direction or gradient magnitudes (horizontally and/or vertically) occur. Seasonal affects have the highest potential to affect gradient magnitudes (both horizontal and vertical) as opposed to averaged flow directions. Also, include representative maps showing high and low tide flow directions.

Response: *The groundwater gradients and flow directions identified as part of the post-construction hydrogeologic conditions evaluation are consistent with regional groundwater flow patterns and information gathered from investigations of the St. Paul and Thea Foss Waterways as part of remedial design (City of Tacoma, 1999). As part of design activities, a tidal study was conducted for the Thea Foss Waterway in August 1997. The design tidal study was conducted during the summer, when water levels are generally low, while the tidal study conducted as part of this evaluation was performed in the fall when in general, intermediate water levels are observed. Although these studies were conducted in different seasons, similar horizontal and vertical groundwater flow gradients were observed adjacent to the waterways.*

Additional information on seasonal affects on groundwater gradients was identified from review of groundwater monitoring at the Reichhold Tacoma facility located adjacent to the Blair Waterway in the Tacoma tideflats. As part of the quarterly groundwater monitoring at the Reichhold facility, groundwater flow gradients are evaluated through performance of quarterly tidal studies. The results of the monitoring performed in 2004 and 2005 at the Reichhold facility were reviewed to assess seasonal variability.

Groundwater at the Reichhold facility flows from recharge areas at higher elevations toward the Blair Waterway and Commencement Bay similar to groundwater flow at the CDF (i.e., from higher elevations to adjacent waterways). The annual average net gradient was upward for both 2004 and 2005 at the Reichhold facility from deep wells to intermediate depth wells. A vertical upward gradient from the deeper wells to the intermediate wells was observed in all four quarterly events in 2004 for all six well pairs. In 2005, a vertical upward gradient was observed in all six well pairs for three quarters and in five of six well pairs in the remaining quarter. The vertical gradient in the remaining well pair was essentially zero (i.e., -0.001). The magnitude of the vertical gradient varied moderately but the direction of the gradient did not change. The standard deviation between the quarterly (seasonal) monitoring events for both 2004 and 2005 was less than 50 percent. Therefore, the vertical gradients between the intermediate and the deep wells varied less than an order of magnitude as a response to seasonal affects.

Similarly, the standard deviation of the horizontal hydraulic gradient between the quarterly (seasonal) monitoring events for both 2004 and 2005 was less than 30 percent. Therefore, the horizontal gradients across the facility also varied less than an order of magnitude in response to seasonal affects.

The calculated vertical and horizontal groundwater gradients were fairly consistent between each quarterly monitoring event and over the course of a total of eight sampling events at the Reichhold facility. These data indicate that the seasonal affects are not substantial and that regional groundwater patterns and tidal cycles have more impact on both the direction and magnitude of groundwater flow and gradients.

Additional figures have been prepared that present the groundwater flow directions at the lowest low tide and the highest high tide for each of the well intervals – shallow, intermediate, and deep. The additional figures are provided with this response to comments.

Comment No. 4. Figure 9, Groundwater Elevations Map for Intermediate Wells – Groundwater flow direction arrows should always be perpendicular to potentiometric contours; therefore flow direction arrow on figure should be revised to be more southwesterly as opposed to westerly. This has implications for which parts of the CDF would actually be monitored by well MW-11.

Response: *Comment noted. Figure 9 has been revised so that the groundwater flow direction indicated by the arrow on the figure is in the southwesterly direction. A revised Figure 9 is provided with this response to comments. Upon approval, this figure will be provided to planholders to replace the existing Figure 9 in the report.*

Comment No. 5. Boring/well logs are missing for MW-01 through MW-04.

Response: *Comment noted. Copies of the boring/well logs for MW-01 through MW-04 are provided with this response to comments. The boring logs for MW-01 through MW-04 must have been inadvertently left out of the copy of the report provided to the Corps in the process of reproduction.*

RESPONSE TO COMMENT ON THE TECHNICAL MEMORANDUM

Comment No. 1. Based on the information presented in the Hydrogeologic Conditions Report, we agree with the proposed baseline monitoring well sampling recommendations and rationale, with two additions, adding sampling of the deep wells MW-12 and MW-08. Although the hydraulic gradient between intermediate and deep wells downgradient (west) of the CDF is upward, there is about a 30-foot span of aquifer not being monitored between the downgradient intermediate and deep well pairs. Section B-B' (Figure 5 of report) shows dredged fill present in the center of the CDF as deep as -55 ft MLLW, indicating groundwater would flow from the base of the CDF west toward but underneath intermediate well MW-11. If only shallow and intermediate wells MW-10 and MW-11 were to be monitored at this location, potential contaminated groundwater from the CDF that could be monitored by MW-12 might be missed. Monitoring of deep downgradient well MW-08 would not be appropriate based solely on the data collected during the investigation because the top of the screen is below the bottom of the CDF in this area, and with an upward gradient all groundwater from the CDF would be passing above the MW-08 well screen. However, seasonally the vertical gradient might reverse and become downward between wells MW-07 and MW-08 (unlikely from a conceptual standpoint but no data exists to disprove this) in which case monitoring of deep well MW-08 would be appropriate.

Also to obtain a more complete data set and confirm gradients present at the site, we recommend adding water level measurements to all site wells during baseline sampling.

Response*: The deep monitoring wells MW-08 and MW-12 will be included as part of the baseline monitoring program (i.e., two years of quarterly monitoring) to provide baseline conditions for all wells located between the CDF and surface waters in the St. Paul and Middle Waterways and Commencement Bay. Monitoring of wells MW-08 and MW-12 will provide additional information on the range of baseline water quality conditions at the site. A revised Figure 1 has been provided that includes MW-08 and MW-12 as wells to be monitored as part of baseline groundwater monitoring.*

It should be noted that, as identified in the Post-Construction Hydrogeologic Conditions Report (Figure 10), the overall horizontal groundwater gradient at the depth of the base of the CDF is flat, so that horizontal transport of water present at depth from the CDF to surface water is not likely to occur. Additionally, the groundwater gradients at depth (i.e., -40 to -70 feet MLLW or approximately 60 to 90 feet below the ground surface) are not likely to be significantly altered by seasonal variation as gradients at depth will be dominated by regional groundwater flow patterns and tidal fluctuations. The results of quarterly tidal studies performed at the nearby

Reichhold facility, located on the Blair Waterway, has shown only minor affects on groundwater gradients from seasonal variation. The vertical gradient in deep wells at the Reichhold facility is consistently upward, similar to the gradient measured in downgradient deep wells adjacent to the CDF and Middle Waterway during the 72-hour tidal study performed at the CDF (see response to Comment 3 above). However, as indicated above, MW-08 and MW-12 will be added to the quarterly monitoring program to establish the baseline conditions.

Water level measurements will be taken as part of standard protocols prior to sampling each well selected for baseline monitoring (i.e., MW-01, MW-02, MW-04, MW-05, MW-06, MW-07, MW-08, MW-10, MW-11, and MW-12) (see Section D.6.1 of the OMMP). However, site-wide "snapshot" groundwater level measurement have not been included as part of monitoring activities because they will not provide additional information concerning overall groundwater gradients and resulting net groundwater flow direction. Site-wide groundwater levels change rapidly due to tidal fluctuations as shown in the Post-Construction Hydrogeologic Conditions Report (see Attachment C-3 of Appendix C). Therefore, collection of an accurate "snapshot" of site-wide groundwater levels during baseline groundwater sampling events is not possible as the water levels in most wells will change significantly in the time it takes to collect water level measurements for all 15 wells. Additionally, "snapshot" water level measurements will not confirm the overall groundwater gradients (i.e., horizontal and vertical gradients) because a "snapshot" only defines an instantaneous point in time and not net groundwater flow direction at the site. The 72-hour tidal study was performed to provide overall groundwater gradients and net groundwater flow direction. Using the data from the 72-hour tidal study, the mean groundwater elevation for each well was calculated from 288 individual water level measurements and used to identify overall horizontal and vertical groundwater gradients and flow direction at the site. As stated in the Post-Construction Hydrogeologic Conditions Report, the horizontal and vertical groundwater gradients identified at the CDF are consistent with those identified during design investigations.

Tacoma

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Thea Foss and Wheeler-Osgood Waterways
Baseline Groundwater Monitoring

Figure 1
Baseline Groundwater Monitoring Locations

DATE: 1/12/2007 9:12:24 AM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\St Paul CDF GW\Baseline GW Memorandum Figures\Figure 1 (Baseline Groundwater Monitoring Locations).mxd

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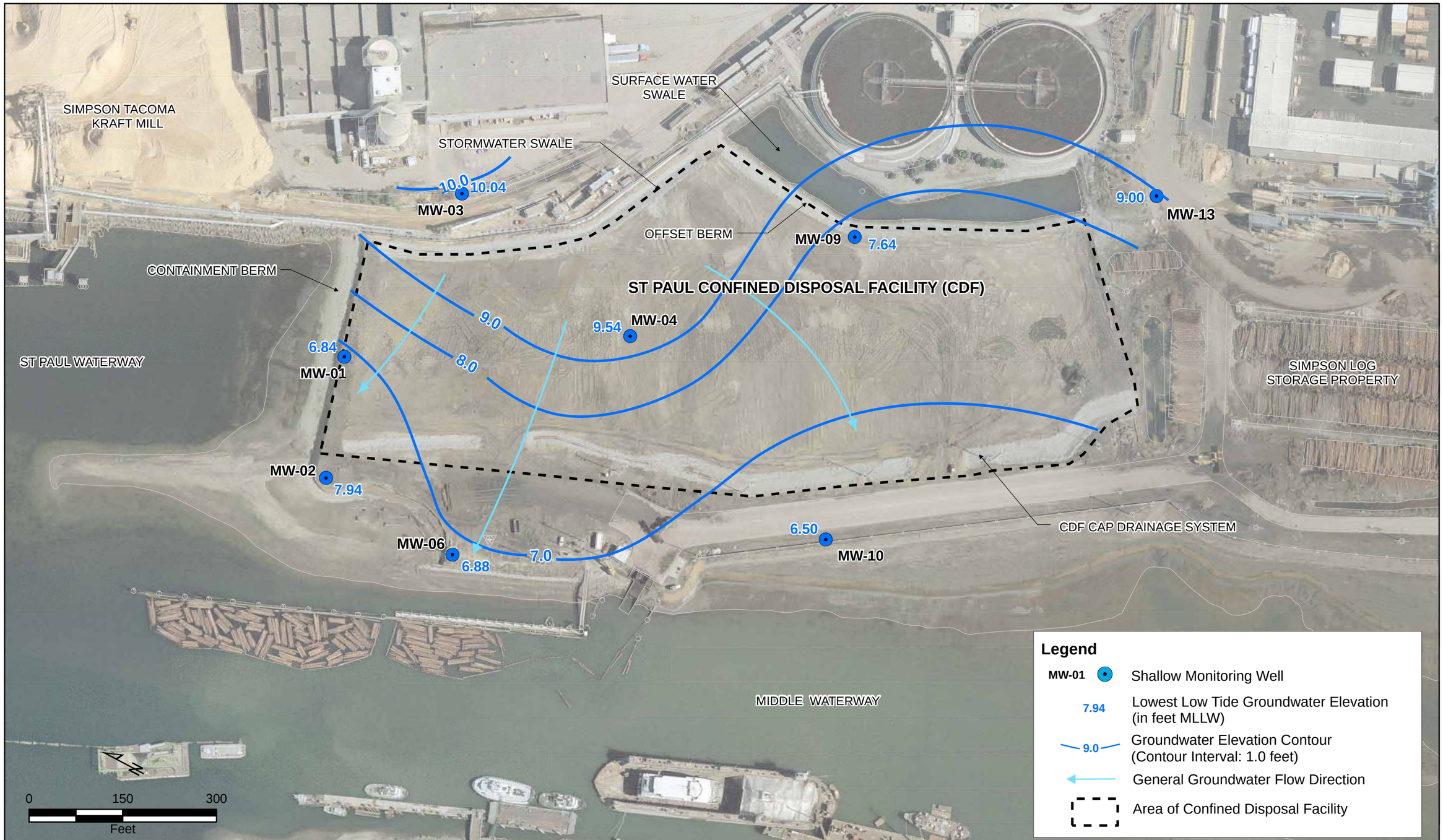
Thea Foss and Wheeler-Osgood Waterways
Post-Construction Hydrogeologic Conditions Report

Figure 9
Groundwater Elevations Map
Intermediate Wells, October 2006

DATE: 11/15/2006 3:31:57 PM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\St Paul CDF GW\Hydrogeologic Conds Report Figures\Figure 9 Groundwater Elevations Intermediate.mxd



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Thea Foss and Wheeler-Osgood Waterways
Post-Construction Hydrogeologic Conditions Report

Groundwater Elevations Map
Shallow Wells, Lowest Low Tide
9:00 AM October 4, 2006

DATE: 12/28/2006 10:23:03 AM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\St Paul CDF GW\Hydrogeologic Conds Report Figures\Revised or New Figures based on EPA Comments\Shallow Groundwater Elevations Lowest Low Tide 122806.mxd

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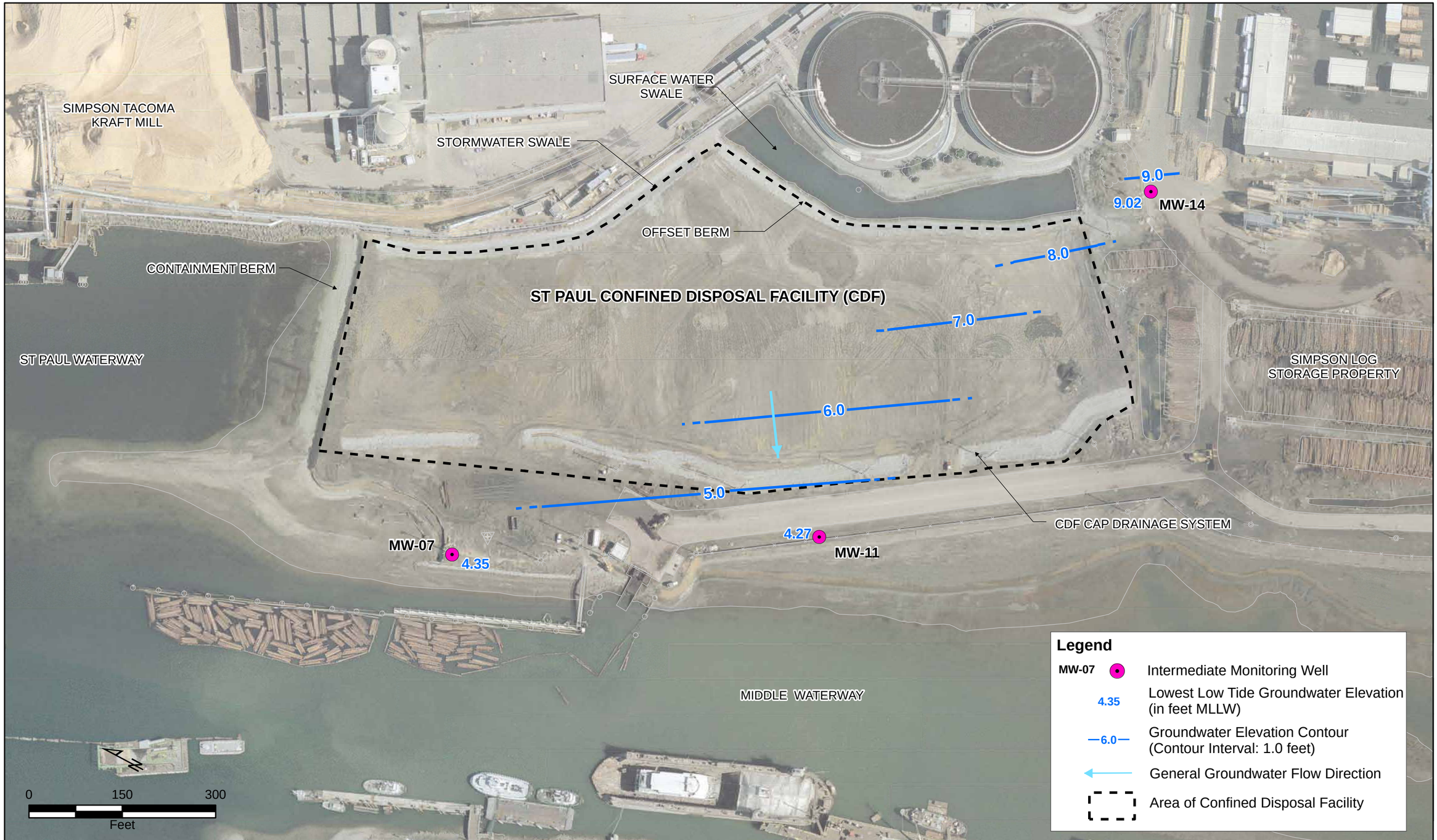
Thea Foss and Wheeler-Osgood Waterways
Post-Construction Hydrogeologic Conditions Report

Groundwater Elevations Map
Shallow Wells, Highest High Tide
3:30 PM October 5, 2006

DATE: 11/15/2006 3:23:02 PM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\St Paul CDF GW\Hydrogeologic Conds Report Figures\Figure 8 Groundwater Elevations Shallow.mxd



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Thea Foss and Wheeler-Osgood Waterways
Post-Construction Hydrogeologic Conditions Report

Groundwater Elevations Map
Intermediate Wells, Lowest Low Tide
9:00 AM October 4, 2006

DATE: 12/28/2006 10:29:06 AM
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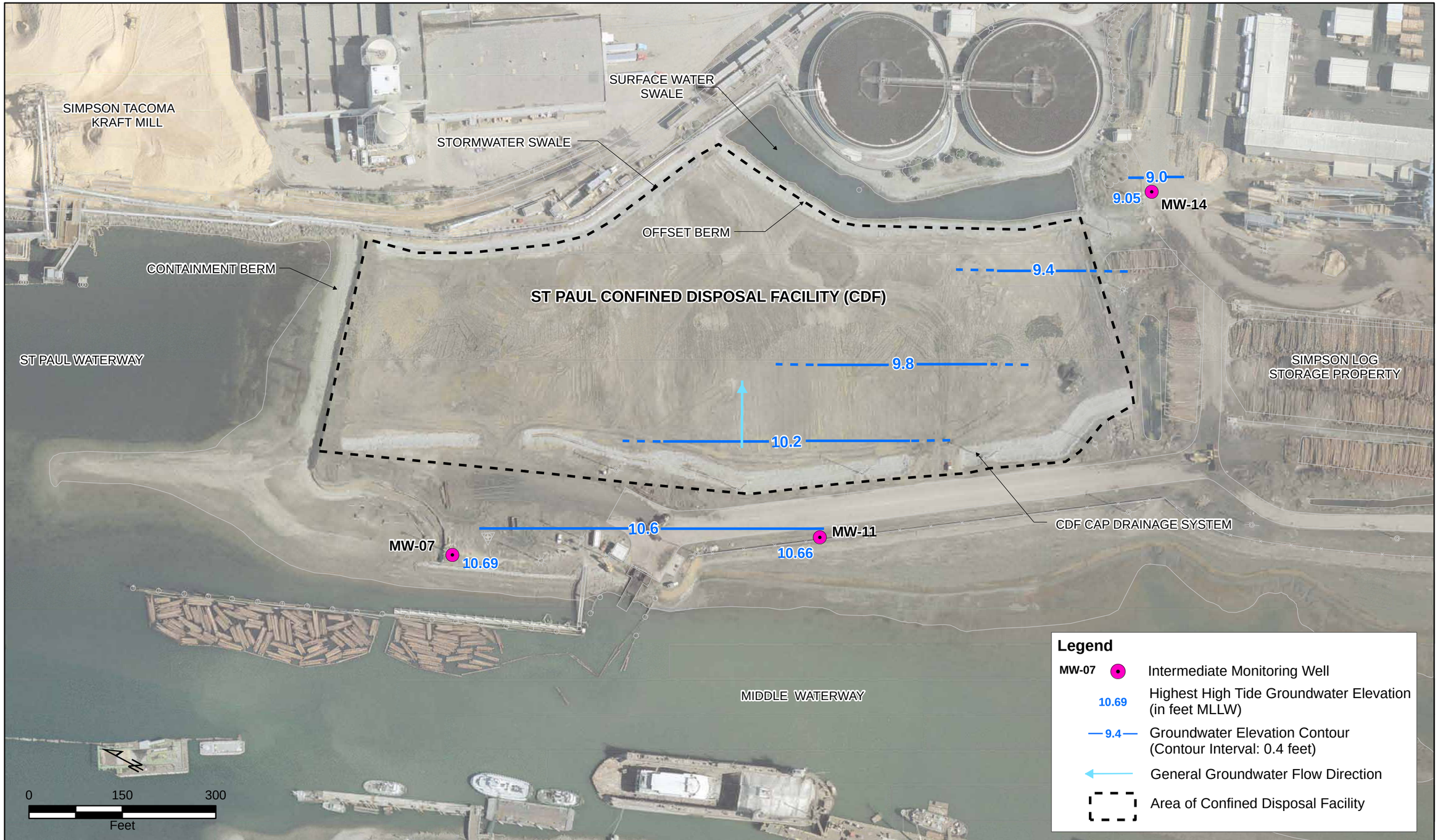

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Thea Foss and Wheeler-Osgood Waterways
Post-Construction Hydrogeologic Conditions Report

Groundwater Elevations Map
Intermediate Wells, Highest High Tide
3:30 PM October 5, 2006

DATE: 12/28/2006 10:28:06 AM
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Thea Foss and Wheeler-Osgood Waterways
Post-Construction Hydrogeologic Conditions Report

Groundwater Elevations Map
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9:00 AM October 4, 2006

DATE: 12/28/2006 11:55:13 AM
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Tacoma

Thea Foss and Wheeler-Osgood Waterways
Post-Construction Hydrogeologic Conditions Report

Groundwater Elevations Map
Deep Wells, Highest High Tide
3:30 PM October 5, 2006

DATE: 12/28/2006 11:31:03 AM
MXD NAME: F:\projects\KPFF Foss\GIS\Revised OMMP\St Paul CDF GW\Hydrogeologic Conds Report Figures\Revised or New Figures based on EPA Comments\Deep Groundwater Elevations Highest High Tide 122806.mxd

Log of Soil Boring and Well Construction B01/MW-01

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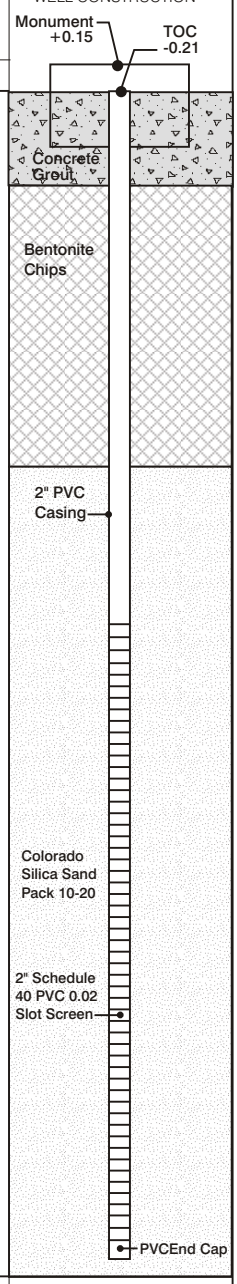
Floyd Snider
Boring B-01/MW-01 Date 8-28-06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Sunny
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 19.0 ATD Water Level Depth 9.0 Ft
Ground Surface Elevation 18.2

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
						Brown, Dry, GRAVEL with Silt and Sand. (Fill)
S-1	6 7 5	2.5	4.0	☒	GW	Brown to gray, damp GRAVEL with fine to coarse Sand.
S-2	2 3 3	7.5	9.0	☒	SW	Brown to gray, fine to coarse, moist SAND and Gravel.
S-3	2 2 3	12.5	14.0	☒	SW	Gray to brown, fine to coarse, wet SAND with Gravel. (Mostly slough. Limited recovery.)
S-4	8 3 5	17.5	19.0	☒	GW	Gray, wet GRAVEL with fine to coarse Sand. (Limited recovery.)
						Bottom of boring at 19.0 feet.

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B02/MW-02

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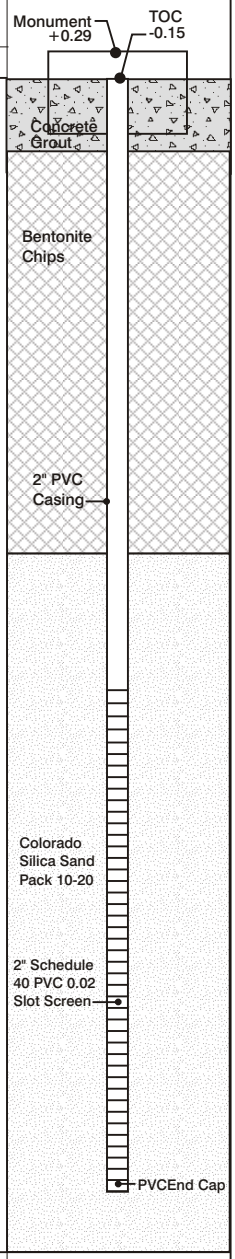
Floyd Snider
Boring B-02/MW-02 Date 8-28-06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Clear/Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Split Spoon
Bottom of Boring 23.5 ATD Water Level Depth 13.75 Ft
Ground Surface Elevation 19.8

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
S-1	8 9 15	3.5	5.0		GM	Dark gray, moist, GRAVEL with Silt and Sand.
S-2	3 3 2	8.5	10.0		SM	Dark gray to brown, moist, fine SAND with Silt.
S-3	0 0 1	13.5	15.0		ML	Gray to black, moist, SILT with Sand. (Abundant wood fragments present throughout drive.)
S-4	0 1 2	18.5	20.0		SM ML	Dark brown, wet, SILT with fine Sand to fine Sand with Silt. (Wood fragments present throughout drive.)
S-5	1 2 4	22.0	23.5		SM	Dark gray, wet, SAND with Silt. (Abundant wood fragments throughout drive. H_2S like odor.)

Bottom of boring at 23.5 feet.

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B03/MW-03

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Floyd Snider
Boring B-03/MW-03 Date 9-5-06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 19.5 ATD Water Level Depth 9.9 Ft
Ground Surface Elevation 17.8

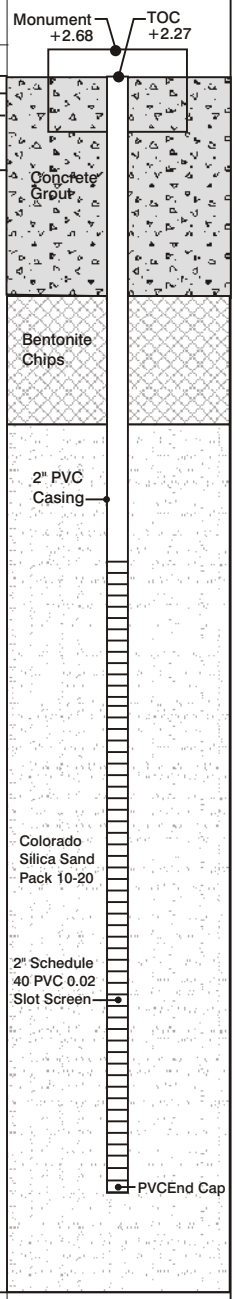
Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
						ASPHALT
						Removed via Vac Truck
						Large 3" to 5" diameter cobbles
S-1	NA	0.6	1.5			Gray, damp, fine SAND.
						(Sample S-1 collected by hand from 0.6' to 1.5' depth interval.)
						0.0' to 0.25' Asphalt 0.25' to 0.60' Large 3" to 5" diameter cobbles 0.60' to ? Gray, damp fine SAND
						Brown to gray, damp GRAVEL with fine to coarse Sand. (Excavated 0' to 10' using vacuum truck due to utility concerns.)
S-2	2	13.0	14.5		SP	Dark gray, wet, fine SAND with trace Silt.
S-3	2	18.0	19.5		SM	Dark gray, wet, fine to medium SAND with Silt.
						Bottom of boring at 19.50 feet.

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Blow counts: 0, 1, 1 (S-2); 0, 1, 1 (S-3)

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Log of Soil Boring and Well Construction B04/MW-04

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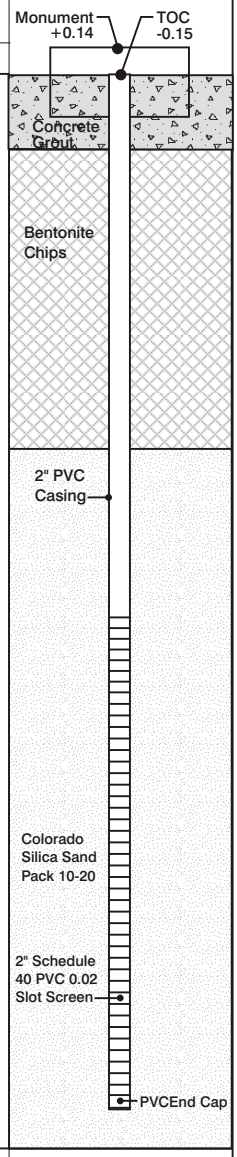
Floyd Snider
Boring B-04/MW-04 Date 9/06/06 Sheet 1 of 1
Job St Paul CDF
Logged By Chris Gardner Weather Sun
Drilled By Holt Drilling
Drill Type/Method 4" ID HSA
Sampling Method 140 lb Auto Hammer
Bottom of Boring 21.5 ATD Water Level Depth 12.20 Ft
Ground Surface Elevation 18.7

Obs. Well Install. ☒ Yes ☐ No

SAMPLE ID	Blow Count N/12"	RECOVERY From	RECOVERY To	GRAPHIC RECOVERY	USCS Symbol	DESCRIPTION: color, texture, moisture MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.
					GM	Brown, loose, damp, GRAVEL with Silt and Sand. (Fill)
						Cuttings show abundant damp wood fragments.
S-1	4	13.5	15.0		ML	Dark gray, moist to wet, SILT with fine Sand. (Abundant wood fragments.)
S-2	1	18.5	20.0		SM-ML	Dark brown, wet, SILT with abundant fine Sand. (Scattered wood fragments throughout drive.)
S-3	2	20.0	21.5			
						Bottom of boring at 21.5 feet.

Blow Count N/12": 3, 2, 2 (S-1); 2, 1, 0, 0, 1, 1 (S-2, S-3)

WELL CONSTRUCTION



Recovery
Subsample for Analysis
Driven Interval

▽ Groundwater Observed At Time of Drilling

Appendix E

Habitat Mitigation Area Monitoring

Attachment E-1

Habitat Mitigation Area Monitoring Preliminary Findings Memorandum

(on enclosed CD)

THEA FOSS AND WHEELER-OSGOOD WATERWAYS REMEDIATION PROJECT

YEAR 0 BASELINE MONITORING

HABITAT MITIGATION AREA MONITORING PRELIMINARY FINDINGS MEMORANDUM

NOVEMBER 30, 2006

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY

Prepared by:

CITY OF TACOMA

PRELIMINARY FINDINGS MEMORANDUM
HABITAT MITIGATION AREA MONITORING

INTRODUCTION

This memorandum presents the findings from the Year 0, baseline habitat mitigation area monitoring performed at the Thea Foss Waterway habitat mitigation and enhancement area sites. This habitat mitigation area monitoring was performed in accordance with the Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006). The OMMP requires that various components of habitat mitigation monitoring occur throughout the first ten years following completion of the remedial action. After 10 years of monitoring, the City and EPA will evaluate the need for and scope of additional monitoring. A summary of the habitat area monitoring activities performed during this baseline monitoring year is provided in Table 1.

The following sections summarize the habitat mitigation area monitoring requirements and the findings of these inspections. As described in the OMMP, both the habitat mitigation areas (North Beach Habitat, Middle Waterway Tideflat Habitat, Puyallup River Side Channel, and the Hylebos Creek Mitigation Site) and the Thea Foss Habitat Enhancement Areas (Johnny's Dock Habitat Enhancement, Head of Thea Foss Shoreline Habitat, SR 509 Esplanade Riparian Habitat, and the Log Step Habitat Enhancement) were inspected. Monitoring activities were performed in accordance with the OMMP. Provided with this memorandum are attachments that contain copies of the field forms and photographs documenting observations and site conditions identified during the inspections.

SUMMARY OF HABITAT MITIGATION AREA BASELINE MONITORING REQUIREMENTS

The OMMP specifies that habitat mitigation monitoring be performed to achieve the following objectives:

- To evaluate the effectiveness of the development of biological features and physical features at the mitigation and enhancement sites to confirm that they are on a trajectory to provide habitat function necessary to meet the objectives for each site; and
- To confirm that the habitat sites have attained and continue to meet the objectives for each site over time.

As required by the OMMP, habitat monitoring activities are generally performed when tidal elevations are below 0.0 feet Mean Lower Low Water (MLLW) except at the Hylebos Creek Mitigation Site where the primary monitoring activities are performed when tidal elevations are below 8.78 feet MLLW.

Standardized field forms are used to document observations of conditions at the sites. The following types of information are recorded during the monitoring activities:

- Various qualitative observations including evidence of erosion or sedimentation, evidence of damage or disease, and condition of large woody debris and goose exclosures;

- Conditions/types of vegetation;
- Species of wildlife observed; and
- Soil/sediment quality.

In addition, photographs are taken during the inspection at designated photo point locations to allow for comparison in subsequent monitoring years. Additional photographs are taken at high tide at the Hylebos Creek Mitigation Site to show conditions at the site during periods of tidal inundation.

Additional baseline monitoring activities include installation and photographing of elevation stakes to monitor sediment erosion/accretion over time at the mitigation areas; brackish marsh monitoring at the Middle Waterway Tideflat Habitat to track the effectiveness of the irrigation system; and surface water elevation monitoring at the Hylebos Creek Mitigation Site.

SUMMARY OF FIELD ACTIVITIES

Year 0 baseline habitat monitoring activities were initiated in April 2006 with the placement of the surface water elevation monitoring probe at the Hylebos Creek Mitigation Site. Salinity monitoring at the Middle Waterway Tideflat Habitat was performed in May, July, August, and September 2006. Qualitative ground surveys, photo documentation, and elevation monitoring were initiated in July 2006. The surface water elevation monitoring at Hylebos Creek was completed on November 2, 2006. A site-by-site discussion follows. Copies of the inspection forms, photographs, and survey information are included in Attachment A.

Mitigation Site Monitoring Activities

NORTH BEACH HABITAT

The St. Paul Beach Habitat, Peninsula Habitat, and Middle Waterway Corridor Habitat areas as defined during the construction process are collectively referred to as the North Beach Habitat. These habitat areas are buffered from upland activities by a 10- to 20-foot wide riparian buffer.

The completed St. Paul Beach portion of the habitat area is composed of low gradient, fine grained beach habitat. The beach slopes at a low angle (10H:1V or flatter) to approximately 8 feet MLLW and is composed of habitat mix. The beach then slopes more steeply upward (approximately 3H:1V), meeting the St. Paul Confined Disposal Facility (CDF) berm at an elevation of approximately 13.5 feet MLLW. The beach surface in this area is comprised of habitat mix and rounded cobbles similar to the nearby Olympic View Resource Area beach. The containment berm face and the adjacent area are planted with native plants to form a riparian buffer.

The peninsula portion of the habitat area is composed of restored littoral habitat including a continuation of the shallow water habitat contours of the St. Paul Beach. Over 1,900 creosote treated piles were removed from this area so that the existing contours could be covered with sand ranging in depth from six inches to several feet. This portion of the habitat area includes the development of an undulating band of marsh habitat at an elevation of 10 feet MLLW to 12 feet MLLW, above the steeper transition between 8 feet MLLW and 10 feet MLLW. The upper beach slopes to a relatively low pass across the central area of the peninsula. This pass allows juvenile salmonids moving across the face of the St. Paul Beach at tides above MLLW to continue their migration in relatively protected shallow water into the entrance of the Middle

Waterway. North of the pass, the habitat area rises to an offshore shoal or reef at 12 feet MLLW. This shoal partially shelters areas to the south and east from waves from the northwest.

Existing uplands at the tip of the Middle/St. Paul Peninsula have been cut back and excavated to provide new marine habitat area at the southwest corner of the site. Eight nodes of marsh species appropriate for lower and upper saltmarsh elevations are planted in this habitat area. Large woody debris has been placed in the southwest corner to increase habitat complexity and to provide protective cover for juvenile salmonids.

The Middle Waterway Corridor portion of the habitat area consists of a narrow shoreline that connects the peninsula portion of the site with the broad mudflats and brackish marsh in the southern portion of Middle Waterway. Approximately 250 feet of stacked concrete bulkhead along the east shore of the Middle Waterway were removed and the slope protected with a thick slope cap and habitat mix. This design provides shallow-water, fish-passable shoreline access to and from the inner Middle Waterway habitat areas during most tidal conditions.

Performance standards for this site include minimal change in elevation; development of saltmarsh and riparian vegetation coverage; and juvenile salmonid presence. Performance standards are intended to ensure that created aquatic and riparian habitat are maintained over time, and to verify that habitat is not lost in the future. Note that for this habitat area, saltmarsh performance standards apply to only five of the eight nodes; the three nodes planted in the most exposed areas of the site were planted on a pilot basis and do not have performance standards associated with them.

Qualitative Ground Survey – The baseline qualitative ground survey at this site was conducted on July 11, 2006. A copy of the completed field form can be found in Attachment A. At the time of the survey, the tidal elevation was approximately -3.0 feet MLLW. Upon arrival, there were some Canada Geese, Caspian Terns, seagulls, great blue heron, crows, cormorant, pigeon guillemot, a white fronted goose, and a harbor seal present at the site. No significant amounts of erosion or sedimentation were identified at the site, however, a slight amount of material movement at the toe of the slope near Photo Point 3 was noted. There were no indications of animal damage, disease, or vandalism found, and only minimal amounts of trash. One piece of a containment boom had floated onto the beach, and will be removed and placed on the upland area near the drainage ditch per Simpson's request. Both the goose exclusion grid and the large woody debris were in place and in good condition and no maintenance activities on these elements were determined to be necessary.

Since the time of the inspection, more erosion of the toe of the slope at the exposed face has been identified. The City has been in contact with both EPA, and a coastal geologist from the Washington State Department of Ecology to discuss corrective actions for this area. A site meeting is planned for early December to assess the situation and to determine follow-up actions.

During the July inspection, the surface soils in the riparian area were noted to be brownish sandy topsoil, and the soils in the aquatic area were brown to brownish-gray cobbly to silty sand. There was no indication of odor or sheen in either area. Overall, there was no apparent site disturbance and no follow-up actions were needed.

The site had been planted in accordance with the approved planting plans. A combination of pickleweed and saltgrass were planted in eight marsh planting nodes. Of these, three are considered pilot nodes due to their exposure. It was noted during the inspection that the

grasses were doing relative poorly in all of the marsh areas, while the pickleweed was doing fairly well in most of the nodes. Overall, there was an estimated 50% survival rate of the plantings in the nodes.

The riparian area is planted with a combination of American dunegrass, Hooker's willow, and oceanspray. Overall, there was an estimated 90% survival rate for the riparian plantings. There were no volunteer species in either the marsh or riparian area, but a few invasive weeds were present in the riparian area, including clover and thistle. Minor weeding of this area is therefore required.

Photo Documentation – Six permanent photo points were established at the locations shown on Figure E-5 of the OMMP. A total of 17 photographs were taken at these points at tidal elevations ranging from approximately -1.66 feet MLLW to 1.91 feet MLLW. Copies of the photographs can be found in Attachment A. Rebar were placed at the photo point locations in July and the points were surveyed to allow for reproducibility in subsequent monitoring years.

Elevation Monitoring – Five elevation stakes were placed at the locations shown on Figure E-5 of the OMMP. These graduated stakes are embedded one-foot into the ground and two feet of the stake is visible above ground. One-inch increments are marked on the stakes both above and below the ground surface to allow for measurement of erosion/sedimentation in subsequent monitoring years. The stakes were surveyed following installation to allow for replacement if needed, and the top and ground surface elevations were also measured. Photographs showing the elevation stakes in place are included in Attachment A.

MIDDLE WATERWAY TIDEFLAT HABITAT

The Middle Waterway Tideflat Habitat with its associated mudflats and tidal channel was constructed on excavated uplands and existing tideflat along approximately 1,450 linear feet of the 1,800-foot long eastern shoreline of the Middle Waterway. This habitat area begins immediately south of the relocated log haul out and immediately to the north of the existing Trustees/Simpson pilot restoration project site along the southeast side of the waterway, and across Middle Waterway from the City's NRDA settlement restoration project and the Middle Waterway Action Committee shoreline restoration project.

The habitat area was excavated from elevations of 18 feet MLLW down to approximately 0 feet MLLW. A meandering tidal channel was excavated down to -4 feet MLLW at the north end, rising to -2 feet MLLW at the south end. The upper shoreline between 13 feet MLLW and 8 feet MLLW is enhanced with at least six inches of topsoil to support riparian plantings.

The marsh site is buffered from adjacent industrial activities with a 10- to 25-foot wide riparian area planted with native tree and shrub species. A freshwater sprinkler irrigation system irrigates approximately 40,000 sq. ft. of the site between elevation 11.5 feet MLLW and 12.5 feet MLLW for the purpose of establishing brackish marsh habitat. Freshwater flow is considered essential to the development of the desired emergent brackish marsh community at this habitat area. The brackish marsh is in the 10 feet MLLW to 13 feet MLLW elevation range, which varies between 10 and 60 feet in width. The irrigation system generally follows the 13 feet MLLW contour and is designed to reduce sediment pore water salinity in the elevation band between 11.5 feet MLLW and 12.5 feet MLLW.

Daily irrigation is controlled by an adjustable timer, sensor switch, and rain gauge, and can be adjusted to achieve the salinity and plant health requirements. The system automatically shuts

off when tidal elevations exceed 11.5 feet MLLW or when precipitation during the run time exceeds 0.1 inch. Typically the irrigation system will loop to irrigate for a short duration several times per day. For example, seven minutes of watering every 30 minutes, 24 hours per day, with no watering during high tide or heavy rainfall. The frequency and duration of watering may be adjusted depending on, but not limited to, field observations of soil and vegetation, pore water salinity monitoring results, and weather conditions.

Twelve 10- by 50-foot (3- by 15-meter) nodes of brackish marsh species have been planted in this zone. Plots are planted to stimulate development of a brackish marsh at the Middle Waterway Tideflat Habitat. Brackish marsh plantings consist of Lyngby's sedge *(Carex lyngbeyi)* and Seacoast bulrush *(Scirpus maritimus)*. It is anticipated that these introduced brackish marsh plants will establish a seed source allowing expansion between the initial planting nodes.

Performance standards for this site include minimal change in elevation over time; development of a brackish marsh and riparian vegetation cover; and juvenile salmonid presence. Performance standards are intended to ensure that created aquatic and riparian habitat are maintained over time, and to verify that habitat is not lost in the future.

Qualitative Ground Survey – The baseline qualitative ground survey at this site was conducted on July 11, 2006. A copy of the completed field form can be found in Attachment A. At the time of the survey, the tidal elevation was approximately -3.0 feet MLLW. Upon arrival, there were some Canada Geese, great blue heron, gulls, crows, barn swallows, and violet green swallows present at the site. No significant erosion or sedimentation were identified at the site, however, some minor amounts of erosion from springs and seeps were observed, as expected. There were no indications of animal damage, disease, or vandalism, and only small amounts of trash present. Both the goose exclusion grids and the large woody debris were in good condition and no maintenance activities were determined to be necessary. Small amounts of bark were present at the site, likely from the log haul out facility located north of the habitat area. This bark did not appear to be impacting establishment of the marsh.

The surface soils in the aquatic area consisted of brown silty sand with some presence of algae. The surface soils in the riparian area were brown topsoil/sandy silt. There was no indication of odor or sheen in the riparian area and only small areas of organic sheen in the aquatic area. Overall, there was no apparent site disturbance and no follow-up actions were needed.

The site had been planted in accordance with the approved planting plans. A combination of Lyngby sedge and Seacoast bulrush were planted in 12 planting nodes between elevation 11.5 feet MLLW and 12.5 feet MLLW. A combination of trees and shrubs, including black cottonwood, red alder, shore pine, Douglas fir, big-leaf maple, Hooker's willow, oceanspray, Sitka willow, and red-flowering currant were planted in the riparian area. It was noted during the inspection that all of the plantings were doing very well, with 90% and 95% survival estimated in the marsh and riparian areas, respectively. Some weeds, including clover and thistle were present in the riparian area at the site, and minor weeding is needed. No volunteer species were observed in either the riparian or marsh area, but sources of pickleweed are present at the south end of the site and are expected to colonize in this area in a short time frame.

Photo Documentation – Four permanent photo points were established at the locations shown on Figure E-6 of the OMMP. A total of eleven photographs were taken at these points at tidal elevations ranging from approximately -3.25 feet MLLW to -2.77 feet MLLW. Copies of the

photographs can be found in Attachment A. Rebar were placed at the photo point locations in July and the points were surveyed to allow for reproducibility in subsequent monitoring years.

Elevation Monitoring – Six elevation stakes were placed at the locations shown on Figure E-6 of the OMMP. These graduated stakes are embedded one-foot into the ground and two feet of the stake are visible above ground. One inch increments are marked on the stakes both above and below the ground surface to allow for measurement of erosion/sedimentation in subsequent monitoring years. The stakes were surveyed following installation to allow for replacement if needed, and the top and ground surface elevations were also measured. Photographs showing the elevation stakes in place are included in Attachment A.

Brackish Marsh Salinity Monitoring – Salinity of the substrate pore-water was monitored in the area where irrigation is being used to maintain conditions suitable for brackish marsh vegetation. Nine salinity monitoring locations were established at the locations shown on Figure E-6 of the OMMP. Six of these stations are located along the contour between 11.5 feet MLLW and 12.5 feet MLLW. In addition, there are three background monitoring locations. Figure E-6 of the OMMP shows the sample locations with their corresponding identification numbers. Salinity measurements were taken at a descending tide, approximately two hours after the tidal elevation had dropped below 11.5 feet MLLW.

In accordance with the OMMP, initial salinity measurements were taken prior to brackish marsh planting. Three rounds of samples were taken in May 2006 as the irrigation system was being adjusted and prior to plant installation. Results of the sampling performed for salinity can be found in Table 2. Data are included in Attachment B.

Plantings at the site were performed in June and July 2006. Following completion of planting in July, additional salinity measurements were taken monthly for three months in July, August, and September in accordance with the OMMP. These results are also shown on Table 2.

Performance criteria established for the salinity measurements are that, in Year 0, if less than 50% of the results meet the salinity threshold of 10 ppt, adjustment of the irrigation system may be needed if plants appear to be stressed. If that situation occurs, sampling is to be continued weekly as tides allow until the threshold is met.

Based on the results shown in Table 2, during the initial monitoring event on May 23, the criteria were exceeded at 4 of the 6 stations, and data could not be collected from the other two locations. Following adjustment to the system, and prior to planting, additional monitoring was performed. In these next two events, 5 out of 6 of the stations monitored in the brackish marsh zone met the 10 ppt criteria. In both sampling events, BW3 was the site that exceeded the threshold. Based on achievement of the performance criteria, the site was planted.

In the July and August monthly monitoring events, again, 5 of the 6 stations met the criteria. Different stations exceeded the criteria in these two events (i.e., BW2 in July and BW6 in August). In September, the third monthly sampling event was required. Prior to this time, an electrical failure had caused the system to shut down for a short period of time. The sampling performed during this period, 50% of the locations did not meet the salinity threshold, and a reading was not available for one of the sites. The system is now back in operation and the plants appear to be doing well. An additional round of sampling will be performed in late November/early December to confirm compliance with the performance criteria. Those results will be included in the Baseline Monitoring Report.

PUYALLUP RIVER SIDE CHANNEL

The Puyallup River Side Channel (PRSC) provides off-channel habitat intended for use by juvenile salmonids for rearing and refuge during their outmigration to the estuary. The project merged an existing isolated wetland and an adjacent parcel that was excavated to as deep as -2 feet MLLW from existing uplands, into a single off-channel habitat area. The existing flood control levee structure was breached following construction of a new levee to allow the river and the associated tidal hydrology to enter. The excavated channel and reconfigured existing wetland contain water during most tides.

A substantial area was left between about 6 feet MLLW and 13 feet MLLW to allow development of brackish marsh and riparian assemblages. The area on the inside of the existing Puyallup River dike has been planted with riparian vegetation. The mudflat areas below Ordinary High Water (OHW) have been left for natural colonization by native brackish marsh species (as occurred at the Gog-Le-Hi-Te site across the river).

Performance standards for this site include the development of riparian vegetation cover and juvenile salmonid presence. Performance standards are intended to ensure that created aquatic and riparian habitat are maintained over time, and to verify that habitat is not lost in the future.

Qualitative Ground Survey – The baseline qualitative ground survey at this site was conducted on July 10, 2006. A copy of the completed field form can be found in Attachment A. At the time of the survey, the tidal elevation was approximately -1.5 feet MLLW. Upon arrival, there were some Canada geese, marsh wren, gulls, crows, great blue heron, ducks, and killdeer present at the site. Only very minimal erosion on the old levee and sedimentation in the breach area were identified at the site. There were no indications of animal damage, disease, or vandalism, and only minimal trash was present at the site. Small quantities of organic material were present in the ends of the channels.

The surface soils in the upland area were gray, sandy gravel. Surface soils in the aquatic area ranged from dark brown to light gray, silty to silty sand. There was no indication of odor or sheen in the upland area and only small areas of organic sheen in the aquatic area. Overall, there was no apparent site disturbance and no follow-up actions were needed.

The site had been planted in accordance with the approved planting plans. A combination of trees and shrubs, including black cottonwood, red alder, shore pine, Douglas fir, big-leaf maple, hooker's willow, oceanspray, red-flowering currant, and Sitka willow were planted on the top of the old, cutdown levee. It was noted during the inspection that overall, the plants were doing very well, and there was a 95% survival rate estimated. Some weeds, including blackberry, thistle, and canary grass were present. Minor weeding of this area is therefore required. A few willows were noted to have volunteered in the upland area.

Photo Documentation – Six permanent photo points were established at the locations shown on Figure E-7 of the OMMP. A total of ten photographs were taken at these points at tidal elevations ranging from approximately -3.10 fee MLLW to -0.83 feet MLLW. Copies of the photographs can be found in Attachment A. Rebar were placed at the photo point locations in July and the points were surveyed to allow for reproducibility in subsequent monitoring years.

Elevation Monitoring – Six elevation stakes were placed at the locations shown on Figure E-7 of the OMMP. These graduated stakes are embedded one-foot into the ground and two feet of the

stake is visible above ground. One-inch increments are marked on the stakes both above and below the ground surface to allow for measurement of erosion/sedimentation in subsequent monitoring years. The stakes were surveyed following installation to allow for replacement if needed, and the top and ground surface elevations were also measured. Photographs showing the elevation stakes in place are included in Attachment A.

HYLEBOS CREEK MITIGATION SITE

Hylebos Creek is the major tributary to the Hylebos Waterway. The project area is located on the right bank of lower Hylebos Creek. Hylebos Creek has a large watershed, the majority of which extends north into King County. The project site is bordered by the 4th Street Bridge at its southern end and the stream reach lies completely within the saltwater wedge associated with Commencement Bay's tidal prism. Approximately 400 feet of creek reach is within the project area. The total project area includes a riparian/forested wetland enhancement and created aquatic habitat.

On-site native vegetation includes: Oregon ash, red osier dogwood, salmonberry, and black cottonwood. This project complements the neighboring restored areas, including the Milgard mitigation project and the NRDA Trustees' Jordan project. Both projects are located to the south of the Hylebos Creek Mitigation Site. The Jordan project is designed to provide off-channel salmon habitat to the east of the creek's bank, while the Milgard project restored the creek's western wetland buffer. The Hylebos Creek Mitigation Site adds to the area's habitat value and extends the wildlife corridor already established.

Habitat in this area was enhanced within a linear band paralleling Hylebos Creek. Enhancements included removal of non-native invasive Himalayan blackberry, reed canary grass, and yellow-flag iris. These species were replaced with native plants appropriate to the new hydrological regime, including Sitka willow, Sitka spruce, nootka rose, mock orange, hooker's willow, and oceanspray.

Where possible with the least disturbance to native vegetation, small channel "fingers" were excavated into the existing bank to allow water inundation during periods of high freshwater flows or tidal surges. The off-channel area provides habitat for the creek's out-migrating juvenile salmonids that need refuge areas while acclimatizing to saltwater. The added aquatic habitat, water retention and wetland enhancement provide a more diverse habitat and increased wildlife protection by screening it from the adjacent open areas. Preservation of the existing mature native bankside vegetation allows for the continued contribution of leaf litter, shade, and nutrients to the creek.

Performance standards for this site include minimal change in elevation; development of forested wetlands vegetative cover; water surface elevation of 2 feet (NGVD 29) at least 30% of the time, and juvenile salmonid presence. Performance standards are intended to ensure that created aquatic habitat is maintained over time, and to verify that habitat is not lost in the future.

<u>Qualitative Ground Survey</u> – The baseline qualitative ground survey at this site was conducted on July 11, 2006. A copy of the completed field form can be found in Attachment A. At the time of the survey, the tidal elevation was approximately 2.0 feet MLLW. Upon arrival, there were some violet green swallows, goldfinch, red-tail hawk, flycatchers, barn swallows, belted kingfishers, and mallard ducks present at the site. No significant erosion and only minor sedimentation were identified at the site. There were no indications of disease or trash, and only minor herbivory of the grasses. There was some indication of human presence at the site

based on the movement and stacking of some of the rocks. The large woody debris that is currently in place were in good condition although one anchor required repair. Additional large woody debris, and some smaller branches, will be placed at the site before the end of 2006 in accordance with discussions held during the final site approval.

The upland surface soils were light brown gravelly sand and surface soils in the aquatic areas were brown to gray, sandy silt to gravelly sand. There was no indication of odor or sheen in either area. Overall, there was no apparent site disturbance and no follow-up actions were needed.

The site had been planted in accordance with the approved planting plans. The upland forest had been planted with a variety of trees and shrubs, including Douglas fir, Sitka spruce, big-leaf maple, shore pine, thimbleberry, oceanspray, snowberry, mock orange, kinnickkinick, western service berry, baldhip rose and bracken fern. Erosion control seed mix had also been placed at the site. It was noted during the inspection that there was slight water stress on the upland forest area due to the difficulty in watering the new plants because of the steep topography. An approximately 75% survival rate was estimated at the time of the inspection. Water stress is expected to become less of a problem as the site becomes established.

The forested wetland portion of the site was also planted with a combination of trees and shrubs, including red alder, Oregon ash, western red cedar, black cottonwood, western crabapple, beaked hazelnut, Pacific ninebark, black twinberry, vine maple, red-osier dogwood, hooker's willow, and Sitka willow. This portion of the site appeared to be doing well and no required maintenance activities were noted. Additional alders will be planted at the site in spring 2007 in accordance with discussions held during the final site approval.

The emergent wetland was planted with a combination of sawbeak sedge, slough sedge, small-fruited bulrush, hardstem bulrush, and reed mannagrass. This portion of the site appeared to be doing well with a 95% survival rate estimated. As noted above, minor herbivory of the grasses was found, but no maintenance activities were determined to be necessary.

Some invasive weeds were identified at the edges of the site, including blackberries, and minor weeding as a part of regularly scheduled maintenance is needed. It was noted that there were some bulrush in the downstream lobe that appeared to be volunteering.

Photo Documentation – Seven permanent photo points were established at the locations shown on Figure E-8 of the OMMP. A total of 21 photographs were taken at these points at tidal elevations ranging from approximately 0.58 feet MLLW to 3.3 feet MLLW. In addition, a second set of photographs were taken at six of the seven photo point locations at a tidal elevation ranging from approximately 12.69 feet MLLW to 12.74 feet MLLW to show site conditions during periods of inundation. Photo Point 5 was inaccessible during the high water photo event. Copies of the photographs can be found in Attachment A. Rebar were placed at the photo point locations in July and the points surveyed to allow for reproducibility in subsequent monitoring years.

Elevation Monitoring – Six elevation stakes were placed at the locations shown on Figure E-8 of the OMMP. These graduated stakes are embedded one-foot into the ground and two feet of the stake is visible above ground. One-inch increments are marked on the stakes both above and below the ground surface to allow for measurement of erosion/sedimentation in subsequent monitoring years. The stakes were surveyed following installation to allow for replacement if

needed, and the top and ground surface elevations were also measured. Photographs showing the elevation stakes in place are included in Attachment A.

Surface Water Elevation Monitoring – Surface water elevation monitoring was performed between April 18, 2006 and November 2, 2006. Descriptive statistics and a graph of all the measurements can be found in Table 3 and Figure 1, respectively. A total of 28,482 water elevation measurements were determined using the water level logger. There were 13,320 measurements with an elevation of 2 feet NGVD29 or higher. This represents 47% of the time and meets the performance criteria of 30%.

Thea Foss Habitat Enhancement Areas

JOHNNY'S DOCK HABITAT ENHANCEMENT

This area is a pocket beach constructed to enhance the habitat between the Foss Landing and Johnny's Dock Marinas. Prior to remediation, an old timber access pier with a brick foundation was present at the site. As part of construction of this habitat area, this structure was removed from the marine environment. A thick quarry spall cap consisting of an 18-inch deep layer of filter material overlain by an 18-inch deep layer of quarry spalls was then placed. Habitat mix was placed on the slope over the quarry spalls between elevations -10 feet MLLW and 13 feet MLLW. Saltmarsh vegetation was planted between 10 feet MLLW and 13 feet MLLW, and large woody debris was added to the slope to add complexity to the habitat feature. A goose exclusion grid was installed to minimize herbivory.

Qualitative Ground Survey – The baseline qualitative ground survey at this site was conducted on July 10, 2006. A copy of the completed field form can be found in Attachment A. At the time of the survey, the tidal elevation was approximately -2.75 feet MLLW. Upon arrival, there were some geese present at the site on the lower beach. No significant erosion or sedimentation were identified at the site. There were no indications of animal damage, disease, trash, or vandalism. Both the goose exclusion grid and the large woody debris were in good condition and no maintenance activities were determined to be necessary.

The surface soils were gravelly sand habitat mix. There was no indication of odor or sheen. Overall, there was no apparent site disturbance and no follow-up actions were needed.

The site had been planted in accordance with the approved planting plans. A combination of pickleweed and saltgrass were planted between elevations 10 feet MLLW and 12 feet MLLW. Tufted hairgrass had been planted above that, between 12 feet MLLW and 13 feet MLLW. It was noted during the inspection that the distichilis was doing very well, and the pickleweed was vigorous in places. There was little evidence of the tufted hairgrass in the higher area where it was planted. Some lady's thumb had volunteered at the site and there was no indication of invasive species present.

As a follow-up to the apparent failure of the hairgrass, a survey was performed to confirm the elevation at the top of the planting area. The survey indicated that the top of the goose exclusion fence was between approximate elevations 13.7 feet MLLW and 14.6 feet MLLW, higher than the top of the planting zone which was 13 feet MLLW. Therefore, the tufted hairgrass was likely planted at a somewhat higher elevation than is optimum for its growth. Additional plants have been ordered and will be installed at a slightly lower elevation in spring 2007.

Photo Documentation – Two permanent photo points were established at the locations shown on Figure E-2 of the OMMP. A total of four photographs were taken at these points at tidal elevations ranging from -2.82 feet MLLW to -2.75 feet MLLW. Copies of the photographs can be found in Attachment A. Rebar were placed at the photo point locations in July and the points were surveyed to allow for reproducibility in subsequent monitoring years.

HEAD OF THEA FOSS SHORELINE HABITAT

A portion of the eastern shoreline at the head of the waterway was cut back as part of the Utilities' remediation project, to create aquatic habitat below ordinary high water. Saltmarsh and littoral vegetation were planted in a 5- to 8-foot side strip landward of a log step structure (at approximately 12.4 feet MLLW) along the shoreline. A goose exclusion grid was constructed across the area to minimize herbivory.

Qualitative Ground Survey – The baseline qualitative ground survey at this site was conducted on July 10, 2006. A copy of the completed field form can be found in Attachment A. At the time of the survey, the tidal elevation was approximately -2.90 feet MLLW. Upon arrival, there were some geese, goldfinch, white crown sparrows, and crows present at the site. No significant erosion or sedimentation were identified at the site. There were no indications of animal damage, disease, or vandalism. Small amounts of trash were found. The log step appeared to be in good condition, but minor repairs to the goose exclusion grid were found to be necessary

The surface soils were grayish-brown silty sand. There was no indication of odor or sheen. Overall, there was no apparent site disturbance and no deficiencies in soil conditions were identified.

The site had been planted in accordance with the approved planting plans. A combination of fleshy jaumea, distichilis, tufted hairgrass, and hooker's willow were planted in the bench behind the log step. The log step was constructed as part of the Utilities project, and plantings in this area were completed in 2005. It was noted during the inspection that the distichilis was doing very well and the other species had a survival rate of approximately 50%. Some gumweed had volunteered both in the riparian area behind the log step and in the planting strip. In addition, there were various weeds, including clover, both in the planting strip and in the riparian area behind. Some weeding is needed, along with some replacement of plants in spring 2007.

Photo Documentation – Two permanent photo points were established at the locations shown on Figure E-1 of the OMMP. A total of two photographs were taken at these points at tidal elevations ranging from approximately -2.96 feet MLLW to -2.89 feet MLLW. Copies of the photographs can be found in Attachment A. Rebar were placed at the photo point locations in July and the points were surveyed to allow for reproducibility in subsequent monitoring years.

SR 509 ESPLANADE RIPARIAN HABITAT

Upland vegetation was planted above the ordinary high water level along the shoreline south of Alber's Mill. In order to account for shading by the SR 509 Bridge, two different assemblages of riparian vegetation were planted: one tree and shrub assemblage appropriate for full sun exposure, and a shrub assemblage appropriate for partial shade. An irrigation system was initially constructed under the bridge in the shaded area and was subsequently extended to the north and south ends of the enhancement area.

Qualitative Ground Survey – The baseline qualitative ground survey at this site was conducted on July 10, 2006. A copy of the completed field form can be found in Attachment A. At the time of the survey, the tidal elevation was approximately -2.5 feet MLLW. Upon arrival, there were some goldfinch, house sparrows, geese, and barn swallows present at the site. No significant sedimentation, and only one very minor area of erosion were identified at the site. There is no wrack or organic material present at the site. There were no indications of animal damage, disease, trash, or vandalism. The sprinkler appears to be in good, working order.

The surface soils were grayish-brown, silty sand. There was no indication of odor or sheen. Overall, there was no apparent site disturbance and no deficiencies in soil conditions were identified.

The site had been planted in accordance with the approved planting plans. As indicated above, two different assemblages were planted due to the shading provided by the SR 509 Bridge. In the area with full sun, a combination of Pacific madrone, shore pine, oceanspray, red-flowering currant, and tall Oregon grape were planted. In the shaded area beneath the bridge, a combination of Pacific rhododendron, salal, and red huckleberry were planted. There were no volunteer species identified during the inspection. Several invasive species of weeds were found including clover, thistle, morning glory, and Himalayan blackberry.

Overall, the plant survival rate was estimated at approximately 90%, with a somewhat lesser percentage for the Pacific madrone. Some weeding is needed, however, no replanting appears to be necessary at this time.

Photo Documentation – Three permanent photo points were established at the locations shown on Figure E-3 of the OMMP. A total of four photographs were taken at these points at tidal elevations ranging from approximately -2.68 feet MLLW to -2.28 feet MLLW. Copies of the photographs can be found in Attachment A. Rebar were placed at the photo point locations in July and the points were surveyed to allow for reproducibility in subsequent monitoring years.

LOG STEP HABITAT ENHANCEMENT

Approximately 35 treated timber piling, a 12- by 14-foot concrete vault, and other debris were removed from an area on the west side of the waterway between the Colonial Fruit warehouse and the Foss Waterway Marina. A portion of the area was dredged, and a thick quarry spall cap consisting of 18 inches of filter material overlain by 18 inches of riprap was constructed. Habitat mix was placed over the area between the elevations of -10 feet MLLW and 11 feet MLLW.

A 2-step log transition was constructed between elevations 11 feet MLLW and 13 feet MLLW and a 3-foot bench was constructed using 18 inches of filter material overlain with an 18-inch deep layer of quarry spalls. Habitat mix was placed over the quarry spalls, and saltmarsh grasses planted at elevation 13 feet MLLW along the 65-foot long high intertidal bench.

Qualitative Ground Survey – The baseline qualitative ground survey at this site was conducted on July 10, 2006. A copy of the completed field form can be found in Attachment A. At the time of the survey, the tidal elevation was approximately -1.24 feet MLLW. Upon arrival, there were some crows and seagulls present at the site. No significant erosion or sedimentation were identified at the site. There were no indications of animal damage, disease, trash, or vandalism. There was no wrack or organic material present at the site. Some algae was present below the log step. The log step appeared to be in good condition, although the anchors needed some minor tightening. The goose exclusion grid was in good condition.

The surface soils were grayish-brown gravelly sand. There was no indication of odor or sheen. Overall, there was no apparent site disturbance and no deficiencies in soil conditions were identified.

The site had been planted in accordance with the approved planting plans. A combination of American dunegrass and tufted hairgrass was planted in a 3-foot wide bench behind the log step at an elevation of approximately 13 feet MLLW. It was noted during the inspection that the dunegrass was doing very well while the hairgrass had a fairly low survival rate. Some invasive species including dandelions, clover, and butterfly bushes are present above the upland edge of the area. Therefore, some weeding is needed, along with replacement of the hairgrass in spring 2007.

Photo Documentation – One permanent photo point was established at the location shown on Figure E-4 of the OMMP. One photograph was taken at this point at a tidal elevation of approximately -1.24 feet MLLW. A copy of the photograph can be found in Attachment A. Rebar was placed at the photo point location in July and the points were surveyed to allow for reproducibility in subsequent monitoring years.

SUMMARY OF PRELIMINARY FINDINGS

The primary purpose of the Year 0 monitoring event was to document that the habitat mitigation and enhancement sites were constructed and planted in accordance with the approved plans and that they are in an appropriate and healthy condition required for establishment. In addition, this monitoring event provides documentation of the baseline conditions at the various sites.

Very few follow-up actions were identified during this monitoring event. Those that were identified were discussed in the sections above, and are summarized in Table 4. The status of these follow-up actions will be discussed in the Baseline Monitoring Report.

Table 1
Baseline Monitoring Activities

	North Beach Habitat	Middle Waterway Tideflat Habitat	Puyallup River Side Channel	Hylebos Creek Mitigation Site	Thea Foss Enhancement Areas
Qualitative Ground Survey	x	x	x	x	x
Photo Documentation	x	x	x	x	x
Quantitative Vegetation Monitoring					
Invertebrate Monitoring					
Elevation Monitoring	x	x	x	x	
Surface Water Elevation Sampling				x	
Brackish Marsh Salinity Monitoring		x			
Juvenile Salmonid Monitoring					

Table 2
Middle Waterway Tideflat Habitat Salinity Monitoring Results (ppt)

Location	May 23, 2006	May 26, 2006	May 30, 2006	July 2006	August 2006	September 2006
BW1	17.2	9.3	9.8	2.9	2.0 U	11.6
BW2	15.5	9.9	8.0	11.2	2.0 U	7.8
BW3	N/A	18.8	15.8	3.6	2.0 U	27.9
BW4	N/A	8.6	2.8	4.6	2.0 U	5.8
BW5	16.5	5.2	2.0	N/A	2.0 U	N/A
BW6	13.4	8.5	7.1	3.1	14.7	24.2
BMC1	N/A	24.4	32.2	22.0	27.3	31.7
BMC2	N/A	27.7	28.0	32.8	12.3	26.0
BMC3	N/A	N/A	18.7	17.5	22.3	20.5

U indicates that the analyte was not detected at or above the reported value.
N/A in result means “not analyzed” due to insufficient liquid to analyze.

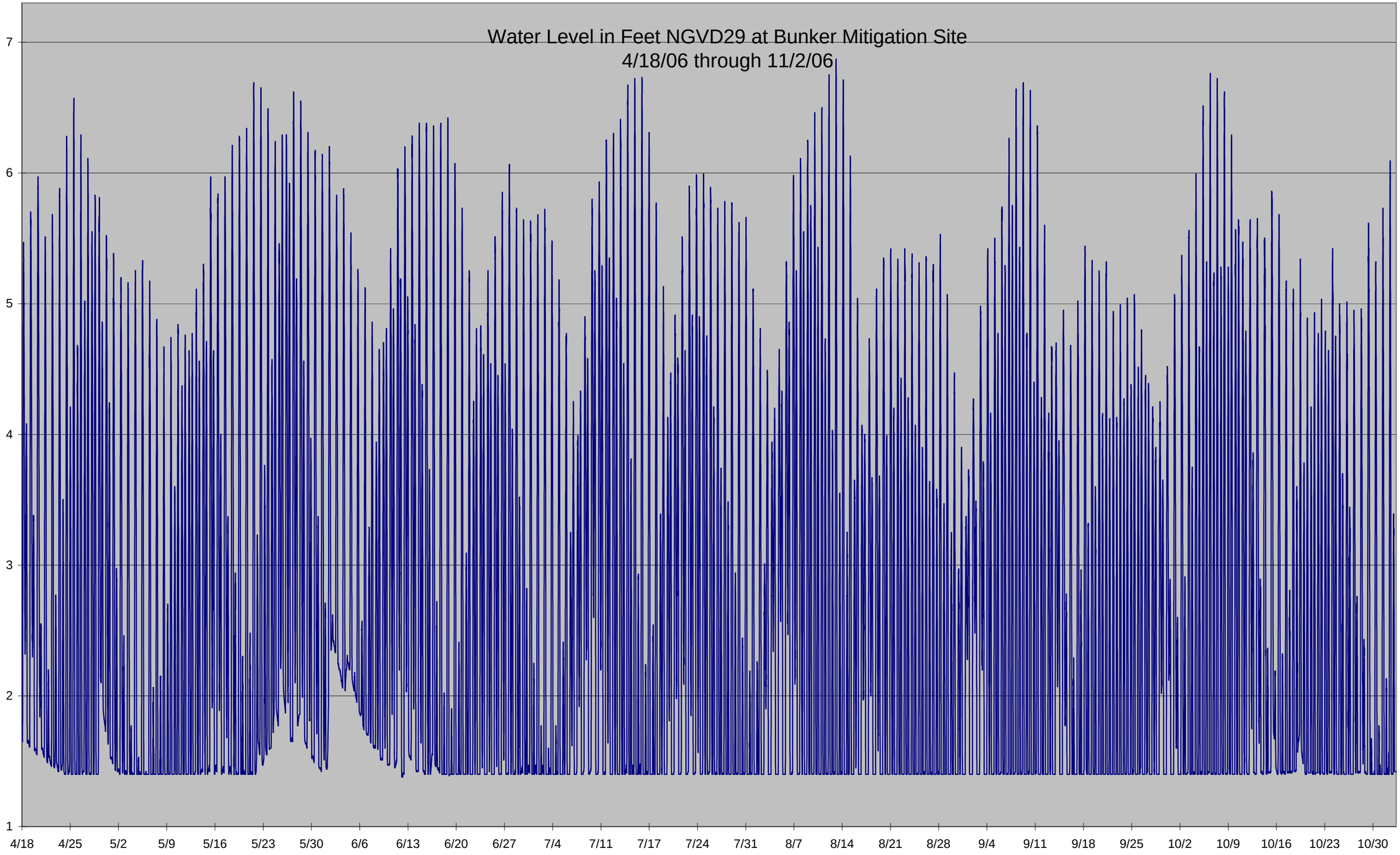
Table 3
Hylebos Creek Water Level Measurement Data

Univariate Statistics	
Average	2.6
Median	1.8
Minimum	1.4
Maximum	6.9
Range	5.5
Standard Deviation	1.4
50th Percentile	1.8
75th Percentile	3.6
90th Percentile	4.9
95th Percentile	5.4
99th Percentile	6.2
# of values $\geq$ 2	13320
# of Measurements	28482
Percent of Values $\geq$ 2	47%

Table 4
Summary of Preliminary Findings

Site	Corrective Action Tasks
North Beach Habitat	- minor repairs to the goose exclusion grid - minor weeding - replanting
Middle Waterway Tideflat Habitat	- minor repairs to the goose exclusion grids - removal of wood debris within goose exclusion
Puyallup River Side Channel	- minor weeding - trash removal
Hylebos Creek Mitigation Site	- minor weeding - repair of anchor on LWD - place additional LWD, small branches, and plant additional red alder per final site approval agreement
Log Step Habitat Enhancement	- minor weeding - tighten anchors on logs
SR 509 Esplanade Riparian Habitat	- minor weeding
Head of Thea Foss Shoreline Habitat	- minor repairs to the goose exclusion grid - minor weeding - replanting
Johnny's Dock Habitat Enhancement	- survey to confirm elevation at top of planting - replanting of Tufted Hairgrass

Figure 1


Water Level in Feet NGVD29 at Bunker Mitigation Site
4/18/06 through 11/2/06
7
6
5
4
3
2
1
4/18
4/25
5/2
5/9
5/16
5/23
5/30
6/6
6/13
6/20
6/27
7/4
7/11
7/17
7/24
7/31
8/7
8/14
8/21
8/28
9/4
9/11
9/18
9/25
10/2
10/9
10/16
10/23
10/30

Attachment A

Habitat Mitigation Area Monitoring Field Forms and Photographs

North Beach Habitat

Qualitative Ground Survey, Mitigation Sites

Date: 7-11-06 9:30 am Year: (0), 2, 3, 4, 5, 6, 7, 8, 9, 10

Site (circle): North Beach Habitat (NBH), Middle Waterway Tideflat (MWT), Puyallup River Side Channel (PRS), Hylebos Creek Habitat (HCH)

Staff Present: John O'Loughlin, Mary Henley

Weather Conditions: partly cloudy, dry

Overall health and vigor of plants: (Excellent) Fair Poor

except grasses which are poor

Qualitative Observations:

	Riparian Area	Marsh Area	Comments
Erosion	slight	wave sorting	slight movement @ toe of slope
Sedimentation	—	slight	
Wildlife	see below		various birds
Vegetation			
Invasive	some	none	thistle, clover
Volunteer	none	none	
Survival (%)	~90%	~50%	grasses poor, pickleweed excellent
Animal Damage	none	none	
Disease	none	none apparent	— grasses?
Trash	none	minimal	
Vandalism	none	none	
Large Woody Debris	—	present	good condition
Wrack or Organic Material	none	minor	as expected

* For the Hylebos Creek site, use "Riparian" column for forested wetland and "Marsh" column for emergent wetland. Include additional qualitative notes on high slope upland vegetation below

Wildlife Notes (Species observed, other evidence):

Caspian terns, seagulls, Canada geese, Great blue heron, crows, cormorant, harbor seal, pigeon guillemot, white fronted goose.

Insect Sampling Notes (Hylebos Creek and PRSC only):

N/A

Observable Prey (e.g., amphipods, mycids, larvae):

N/A

Soil/Sediment Quality:	upland	aquatic areas
Odor:	none	none
Sheen:	none	none
Color:	brown	brown — brownish gray
Texture:	topsoil	cobbly sand - silty sand

Presence/condition of habitat mix/fine-grained material at surface (North Beach and PRSC only):

Yes

Notes:

- Grasses in nodes not doing well. Give another year to see if it is related to shock. Pickleweed good in some nodes.
- minor weeding needed
- Goose exclusion grids in good shape
- Contact Simpson to remove piece of boom @ St. Paul beach.

Photo Points (Circle Site): Year 0, 1, 2, 4, 7, 10

North Beach	1A #2 (W)	1B #3 (NW)	2A #4 (E)	2B #5 (N)
2C #6 (W)	3A #7 (E)	3B #8 (N)	3C #9 (NW)	3D #10 (S)
4A #11 (S)	4B #12 (SW)	4C #13 (NW)	5A #14 (S)	5B #15 (W)
5C #16 (N)	5D #17 (E)	6 #1		
Middle Waterway Tideflat	1A	1B	2A	2B
2C	3A	3B	4A	4B
4C	4D			
Puyallup River Side Channel	1	2A	2B	3A
3B	4A	4B	5A	5B
6				
Hylebos Creek	1A	1B	2A	2B
2C	3A	3B	3C	4A
4B	4C	5A	5B	5C
5D	6A	6B	6C	6D
7A	7B			

Additional Notes/Photos:

#2 and #3 in middle were taken of wildlife

North Beach Habitat, Photo Point 1A, facing west. Photo taken July 11, 2006 at 10:53 AM, tide at approximately -2.72 feet MLLW. [IMG_0006]

North Beach Habitat, Photo Point 1B, facing northwest. Photo taken July 11, 2006 at 10:54 AM, tide at approximately -2.72 feet MLLW. [IMG_0007]

North Beach Habitat, Photo Point 2A, facing east. Photo taken July 11, 2006 at 10:56 AM, tide at approximately -2.76 feet MLLW. [IMG_0008]

North Beach Habitat, Photo Point 2B, facing north. Photo taken July 11, 2006 at 11:56 AM, tide at approximately -2.76 feet MLLW [IMG_0009]

North Beach Habitat, Photo Point 2C, facing west. Photo taken July 11, 2006 at 10:56 AM, tide at approximately -2.76 feet MLLW. [IMG_0010]

North Beach Habitat, Photo Point 3A, facing east. Photo taken July 11, 2006 at 11:10 AM, tide at approximately -3.03 feet MLLW. [IMG_0011]

North Beach Habitat, Photo Point 3B, facing north. Photo taken July 11, 2006 at 11:10 AM, tide at approximately -3.03 feet MLLW [IMG_0012]

North Beach Habitat, Photo Point 3C, facing northwest. Photo taken July 11, 2006 at 11:10 AM, tide at approximately -3.03 feet MLLW. [IMG_0013]

North Beach Habitat, Photo Point 3D, facing south. Photo taken July 11, 2006 at 11:10 AM, tide at approximately -3.03 feet MLLW. [IMG_0014]

North Beach Habitat, Photo Point 4A, facing south. Photo taken July 11, 2006 at 11:19 AM, tide at approximately -3.15 feet MLLW [IMG_0015]

North Beach Habitat, Photo Point 4B, facing southwest. Photo taken July 11, 2006 at 11:19 AM, tide at approximately -3.15 feet MLLW. [IMG_0016]

North Beach Habitat, Photo Point 4C, facing northwest. Photo taken July 11, 2006 at 11:19 AM, tide at approximately -3.15 feet MLLW. [IMG_0017]

North Beach Habitat, Photo Point 5A, facing south. Photo taken October 17, 2006 at 8:40 AM, tide at approximately 1.91 feet MLLW. [IMG_0058]

North Beach Habitat, Photo Point 5B, facing west. Photo taken October 17, 2006 at 8:40 AM, tide at approximately 1.91 feet MLLW. [IMG_0059]

North Beach Habitat, Photo Point 5C, facing north. Photo taken October 17, 2006 at 8:40 AM, tide at approximately 1.91 feet MLLW. [IMG_0060]

North Beach Habitat, Photo Point 5D, facing east. Photo taken October 17, 2006 at 8:40 AM, tide at approximately 1.91 feet MLLW. [IMG_0061]

North Beach Habitat, Photo Point P6, facing west. Photo taken July 11, 2006 at 10:18 AM, tide at approximately -1.66 feet MLLW. [IMG_0003]

North Beach Habitat, elevation stake E1. Photo taken July 13, 2006.
[IMG_0075]

North Beach Habitat, elevation stake E2. Photo taken July 13, 2006.
[IMG_0076]

North Beach Habitat, elevation stake E3. Photo taken July 13, 2006.
[IMG_0077]

North Beach Habitat, elevation stake E4. Photo taken July 13, 2006.
[IMG_0078]

North Beach Habitat, elevation stake E5. Photo taken July 13, 2006.
[IMG_0079]

Middle Waterway Tideflat Habitat

Qualitative Ground Survey, Mitigation Sites

Date: 7/11/06 12:00 noon Year: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Site (circle): North Beach Habitat (NBH), Middle Waterway Tidefiat (MWT), Puyallup River Side Channel (PRS), Hylebos Creek Habitat (HCH)

Staff Present: John O'Loughlin, Mary Henley

Weather Conditions: Partly cloudy, dry

Overall health and vigor of plants: Excellent Fair Poor

Qualitative Observations

	Riparian Area	Marsh Area	Comments
Erosion	none	some	from spring seeps as expected
Sedimentation	none	minor	
Wildlife	yes		see below
Vegetation			
Invasive	some	none	clover, thistle, various weeds
Volunteer	none	none	pickleweed towards at south end
Survival (%)	~95%	~90%	
Animal Damage	none	none	
Disease	none	none	
Trash	none	some	minimal from water source
Vandalism	none	none	
Large Woody Debris	n/a	present	good condition
Wrack or Organic Material	none	minor	as expected

* For the Hylebos Creek site, use "Riparian" column for forested wetland and "Marsh" column for emergent wetland

Include additional qualitative notes on high slope upland vegetation below

Wildlife Notes (Species observed, other evidence)

Great blue heron, gulls, crows, Canada geese, barn swallow, violet green swallow.

Insect Sampling Notes (Hylebos Creek and PRSC only)

N/A

Observable Prey (e.g., amphipods, mysids, larvae)

N/A

Soil/Sediment Quality	upland	aquatic areas
Odor	none	none
Sheen	none	some organic
Color	brown	brown - green w/ algae
Texture	topsoil / sandy silt	silty sand

Presence/condition of habitat mix/fine-grained material at surface (North Beach and PRSC only)

N/A

Notes

Goose exclusion grid in good condition

Minor weeding needed

Photo Points (Circle Site): Year 0, 1, 2, 4, 7, 10

North Beach	1A	1B	2A	2B
2C	3A	3B	3C	3D
4A	4B	4C	5A	5B
5C	5D	6		
Middle Waterway Tideflat	1A #18 (NW)	1B #19 (SW)	2A #20 (N)	2B #21 (W)
2C #22 (S)	3A #23 (N)	3B #24 (W)	4A #25 (S)	4B #26 (W)
4C #27 (N)	4D #28 (E)			
Puyallup River Side Channel	1	2A	2B	3A
3B	4A	4B	5A	5B
6				
Hylebos Creek	1A	1B	2A	2B
2C	3A	3B	3C	4A
4B	4C	5A	5B	5C
5D	6A	6B	6C	6D
7A	7B			

Additional Notes/Photos:

Middle Waterway Tideflat Habitat, Photo Point 1A, facing northwest. Photo taken July 11, 2006 at 11:59 AM, tide at approximately -3.25 feet MLLW.
[IMG_0018]

Middle Waterway Tideflat Habitat, Photo Point 1B, facing southwest. Photo taken July 11, 2006 at 11:59 AM, tide at approximately -3.25 feet MLLW.
[IMG_0019]

Middle Waterway Tideflat Habitat, Photo Point 2A, facing north. Photo taken July 11, 2006 at 12:15 PM, tide at approximately -3.08 feet MLLW.
[IMG_0020]

Middle Waterway Tideflat Habitat, Photo Point 2B, facing west. Photo taken July 11, 2006 at 12:15 PM, tide at approximately -3.08 feet MLLW.
[IMG_0021]

Middle Waterway Tideflat Habitat, Photo Point 2C, facing south. Photo taken July 11, 2006 at 12:15 PM, tide at approximately -3.08 feet MLLW.
[IMG_0022]

Middle Waterway Tideflat Habitat, Photo Point 3A, facing north. Photo taken July 11, 2006 at 12:30 PM, tide at approximately -2.83 feet MLLW.
[IMG_0023]

Middle Waterway Tideflat Habitat, Photo Point 3B, facing west. Photo taken July 11, 2006 at 12:30 PM, tide at approximately -2.83 feet MLLW.
[IMG_0024]

Middle Waterway Tideflat Habitat, Photo Point 4A, facing south. Photo taken July 11, 2006 at 12:33 PM, tide at approximately -2.77 feet MLLW.
[IMG_0025]

Middle Waterway Tideflat Habitat, Photo Point 4B, facing west. Photo taken July 11, 2006 at 12:33 PM, tide at approximately -2.77 feet MLLW.
[IMG_0026]

Middle Waterway Tideflat Habitat, Photo Point 4C, facing north. Photo taken July 11, 2006 at 12:33 PM, tide at approximately -2.77 feet MLLW.
[IMG_0027]

Middle Waterway Tideflat Habitat, Photo Point 4D, facing east. Photo taken July 11, 2006 at 12:33 PM, tide at approximately -2.77 feet MLLW.
[IMG_0028]

Middle Waterway Tideflat Habitat, elevation stake E1. Photo taken July 13, 2006.
[IMG_0070]

Middle Waterway Tideflat Habitat, elevation stake E2. Photo taken July 13, 2006.
[IMG_0071]

Middle Waterway Tideflat Habitat, elevation stake E3. Photo taken July 13, 2006.
[IMG_0072]

Middle Waterway Tideflat Habitat, elevation stake E4. Photo taken July 13, 2006.
[IMG_0073]

Middle Waterway Tideflat Habitat, elevation stake E5. Photo taken July 13, 2006.
[IMG_0074]

Middle Waterway Tideflat Habitat, elevation stake E6. Photo taken July 13, 2006.
[IMG_0092]

Puyallup River Side Channel

Qualitative Ground Survey, Mitigation Sites

Date: 7/10/06 12:00 noon Year: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Site (circle): North Beach Habitat (NBH), Middle Waterway Tideflat (MWT), Puyallup River Side Channel (PRS), Hylebos Creek Habitat (HCH)

Staff Present: John O'Loughlin

Weather Conditions: cloudy, dry

Overall health and vigor of plants: Excellent Fair Poor

Qualitative Observations:

	Riparian Area	Marsh Area	Comments
Erosion	minimal	none	
Sedimentation	none	minimal	at breach
Wildlife	yes	yes	gulls - see below
Vegetation			
Invasive	some	none	see below
Volunteer	some	none	Few willows
Survival (%)	~95%	N/A	
Animal Damage	none	none	
Disease	none	none	
Trash	none	some	- minimal debris
Vandalism	none	none	
Large Woody Debris	N/A		
Wrack or Organic Material		some	in ends of channels

* For the Hylebos Creek site, use "Riparian" column for forested wetland and "Marsh" column for emergent wetland. Include additional qualitative notes on high slope upland vegetation below

Wildlife Notes (Species observed, other evidence):
marsh wren, gulls, Canada geese, crows, Great blue heron, ducks, killdeer

Insect Sampling Notes (Hylebos Creek and PRSC only):
N/A for Year 0

Observable Prey (e.g., amphipods, mycids, larvae):
N/A for Year 0

Soil/Sediment Quality:	upland	aquatic areas
Odor:	none	none
Sheen:	none	slight organic
Color:	gray	dark brown → light gray
Texture:	sandy gravel	silty - silty sand

Presence/condition of habitat mix/fine-grained material at surface (North Beach and PRSC only):
Yes

Notes:
- invasive weeds — blackberry, thistle, canary grass, etc.
- Small erosion area on old levee, riverside ~ midway between breach and upriver end. No action needed - keep watching.
- periodic trash removal likely necessary

Photo Points (Circle Site): Year 0, 1, 2, 4, 7, 10

North Beach	1A	1B	2A	2B
2C	3A	3B	3C	3D
4A	4B	4C	5A	5B
5C	5D	6		
Middle Waterway Tideflat	1A	1B	2A	2B
2C	3A	3B	4A	4B
4C	4D			
Puyallup River Side Channel	1 #14	2A #15 old levee	2B #16 new levee	3A #17 breach
3B #18 ol stake	4A #19 breach	4B #20 upriver	5A #21 new levee	5B #22 old levee
6 #23 *	#13 camera check. * note - photo retaken 7/12/06 due to tech problem - cloudy, light rain 12:57 pm			
Hylebos Creek	1A	1B	2A	2B
2C	3A	3B	3C	4A
4B	4C	5A	5B	5C
5D	6A	6B	6C	6D
7A	7B			

Additional Notes/Photos:

Puyallup River Side Channel, Photo Point 1, facing west. Photo taken July 10, 2006 at 12:12 PM, tide at approximately -1.86 feet MLLW [IMAG0014]

Puyallup River Side Channel, Photo Point 2A, facing south. Photo taken July 10, 2006 at 12:27 PM, tide at approximately -1.38 feet MLLW. [IMAG0015]

Puyallup River Side Channel, Photo Point 2B, facing southwest. Photo taken July 10, 2006 at 12:27 PM, tide at approximately -1.38 feet MLLW.
[IMAG0016]

Puyallup River Side Channel, Photo Point 3A, facing southeast. Photo taken July 10, 2006 at 12:30 PM, tide at approximately -1.28 feet MLLW.
[IMAG0017]

Puyallup River Side Channel, Photo Point 3B, facing east. Photo taken July 10, 2006 at 12:30 PM, tide at approximately -1.28 feet MLLW. [IMAG0001]

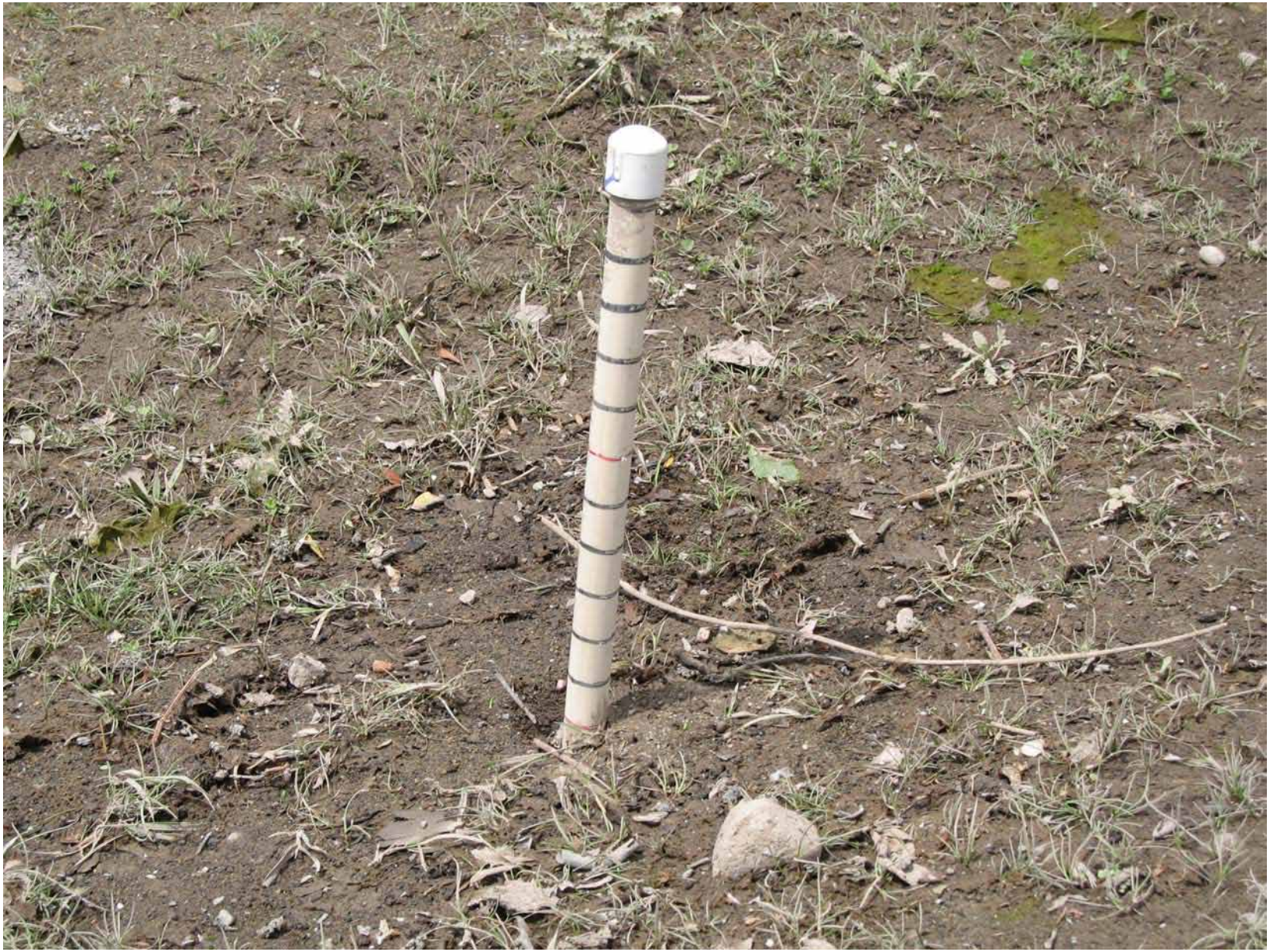
Puyallup River Side Channel, Photo Point 4A, facing northeast. Photo taken July 10, 2006 at 12:37 PM, tide at approximately -1.02 feet MLLW.
[IMAG0002]

Puyallup River Side Channel, Photo Point 4B, facing southeast. Photo taken July 10, 2006 at 12:37 PM, tide at approximately -1.02 feet MLLW.
[IMAG0003]

Puyallup River Side Channel, Photo Point 5A, facing north. Photo taken July 10, 2006 at 12:42 PM, tide at approximately -0.83 feet MLLW. [IMAG0004]

Puyallup River Side Channel, Photo Point 5B, facing northeast. Photo taken July 10, 2006 at 12:42 PM, tide at approximately -0.83 feet MLLW.
[IMAG0005]

Puyallup River Side Channel, Photo Point 6, facing west. Photo taken July 12, 2006 at 12:57 PM, tide at approximately -3.10 feet MLLW [IMG_0069]



Puyallup River Side Channel, elevation stake E1. Photo taken July 13, 2006.
[IMG_0080]

Puyallup River Side Channel, elevation stake E2. Photo taken July 13, 2006.
[IMG_0081]

Puyallup River Side Channel, elevation stake E3. Photo taken July 13, 2006.
[IMG_0082]

Puyallup River Side Channel, elevation stake E4. Photo taken July 13, 2006.
[IMG_0083]

Puyallup River Side Channel, elevation stake E5. Photo taken July 13, 2006.
[IMG_0084]

Puyallup River Side Channel, elevation stake E6. Photo taken July 13, 2006.
[IMG_0085]

Hylebos Creek Mitigation Site

Qualitative Ground Survey, Mitigation Sites

Date: 7/11/06 2:00 pm Year: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Site (circle): North Beach Habitat (NBH), Middle Waterway Tideflat (MWT), Puyallup River Side Channel (PRS), Hylebos Creek Habitat (HCH)

Staff Present: John O'Loughlin, Mary Henley

Weather Conditions: partly cloudy, dry

Overall health and vigor of plants: Excellent Fair Poor

Qualitative Observations:

	Riparian Area	Marsh Area	Comments
Erosion	none	none	
Sedimentation	none	minor	
Wildlife	yes		see below
Vegetation			
Invasive	minor	minor	see below
Volunteer	none	possible	some bulrush at downstream lobe
Survival (%)	~75%	~95%	
Animal Damage	none	minor herbivory of grasses	
Disease	none	none	
Trash	none	none	
Vandalism	none	minor	minimal rock movement
Large Woody Debris	none	ok	one anchor needs repair
Wrack or Organic Material	none	none	

* For the Hylebos Creek site, use "Riparian" column for forested wetland and "Marsh" column for emergent wetland. Include additional qualitative notes on high slope upland vegetation below

Wildlife Notes (Species observed, other evidence):

Violet green swallow, goldfinch, red-tail hawk, flycatcher, barn swallow, belted kingfisher, mallard duck

Insect Sampling Notes (Hylebos Creek and PRSC only):

N/A for Year 0

Observable Prey (e.g., amphipods, mycids, larvae).

N/A for Year 0.

Soil/Sediment Quality:	upland	aquatic areas
Odor:	none	none
Sheen:	none	none
Color:	light brown	brown → gray
Texture:	gravelly sand	sandy silt → gravelly sand

Presence/condition of habitat mix/fine-grained material at surface (North Beach and PRSC only).

N/A

Notes:

Some blackberries @ edges, few weeds

Little water stress on upland forest

Photo Points (Circle Site): Year: (0), 1, 2, 4, 7, 10

North Beach	1A	1B	2A	2B
2C	3A	3B	3C	3D
4A	4B	4C	5A	5B
5C	5D	6		
Middle Waterway Tideflat	1A	1B	2A	2B
2C	3A	3B	4A	4B
4C	4D			
Puyallup River Side Channel	1	2A	2B	3A
3B	4A	4B	5A	5B
6				
Hylebos Creek	1A #48 (E) Hi → #94	1B #49 (S) #95	2A #45 (SE) #96	2B #47 #97
2C #46 (W) #98	3A #38 (SW) #99	3B #39 (W) #100	3C #40 (NW) #101	4A #35 (NE) #102
4B #36 (N) #104	4C #37 (NW) #105	5A #41 (S) *	5B #42 (W) *	5C #43 (N) *
5D #44 (E) *	6A #31 (N) #108	6B #32 (NE) #109	6C #33 (SE) #110	6D #34 (S) #111
7A #29 (NE) #112	7B #30 (N) #113			

Hi tide

Additional Notes/Photos.

* Photo Point 5 is inaccessible at high tide.

Photos 106 + 107 were taken from upstream land lobe looking northwest and northeast, respectively

High tide photos taken 7/13/06 at approximately 8:15 - 8:30 pm

Hylebos Creek, Photo Point 1A, facing east. Photo taken July 11, 2006 at 2:53 PM, tide at approximately 3.30 feet MLLW.
[IMG_0048]

Hylebos Creek, Photo Point 1A, facing east. Photo taken July 13, 2006 at 8:20 PM, tide at approximately 12.69 feet MLLW.
[IMG_0094]

Hylebos Creek, Photo Point 1B, facing south. Photo taken July 11, 2006 at 2:53 PM, tide at approximately 3.30 feet MLLW. [IMG_0050]

Hylebos Creek, Photo Point 1B, facing south. Photo taken Juy 13, 2006 at 8:20 PM, tide at approximately 12.69 feet MLLW. [IMG_0095]

Hylebos Creek, Photo Point 2A, facing southeast. Photo taken July 11, 2006 at 2:49 PM, tide at approximately 3.05 feet MLLW. [IMG_0045]

Hylebos Creek, Photo Point 2A, facing southeast. Photo taken July 13, 2006 at 8:22 PM, tide at approximately 12.7 feet MLLW. [IMG_0096]

Hylebos Creek, Photo Point 2B, facing southwest. Photo taken July 11, 2006 at 2:49 PM, tide at approximately 3.05 feet MLLW. [IMG_0047]

Hylebos Creek, Photo Point 2B, facing southwest. Photo taken July 13, 2006 at 8:22 PM, tide at approximately 12.7 feet MLLW. [IMG_0097]

Hylebos Creek, Photo Point 2C, facing west. Photo taken July 11, 2006 at 2:49 PM, tide at approximately 3.05 feet MLLW.
[IMG_0046]

Hylebos Creek, Photo Point 2C, facing west. Photo taken July 13, 2006 at 8:22 PM, tide at approximately 12.7 feet MLLW.
[IMG_0098]

Hylebos Creek, Photo Point 3A, facing southwest. Photo taken July 11, 2006 at 2:32 PM, tide at approximately 2.14 feet MLLW. [IMG_0038]

Hylebos Creek, Photo Point 3A, facing southwest. Photo taken July 13, 2006 at 8:28 PM, tide at approximately 12.73 feet MLLW. [IMG_0099]

Hylebos Creek, Photo Point 3B, facing west. Photo taken July 11, 2006 at 2:32 PM, tide at approximately 2.14 feet MLLW.
[IMG_0039]

Hylebos Creek, Photo Point 3B, facing west. Photo taken July 13, 2006 at 8:28 PM, tide at approximately 12.73 feet MLLW. [IMG_0100]

Hylebos Creek, Photo Point 3C, facing northwest. Photo taken July 11, 2006 at 2:32 PM, tide at approximately 2.14 feet MLLW. [IMG_0040]

Hylebos Creek, Photo Point 3C, facing northwest. Photo taken July 13, 2006 at 8:28 PM, tide at approximately 12.73 feet MLLW. [IMG_0101]

Hylebos Creek, Photo Point 4A, facing northeast. Photo taken July 11, 2006 at 2:20 PM, tide at approximately 1.5 feet MLLW. [IMG_0035]

Hylebos Creek, Photo Point 4A, facing northeast. Photo taken July 13, 2006 at 8:32 PM, tide at approximately 12.73 feet MLLW. [IMG_0102]

Hylebos Creek, Photo Point 4B, facing north. Photo taken July 11, 2006 at 2:20 PM, tide at approximately 1.5 feet MLLW.
[IMG_0036]

Hylebos Creek, Photo Point 4B, facing north. Photo taken July 13, 2006 at 8:32 PM, tide at approximately 12.73 feet MLLW. [IMG_0104]

Hylebos Creek, Photo Point 4C, facing northwest. Photo taken July 11, 2006 at 2:20 PM, tide at approximately 1.5 feet MLLW. [IMG_0037]

Hylebos Creek, Photo Point 4C, facing northwest. Photo taken July 13, 2006 at 8:32 PM, tide at approximately 12.73 feet MLLW. [IMG_0105]

Hylebos Creek, Photo Point 5A, facing south. Photo taken July 11, 2006 at 2:41 PM, tide at approximately 2.65 feet MLLW. [IMG_0041]

Hylebos Creek, Photo Point 5B, facing west. Photo taken July 11, 2006 at 2:41 PM, tide at approximately 2.65 feet MLLW.
[IMG_0042]

Hylebos Creek. Photo taken July 13, 2006 at 8:34 PM, tide at approximately 12.74 feet MLLW.
[IMG_0107]

Hylebos Creek, Photo Point 5C, facing north. Photo taken July 11, 2006 at 2:41 PM, tide at approximately 2.65 feet MLLW.
[IMG_0043]

Hylebos Creek, Photo Point 5D, facing east. Photo taken July 11, 2006 at 2:41 PM, tide at approximately 2.65 feet MLLW.
[IMG_0044]

Hylebos Creek. Photo taken July 13, 2006 at 8:34 PM, tide at approximately 12.74 feet MLLW.
[IMG_0106]

Hylebos Creek, Photo Point 6A, facing north. Photo taken July 11, 2006 at 2:06 PM, tide at approximately 0.77 feet MLLW.
[IMG_0031]

Hylebos Creek, Photo Point 6A, facing north. Photo taken July 13, 2006 at 8:35 PM, tide at approximately 12.74 feet MLLW. [IMG_0108]

Hylebos Creek, Photo Point 6B, facing northeast. Photo taken July 11, 2006 at 2:06 PM, tide at approximately 0.77 feet MLLW. [IMG_0032]

Hylebos Creek, Photo Point 6B, facing northeast. Photo taken July 13, 2006 at 8:35 PM, tide at approximately 12.74 feet MLLW. [IMG_0109]

Hylebos Creek, Photo Point 6C, facing southeast. Photo taken July 11, 2006 at 2:06 PM, tide at approximately 0.77 feet MLLW. [IMG_0033]

Hylebos Creek, Photo Point 6C, facing southeast. Photo taken July 13, 2006 at 8:35 PM, tide at approximately 12.74 feet MLLW. [IMG_0110]

Hylebos Creek, Photo Point 6D, facing south. Photo taken July 11, 2006 at 2:06 PM, tide at approximately 0.77 feet MLLW. [IMG_0034]

Hylebos Creek, Photo Point 6D, facing south. Photo taken July 13, 2006 at 8:35 PM, tide at approximately 12.74 feet MLLW. [IMG_0111]

Hylebos Creek, Photo Point 7A, facing northeast. Photo taken July 11, 2006 at 2:02 PM, tide at approximately 0.58 feet MLLW. [IMG_0029]

Hylebos Creek, Photo Point 7A, facing northeast. Photo taken July 13, 2006 at 8:36 PM, tide at approximately 12.74 feet MLLW. [IMG_0112]

Hylebos Creek, Photo Point 7B, facing north. Photo taken July 11, 2006 at 2:02 PM, tide at approximately 0.58 feet MLLW.
[IMG_0030]

Hylebos Creek, Photo Point 7B, facing north. Photo taken July 13, 2006 at 8:36 PM, tide at approximately 12.74 feet MLLW. [IMG_0113]

Hylebos Creek, elevation stake E1. Photo taken July 13, 2006.
[IMG_0086]

Hylebos Creek, elevation stake E2. Photo taken July 13, 2006.
[IMG_0087]

Hylebos Creek, elevation stake E3. Photo taken July 13, 2006.
[IMG_0088]

Hylebos Creek, elevation stake E4. Photo taken July 13, 2006.
[IMG_0089]

Hylebos Creek, elevation stake E5. Photo taken July 13, 2006.
[IMG_0090]

Hylebos Creek, elevation stake E6. Photo taken July 13, 2006.
[IMG_0091]

Johnny’s Dock Habitat Enhancement

Qualitative Ground Survey, Thea Foss Enhancement Sites

Date: 7/10/06 11:30 am Year (0) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Site (circle): Johnny's Dock (JDH) Head of Thea Foss (HTF), SR509 Esplanade (509), Log Step Habitat (LSH)

Staff Present: John O'Loughlin, Mary Henley

Weather Conditions: cloudy, dry

Overall health and vigor of plants: (Excellent) Fair Poor

Qualitative Observations:

	Riparian Area	Marsh Area	Comments
Erosion		none	
Sedimentation		none	
Wildlife		Yes	Geese
Vegetation			
Invasive		none	few lady's thumb
Volunteer		none	
Survival (%)		~ 75 %	
Animal Damage		none	
Disease		none	
Trash		none	
Vandalism		none	
Large Woody Debris		good	
Wrack or Organic Materia		none	

Wildlife Notes (species observed, other evidence):

Canada Geese

Soil/Sediment Quality:	upland	aquatic areas
Odor		none
Sheen:		none
Color:		gray
Texture:		gravelly sand

Notes:

Photo Points (Circle Site): Year (0) 1, 2, 4, 7, 10

Johnny's Dock	1A #9 (SW)	1B #10 (NW)	2A #11 (NW)	2B #12 (NE)
Head of Thea Foss	1	2		
SR509 Esplanade	1	2A	2B	3
Log Step	1			
Additional Photos				

Exclusion Grid Status (Johnny's Dock, Head of Thea, Log Step)

Good condition

Vegetation Diversity Notes:

RIPARIAN

Planted Species

N/A

Volunteer Species

none

Invasive Species

none

MARSH

Planted Species distichilis - doing very well
Hairgrass - none apparent above ground
Pickleweed - vigorous in areas

Volunteer Species

N/A

Invasive Species Few lady's thumb

MISCELLANEOUS ADDITIONAL NOTES:

Check survey for elevation of upper end of planting - Hairgrass may have been planted too high + need to be replaced.

Johnny's Dock, Photo Point 1A, facing southwest. Photo taken July 10, 2006 at 11:25 AM, tide at approximately -2.82 feet MLLW. [IMAG0009]

Johnny's Dock, Photo Point 1B, facing northwest. Photo taken July 10, 2006 at 11:25 AM, tide at approximately -2.82 feet MLLW. [IMAG0010]

Johnny's Dock, Photo Point 2A, facing northwest. Photo taken July 10, 2006 at 11:31 AM, tide at approximately -2.75 feet MLLW. [IMAG0011]

Johnny's Dock, Photo Point 2B, facing northeast. Photo taken July 10, 2006 at 11:31 AM, tide at approximately -2.75 feet MLLW. [IMAG0012]

Head of Thea Foss Shoreline Habitat

Qualitative Ground Survey, Thea Foss Enhancement Sites

Date: : 7/10/06 10:45 am Year (0) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Site (circle): Johnny's Dock (JDH), (Head of Thea Foss (HTF)), SR509 Esplanade (509), Log Step Habitat (LSH)

Staff Present: John O'Loughlin, Mary Henley

Weather Conditions: cloudy, dry

Overall health and vigor of plants: Excellent (Fair) Poor

Qualitative Observations:

	Riparian Area	Marsh Area	Comments
Erosion		none	
Sedimentation		none	
Wildlife		yes	goldfinch, geese
Vegetation			
Invasive		yes	
Volunteer		yes	gumweed
Survival (%)		≥ 50 %	
Animal Damage		none	
Disease		none	
Trash		some	minor
Vandalism		none	
Large Woody Debris		good	(log step)
Wrack or Organic Material		none	

Wildlife Notes (species observed, other evidence).

Goldfinch, Canada Geese, crows, white crown sparrow

Soil/Sediment Quality:	upland	aquatic areas
Odor:		none
Sheen:		none
Color:		grayish-brown
Texture:		silty sand

Notes:

Log Step in good condition

minor repairs on Goose exclusion grid needed.

weeding needed

Photo Points (Circle Site): Year (0) 1, 2, 4, 7, 10

Johnny's Dock	1A	1B	2A	2B
Head of Thea Foss	1 #7	2 #8		
SR509 Esplanade	1	2A	2B	3
Log Step	1			

Additional Photos

Exclusion Grid Status (Johnny's Dock, Head of Thea, Log Step)

Generally in good condition, minor repairs only

Vegetation Diversity Notes.

RIPARIAN

Planted Species

N/A

Volunteer Species

Cocklebur

Invasive Species

clover - various weeds

MARSH

Planted Species

willow stakes - good in higher areas - 50%
distichlis - excellent
jaumea - few
hairgrass - few

Volunteer Species

Cocklebur

Invasive Species

Various weeds

MISCELLANEOUS ADDITIONAL NOTES:

Head of Thea Foss, Photo Point 1, facing south. Photo taken July 10, 2006 at 10:41 AM, tide at approximately -2.89 feet MLLW. [IMAG0007]

Head of Thea Foss, Photo Point 2, facing north. Photo taken July 10, 2006 at 10:55 AM, tide at approximately -2.96 feet MLLW. [IMAG0008]

SR 509 Esplanade Riparian Habitat

Qualitative Ground Survey, Thea Foss Enhancement Sites

Date: 7/10/06 10:00 am Year (0) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Site (circle): Johnny's Dock (JDH), Head of Thea Foss (HTF), (SR509 Esplanade (509)), Log Step Habitat (LSH)

Staff Present: John O'Loughlin, Mary Henley

Weather Conditions: cloudy, dry

Overall health and vigor of plants: Excellent (Fair) Poor

Qualitative Observations:

	Riparian Area	Marsh Area	Comments
Erosion	none		very minor in one area - sprinkler
Sedimentation	none		
Wildlife	yes		various birds - see below
Vegetation			
Invasive	~~yes~~		various weeds
Volunteer	none		
Survival (%)	~90%		
Animal Damage	none apparent		
Disease	none		
Trash	none		
Vandalism	none		
Large Woody Debris	N/A		
Wrack or Organic Material	none		

Wildlife Notes (species observed, other evidence):

goldfinch, house sparrows, Canada geese, barn swallows

Soil/Sediment Quality:	upland	aquatic areas
Odor:	none	
Sheen:	none	
Color	grayish brown	
Texture:	silty sand	

Notes:

Some weeding of blackberry, morning glory etc needed

Sprinkler system appears to be in good working order

Photo Points (Circle Site) Year: 0 1 2 4 7 10

Johnny's Dock	1A	1B	2A	2B
Head of Thea Foss	1	2		
SR519 Esplanade	1 #5	2A #4 (6)	2B #3 (5)	3 #2
Log Step	1			

Additional Photos

#6 weed at area north of bridge

Exclusion Grid Status (Johnny's Dock, Head of Thea, Log Step)

N/A

Vegetation Diversity Notes

RIPARIAN

Planted Species ~50% survival on medrone - doesn't appear to be caused by herbivory
Also planted: shore pine, ocean spray, red-flowering currant, tall Oregon grape, Pacific Ninebark, Salal + Red huckleberry - all doing fairly well

Volunteer Species none

Invasive Species general weeds - clover, thistle, morning glory, blackberry

MARSH

Planted Species

Volunteer Species N/A

Invasive Species

MISCELLANEOUS ADDITIONAL NOTES

Little mold on some currant

SR509 Esplanade, Photo Point 1, facing south. Photo taken July 10, 2006 at 10:23 AM, tide at approximately -2.68 feet MLLW. [IMAG0005A]

SR509 Esplanade, Photo Point 2A, facing east. Photo taken July 10, 2006 at 10:15 AM, tide at approximately -2.54 feet MLLW. [IMAG0004A]

SR509 Esplanade, Photo Point 2B, facing south. Photo taken July 10, 2006 at 10:15 AM, tide at approximately -2.54 feet MLLW. [IMAG0003A]

SR509 Esplanade, Photo Point 3, facing north. Photo taken July 10, 2006 at 10:03 AM, tide at approximately -2.28 feet MLLW. [IMAG0002A]

Log Step Habitat Enhancement

Qualitative Ground Survey, Thea Foss Enhancement Sites

Date : 7/10/06 9:30 am Year: (0) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Site (circle): Johnny's Dock (JDH), Head of Thea Foss (HTF), SR509 Esplanade (509), (Log Step Habitat) (LSH)

Staff Present: John O'Laughlin, Mary Henley

Weather Conditions: cloudy, dry

Overall health and vigor of plants: (Excellent) Fair Poor

Qualitative Observations

	Riparian Area	Marsh Area	Comments
Erosion		none	
Sedimentation		none	
Wildlife		yes	crows, seagulls
Vegetation			
Invasive		none	butterfly bush at edge of site.
Volunteer		none	
Survival (%)		~100% for dunegrass - minimal for hairgrass	
Animal Damage		none	
Disease		none	
Trash		none	
Vandalism		none	
Large Woody Debris		present	tighten anchors
Wrack or Organic Material		none	some algae below step

Wildlife Notes (species observed, other evidence):

crows + seagulls

Soil/Sediment Quality:	upland	aquatic areas
Odor:		none
Sheen:		none
Color:		gray brown, gravelly sand
Texture:		gravelly sand

Notes:

Anchors on LWD require tightening (log step)

Goose exclusion grid in good condition

Photo Points (Circle Site) Year: 0 1, 2, 4, 7, 10

Johnny's Dock	1A	1B	2A	2B
Head of Thea Foss	1	2		
SR509 Esplanade	1	2A	2B	3
Log Step	1 → 1			

Additional Photos

Exclusion Grid Status (Johnny's Dock, Head of Thea, Log Step)

Good Condition

Vegetation Diversity Notes

RIPARIAN

Planted Species

N/A

Volunteer Species

Invasive Species above planted area – dandelion, clover, ivy, berry bush

MARSH

Planted Species American Dunegrass – near 100%
Tufted Hairgrass – minimal

Volunteer Species

N/A

Invasive Species

N/A

MISCELLANEOUS ADDITIONAL NOTES:

Log Step, Photo Point 1, facing north. Photo taken July 10, 2006 at 9:28 AM, tide at approximately -1.24 feet MLLW.
[IMAG0001A]

Attachment B

Middle Waterway Tideflat Habitat Salinity Monitoring Data

City of Tacoma
Environmental Services
Science and Engineering Division

Memorandum

TO: Desiree Pooley, Sr. Environmental Specialist

FROM: Christopher L. Getchell, Sr. Environmental Specialist

SUBJECT: Middle Waterway Sediment Salinity SAP ENV-00042-03-10

DATE: July 27, 2006

Attached are the corrected data reports for the Middle Waterway Sediment Salinity samples collected May 23, 26, and 30, 2006. The Soil Salinity values in the original reports were reported with the wrong units.

All raw data concerning the analysis of these samples is stored in the Science and Engineering Division's archives and is immediately available.

If you have any questions concerning these results, call me at (253) 502-2130. Please note that the samples associated with this report will be discarded six months from the date of this report unless requested otherwise.

Christopher L. Getchell
Sr. Environmental Specialist

CLG:LAZ

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Fs005\lab_reports\SurfaceWater\Miscellaneous\MWW_20060523a.pdf

City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253 591.5588 Fax: 253.502.2170

Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060523163
Sample ID: MWTF-BW1
Sample Type: Water
Sample Date: 5/23/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	**26100**	uS/cm
Soil Salinity	**17.2**	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

Flags: U: The analyte was not detected at or above the reported value
UJ: The analyte was not detected at or above the reported estimated value
NJ: There is evidence the analyte is present. The associated value is an estimate
J: The analyte was positively identified. The associated value is an estimate
B: The analyte was detected but is less than the reporting limit goal

City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax. 253.502.2170

Project: Stormwater Investigation
Date July 27, 2006

Lab#: 20060523164
Sample ID: MWTF-BW2
Sample Type: Water
Sample Date: 5/23/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	**23800**	uS/cm
Soil Salinity	**15.5**	ppt

Lori A Zboralski July 27, 2006
Reviewed By: **Date**

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City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253.502.2170

Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060523165
Sample ID: MWTF-BW3
Sample Type: Water
Sample Date: 5/23/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	N/A	uS/cm
Soil Salinity	N/A	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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- B: The analyte was detected but is less than the reporting limit goal

City of Tacoma
Science and Engineering Division
3201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253.502 2170

Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060523166
Sample ID: MWTF-BW4
Sample Type: Water
Sample Date: 5/23/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	N/A	uS/cm
Soil Salinity	N/A	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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UJ: The analyte was not detected at or above the reported estimated value
NJ: There is evidence the analyte is present. The associated value is an estimate
J: The analyte was positively identified. The associated value is an estimate
B: The analyte was detected but is less than the reporting limit goal

City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253 591.5588 Fax: 253 502.2170

Project: Stormwater Investigation
Date July 27, 2006

Lab#: 20060523167
Sample ID: MWTF-BW5
Sample Type: Water
Sample Date: 5/23/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	**25300**	uS/cm
Soil Salinity	**16.5**	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
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Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060523168
Sample ID: MWTF-BW6
Sample Type: Water
Sample Date: 5/23/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	20700	uS/cm
Soil Salinity	13.4	ppt

Lori A Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

Flags:
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- J: The analyte was positively identified. The associated value is an estimate
- B: The analyte was detected but is less than the reporting limit goal

City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone. 253.591.5588 Fax· 253 502.2170

Project: Stormwater Investigation
Date July 27, 2006

Lab#: 20060523169
Sample ID: MWTF-BMC1
Sample Type: Water
Sample Date: 5/23/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	N/A	uS/cm
Soil Salinity	N/A	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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- UJ: The analyte was not detected at or above the reported estimated value
- NJ: There is evidence the analyte is present. The associated value is an estimate
- J: The analyte was positively identified. The associated value is an estimate
- B: The analyte was detected but is less than the reporting limit goal

City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253.502.2170

Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060523170
Sample ID: MWTF-BMC2
Sample Type: Water
Sample Date: 5/23/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	N/A	uS/cm
Soil Salinity	N/A	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253.502.2170

Project: Stormwater Investigation
Date July 27, 2006

Lab#: 20060523171
Sample ID: MWTF-BMC3
Sample Type: Water
Sample Date: 5/23/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	N/A	uS/cm
Soil Salinity	N/A	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

Flags:
- U: The analyte was not detected at or above the reported value
- UJ: The analyte was not detected at or above the reported estimated value
- NJ: There is evidence the analyte is present. The associated value is an estimate
- J: The analyte was positively identified. The associated value is an estimate
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City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253 591.5588 Fax: 253.502.2170

Project:	Stormwater Investigation
Date	July 27, 2006

Lab#:	20060526187
Sample ID:	MWTF-BW1
Sample Type:	Water
Sample Date:	5/26/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	14200	uS/cm
Soil Salinity	9.30	ppt

Lori A. Zboralski July 27, 2006

Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

Flags:
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- UJ: The analyte was not detected at or above the reported estimated value
- NJ: There is evidence the analyte is present. The associated value is an estimate
- J: The analyte was positively identified. The associated value is an estimate
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Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253.502.2170

Project: Stormwater Investigation
Date July 27, 2006

Lab#: 20060526188
Sample ID: MWTF-BW2
Sample Type: Water
Sample Date: 5/26/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	15000	uS/cm
Soil Salinity	9.90	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

Flags.
- U: The analyte was not detected at or above the reported value
- UJ: The analyte was not detected at or above the reported estimated value
- NJ: There is evidence the analyte is present. The associated value is an estimate
- J: The analyte was positively identified. The associated value is an estimate
- B: The analyte was detected but is less than the reporting limit goal

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Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253 591.5588 Fax: 253.502.2170

Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060526189
Sample ID: MWTF-BW3
Sample Type: Water
Sample Date: 5/26/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	**28000**	uS/cm
Soil Salinity	**18.8**	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

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Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060526190
Sample ID: MWTF-BW4
Sample Type: Water
Sample Date: 5/26/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	13700	uS/cm
Soil Salinity	**8.60**	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060526191
Sample ID: MWTF-BW5
Sample Type: Water
Sample Date: 5/26/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	**8330**	uS/cm
Soil Salinity	**5.20**	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax. 253.502.2170

Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060526192
Sample ID: MWTF-BW6
Sample Type: Water
Sample Date: 5/26/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	13000	uS/cm
Soil Salinity	8.50	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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City of Tacoma

Science and Engineering Division

2201 Portland Avenue Tacoma WA 98421
Phone: 253 591.5588 Fax: 253 502.2170

Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060526193
Sample ID: MWTF-BMC1
Sample Type: Water
Sample Date: 5/26/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	3400	uS/cm
Soil Salinity	24.4	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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City of Tacoma
Science and Engineering Division
2701 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253.502.2170

Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060526194
Sample ID: MWTF-BMC2
Sample Type: Water
Sample Date: 5/26/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	38700	uS/cm
Soil Salinity	27.7	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

Flags:
- U: The analyte was not detected at or above the reported value
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Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax. 253.502.2170

Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060526195
Sample ID: MWTF-BMC3
Sample Type: Water
Sample Date: 5/26/2006

Test	Result	Units
CONVENTIONAL		
Conductivity	N/A	uS/cm
Soil Salinity	N/A	ppt

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591 5588 Fax: 253.502.2170

Project: Stormwater Investigation
Date July 27, 2006

Lab#: 20060530198
Sample ID: MWTF-BW1
Sample Type: Water
Sample Date: 5/30/2006

Test	Result	Units
CONVENTIONAL		
Soil Salinity	9.80	ppt
FIELD		
Conductivity	12200	uS/cm

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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Science and Engineering Division
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Phone: 253.591.5588 Fax. 253.502 2170

Project:	Stormwater Investigation
Date	July 27, 2006

Lab#:	20060530199
Sample ID:	MWTF-BW2
Sample Type:	Water
Sample Date:	5/30/2006

Test	Result	Units
CONVENTIONAL		
Soil Salinity	8.00	ppt
FIELD		
Conductivity	10100	uS/cm

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

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Science and Engineering Division
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Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060530200
Sample ID: MWTF-BW3
Sample Type: Water
Sample Date: 5/30/2006

Test	Result	Units
CONVENTIONAL		
Soil Salinity	**15.8**	ppt
FIELD		
Conductivity	**18900**	uS/cm

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

Flags:
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Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060530201
Sample ID: MWTF-BW4
Sample Type: Water
Sample Date: 5/30/2006

Test	Result	Units
CONVENTIONAL		
Soil Salinity	**2.80**	ppt
FIELD		
Conductivity	**3800**	uS/cm

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

Flags:
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Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060530202
Sample ID: MWTF-BW5
Sample Type: Water
Sample Date: 5/30/2006

Test	Result	Units
CONVENTIONAL		
Soil Salinity	**2.00**	ppt
FIELD		
Conductivity	**2800**	uS/cm

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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Project: Stormwater Investigation
Date July 27, 2006

Lab#: 20060530203
Sample ID: MWTF-BW6
Sample Type: Water
Sample Date: 5/30/2006

Test	Result	Units
CONVENTIONAL		
Soil Salinity	7.10	ppt
FIELD		
Conductivity	9000	uS/cm

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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Science and Engineering Division
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Project: **Stormwater Investigation**
Date July 27, 2006

Lab#: 20060530204
Sample ID: MWTF-BMC1
Sample Type: Water
Sample Date: 5/30/2006

Test	Result	Units
CONVENTIONAL		
Soil Salinity	**32.2**	ppt
FIELD		
Conductivity	**36200**	uS/cm

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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Science and Engineering Division
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Phone: 253.591.5568 Fax: 253.502 2170

Project: Stormwater Investigation
Date July 27, 2006

Lab#: 20060530205
Sample ID: MWTF-BMC2
Sample Type: Water
Sample Date: 5/30/2006

Test	Result	Units
CONVENTIONAL		
Soil Salinity	28.0	ppt
FIELD		
Conductivity	31900	uS/cm

Lori A. Zboralski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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Science and Engineering Division
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Phone: 253.591.5588 Fax. 253.502.2170

Project: Stormwater Investigation
Date July 27, 2006

Lab#: 20060530206
Sample ID: MWTF-BMC3
Sample Type: Water
Sample Date: 5/30/2006

Test	Result	Units
CONVENTIONAL		
Soil Salinity	**18.7**	ppt
FIELD		
Conductivity	**22100**	uS/cm

Lori A. Zbovalski July 27, 2006
Reviewed By: **Date**

ppt in Units indicates parts per thousand. N/A in Result means "not analyzed" due to insufficient liquid to analyze.

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City of Tacoma
Environmental Services
Science and Engineering Division

Memorandum

TO: Mary Henley, Senior Engineer, Foss Construction Management

FROM: Christopher L. Getchell, Sr. Environmental Specialist

SUBJECT: Middle Waterway Sediment Salinity SAP ENV-00042-03-10

DATE: August 1, 2006

Attached are the data reports for the Middle Waterway Sediment Salinity samples collected July 24, 2006. These samples are associated with the sprinkler system placement on the Middle Waterway restoration sites.

The Science and Engineering Division Laboratory personnel collected and analyzed the samples for Soil Salinity and Conductivity.

All raw data concerning the analysis of these samples is stored in the Science and Engineering Division's archives and is immediately available.

If you have any questions concerning these results, call me at (253) 502-2130. Please note that the samples associated with this report will be discarded six months from the date of this report unless requested otherwise.

Christopher L. Getchell
Sr. Environmental Specialist

CLG:BJP

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City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253.502.2170

Project: Stormwater Investigation

Date: August 01, 2006

Lab#:	20060725138	20060725139	20060725140	
Sample ID:	MWTF-BW1	MWTF-BW2	MWTF-BW3	
Sample Type:	Water	Water	Water	
Sample Date:	7/24/2006	7/24/2006	7/24/2006	
Test	**Result**	**Result**	**Result**	**Units**
CONVENTIONAL				
Soil Salinity	2.90	11.2	3.60	PPT
FIELD				
Conductivity	4800	17000	5880	uS/cm

Barbara Lumberton August 1, 2006

Reviewed By: **Date**

Flags:
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- *: The value falls outside of QC High or Low Limit.

City of Tacoma

Science and Engineering Division

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Project: Stormwater Investigation

Date: August 01, 2006

Lab#:	20060725141	20060725142	20060725143	
Sample ID:	MWTF-BW4	MWTF-BW5	MWTF-BW6	
Sample Type:	Water	Water	Water	
Sample Date:	7/24/2006	7/24/2006	7/24/2006	
Test	**Result**	**Result**	**Result**	**Units**
CONVENTIONAL				
Soil Salinity	**4.60**	Too dry	**3.10**	PPT
FIELD				
Conductivity	**7480**	**Too dry**	**5200**	uS/cm

Barbara J Emberton — August 1, 2006

Reviewed By: **Date**

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UJ: The analyte was not detected at or above the reported estimated result.
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City of Tacoma
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Phone 253.591.5588 Fax: 253.502.2170

Project: **Stormwater Investigation**

Date: August 01, 2006

Lab#:	20060725144	20060725145	20060725146	
Sample ID:	MWTF-BMC1	MWTF-BMC2	MWTF-BMC3	
Sample Type:	Water	Water	Water	
Sample Date:	7/24/2006	7/24/2006	7/24/2006	
Test	**Result**	**Result**	**Result**	**Units**
CONVENTIONAL				
Soil Salinity	**22.0**	**32.8**	**17.5**	PPT
FIELD				
Conductivity	**31500**	**45200**	**25600**	uS/cm

Barbara J Imberton August 1, 2006

Reviewed By: **Date**

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- *: The value falls outside of QC High or Low Limit

City of Tacoma
Environmental Services
Science and Engineering Division

Memorandum

TO: Mary Henley, Senior Engineer, Foss Construction Management

FROM: Christopher L. Getchell, Sr. Environmental Specialist

SUBJECT: Middle Waterway Sediment Salinity SAP ENV-00042-03-10

DATE: August 30, 2006

Attached are the data reports for the Middle Waterway Sediment Salinity samples collected August 21, 2006. These samples are associated with the sprinkler system placement on the Middle Waterway restoration sites.

The Science and Engineering Division Laboratory personnel collected and analyzed the samples for Soil Salinity and Conductivity.

All raw data concerning the analysis of these samples is stored in the Science and Engineering Division's archives and is immediately available.

If you have any questions concerning these results, call me at (253) 502-2130. Please note that the samples associated with this report will be discarded six months from the date of this report unless requested otherwise.

Christopher L. Getchell
Sr. Environmental Specialist

CLG:BJP

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Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253.502.2170

Project: Stormwater Investigation
ENV-00042-03-10
Date: August 30, 2006

Lab#:	20060829318	20060829319	20060829320	
Sample ID:	MWTF-BW1	MWTF-BW2	MWTF-BW3	
Sample Type:	Water	Water	Water	
Sample Date:	8/21/2006	8/21/2006	8/21/2006	
Test	**Result**	**Result**	**Result**	**Units**
CONVENTIONAL				
Soil Salinity	2.0 U	2.0 U	2.0U	0/00
FIELD				
Conductivity	**1410**	**625**	**2560**	uS/cm

Barbara Hembeton August 30, 2006
Reviewed By: **Date**

Flags
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Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253.502.2170

Project: Stormwater Investigation
ENV-00042-03-10
Date: August 30, 2006

Lab#:	20060829321	20060829322	20060829323	
Sample ID:	MWTF-BW4	MWTF-BW5	MWTF-BW6	
Sample Type:	Water	Water	Water	
Sample Date:	8/21/2006	8/21/2006	8/21/2006	
Test	**Result**	**Result**	**Result**	**Units**
CONVENTIONAL				
Soil Salinity	2.0 U	2.0 U	14.7	0/00
FIELD				
Conductivity	26 U	26 U	22800	uS/cm

Barbara Lambston — August 30, 2006
Reviewed By: **Date**

Flags:
- U: The analyte was not detected at or above the reported value.
- UJ: The analyte was not detected at or above the reported estimated result.
- NJ: There is evidence the analyte is present. The associated value is an estimate.
- J: The analyte was positively identified. The associated value is an estimate.
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- *: The value falls outside of QC High or Low Limit.

City of Tacoma
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Project: Stormwater Investigation
ENV-00042-03-10
Date: August 30, 2006

Lab#:	20060829324	20060829325	20060829326	
Sample ID:	MWTF-BMC1	MWTF-BMC2	MWTF-BMC3	
Sample Type:	Water	Water	Water	
Sample Date:	8/21/2006	8/21/2006	8/21/2006	
Test	**Result**	**Result**	**Result**	**Units**
CONVENTIONAL				
Soil Salinity	27.3	12.3	22.3	0/00
FIELD				
Conductivity	38400	18600	31900	uS/cm

Barbara Pembeton — August 30, 2006
Reviewed By: **Date**

Flags:
- U: The analyte was not detected at or above the reported value.
- UJ: The analyte was not detected at or above the reported estimated result.
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- B: The value is less than the reporting limit but greater than detection limit.
- *: The value falls outside of QC High or Low Limit.

City of Tacoma
Environmental Services
Science and Engineering Division

Memorandum

TO: Mary Henley, Senior Engineer, Foss Construction Management

FROM: Christopher L. Getchell, Sr. Environmental Specialist

SUBJECT: Middle Waterway Sediment Salinity SAP ENV-00042-03-10

DATE: September 26, 2006

Attached are the data reports for the Middle Waterway Sediment Salinity samples collected September 18, 2006. These samples are associated with the sprinkler system placement on the Middle Waterway restoration sites.

The Science and Engineering Division Laboratory personnel collected and analyzed the samples for Soil Salinity and Conductivity.

All raw data concerning the analysis of these samples is stored in the Science and Engineering Division's archives and is immediately available.

If you have any questions concerning these results, call me at (253) 502-2130. Please note that the samples associated with this report will be discarded six months from the date of this report unless requested otherwise.

Christopher L. Getchell
Sr. Environmental Specialist

CLG:LAZ

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City of Tacoma
Science and Engineering Division
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Phone: 253.591 5588 Fax: 253.502.2170

Project: **Stormwater Investigation**
ENV-00042-03-10
Date: September 26, 2006

Lab#:	20060922080	20060922081	20060922082	
Sample ID:	MWTF-BW1	MWTF-BW2	MWTF-BW3	
Sample Type:	Water	Water	Water	
Sample Date:	9/18/2006	9/18/2006	9/18/2006	
Test	**Result**	**Result**	**Result**	**Units**
CONVENTIONAL				
Soil Salinity	11.6	7.80	27.9	0/00
FIELD				
Conductivity	16000	11600	37000	uS/cm

Lori A. Zboralski — September 26, 2006
Reviewed By: **Date**

Flags: U: The analyte was not detected at or above the reported value.
UJ: The analyte was not detected at or above the reported estimated result.
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J: The analyte was positively identified. The associated value is an estimate.
B: The value is less than the reporting limit but greater than detection limit.
*: The value falls outside of QC High or Low Limit.

City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253.502.2170

Project: Stormwater Investigation
ENV-00042-03-10
Date: September 26, 2006

Lab#:	20060922083	20060922084	20060922085	
Sample ID:	MWTF-BW4	MWTF-BW5	MWTF-BW6	
Sample Type:	Water	Water	Water	
Sample Date:	9/18/2006	9/18/2006	9/18/2006	
Test	**Result**	**Result**	**Result**	**Units**
CONVENTIONAL				
Soil Salinity	5.80	not read	24.2	0/00
FIELD				
Conductivity	8770	no water	32600	uS/cm

Lori R. Zbrzalski — September 26, 2006
Reviewed By: **Date**

Flags:
- U: The analyte was not detected at or above the reported value.
- UJ: The analyte was not detected at or above the reported estimated result.
- NJ: There is evidence the analyte is present. The associated value is an estimate.
- J: The analyte was positively identified. The associated value is an estimate.
- B: The value is less than the reporting limit but greater than detection limit
- *: The value falls outside of QC High or Low Limit.

City of Tacoma
Science and Engineering Division
2201 Portland Avenue Tacoma WA 98421
Phone: 253.591.5588 Fax: 253 502 2170

Project: **Stormwater Investigation**
ENV-00042-03-10
Date: September 26, 2006

Lab#:	20060922086	20060922087	20060922088	
Sample ID:	MWTF-BMC1	MWTF-BMC2	MWTF-BMC3	
Sample Type:	Water	Water	Water	
Sample Date:	9/18/2006	9/18/2006	9/18/2006	
Test	**Result**	**Result**	**Result**	Units
CONVENTIONAL				
Soil Salinity	31.7	26.0	20.5	0/00
FIELD				
Conductivity	41500	34700	28000	uS/cm

Lori A. Zboralski — September 26, 2006
Reviewed By: **Date**

Flags:
- U: The analyte was not detected at or above the reported value.
- UJ: The analyte was not detected at or above the reported estimated result.
- NJ: There is evidence the analyte is present. The associated value is an estimate.
- J: The analyte was positively identified. The associated value is an estimate.
- B: The value is less than the reporting limit but greater than detection limit.
- *: The value falls outside of QC High or Low Limit.

Attachment E-2

Response to Comments

Comments on Thea Foss OMMP Preliminary Findings Memorandum - Baseline Habitat Monitoring, dated November 30, 2006:

General: *As specified in Section 1.0 of the OMMP, the purpose of the Preliminary Findings Memorandum is to inform EPA of new monitoring results to facilitate decisions and/or contingency actions, if necessary. Given the purpose of the Preliminary Findings Memorandum, EPA approval of the document is not a planned part of the process. Therefore, we will incorporate responses to these comments in the Annual Monitoring Report, as appropriate. General responses to the comments are provided below.*

Comment 1. General. Monitoring reports should be sent to all stakeholders for review and comment.

Response: *The City intends to distribute the Annual Monitoring Report to the other review agencies as follows: EPA (3), ACOE (2), USFWS (1), WDFW (1), Puyallup Tribe (1), DNR (1), Ecology (1) and NOAA (1). In addition, reports will be sent to Simpson, the Utilities, and CHB. Please let us know if you have any changes to this distribution. As stated above, the Preliminary Findings Memorandum is provided for informational purposes. In the event that issues requiring followup are identified, the adaptive management/contingency planning procedures will be implemented and the specifics of the issue will be distributed to the broader group of reviewers.*

Comment 2. General. Recommend including created habitat acreages in the project description section for each site.

Response: *A copy of the habitat acreage table from Section 6.0 of the OMMP will be included in the Annual Report.*

Comment 3. General. Include plan view drawings or annual aerial photos for each project site if available. These should indicate locations of photo points, elevation stakes, and other relevant locations pertinent to the document. This would provide context for the reader. This would be particularly useful for locating the elevation stakes.

Response: *These figures will be included in the Annual Report, and in the future will also be provided in the Preliminary Findings Memorandum.*

Comment 4. General. A summary table of performance criteria should be part of the monitoring report noting when criteria is or is not met.

Response: *This Preliminary Findings Memorandum documents the baseline conditions at the site, and specific performance standards do not apply at this time (see Table 6-3 from the OMMP). In future monitoring years, when specific performance standards apply a table will be included along with an indication as to whether or not the criteria was met.*

Comment 5. General. Stream flow (cfs) should be recorded for PRSC and Hylebos Creek sites at the time of monitoring survey (i.e. x cfs at stream gage y on the Puyallup River). This is important data that provides context to the photos. For example, the sites will look different during a higher flow. Alternatively, since monitoring occurs during the summer, criteria can be established requiring monitoring to be conducted when flows are below a certain level. This will ensure monitoring is not done immediately after a storm or when the river is high, and that environmental conditions are consistent during each monitoring survey.

Response: *This data was not collected during this baseline monitoring event, but can be noted in future years during qualitative monitoring events.*

Comment 6. Page 8, fifth full paragraph. Discusses water surface elevation performance standard. This is also discussed on page 10 stating that since the water surface is 2 ft NGVD 47% of the time, the performance standard is met. This is a misunderstanding of the purpose of this measurement and relationship to the performance criteria. The relevant performance criteria is water depth, which is determined by measuring the water surface elevation and channel bottom elevation. Water surface elevation (2 ft NGVD) minus channel bottom elevation (x NGVD) is equal to water depth at the site. This calculation should be made and evaluated against the performance standard which is 2 ft of water depth at the site 30% of the time. A presentation of surface water elevation by itself has no meaning for the site. Additional detail should describe the measurement interval and overall time period the water elevation measurements represent. Are these all from 1 day? Are they collected 12 times per day over 6 months?

Response: *This issue is being discussed separately in the context of final comments on the OMMP. The Annual Report will be modified accordingly upon final resolution.*

Comment 7. Table 2. A map indicating location of salinity monitoring points is needed.

Response: *Figure E-6 in the OMMP, and Figure 6-2 in the Annual Report will show the locations of these points.*

Comment 8. Table 3. Should be modified for water depth. See comment #6.

Response: *See response to comment 6, above.*

Appendix F

Health and Safety Plan

There were no addenda to the Health and Safety Plan during the reporting period. However, for consistency in reporting, the structure of the Baseline OMMP Report, and subsequent annual reports will follow the outline of the OMMP. This will provide consistent presentation and placement of information generated during the monitoring of remedial actions performed as part of the Thea Foss and Wheeler-Osgood Waterways Remediation Project. Any future addenda to the Health and Safety Plan will be included in Appendix F of the applicable annual report.

Appendix G

Additional Project Related Activities

Attachment G-1

Simpson 2004 Log Haul Monitoring Report

Grette Associates LLC
ENVIRONMENTAL CONSULTANTS

DRAFT TECHNICAL MEMORANDUM

To: Dave McEntee, Simpson Tacoma Land Co. October 19, 2004

From: Grette Associates, LLC File No.: 316-001

Re: Simpson Middle Waterway Log Haul Facility: Pre-Operations (Baseline) Survey

Introduction

In order to construct the sediment containment facility for dredge materials from the Tacoma Thea Foss Waterway Remediation, the St Paul Waterway nearshore fill was designed and developed to include a containment berm within the St. Paul Waterway. Before construction of the nearshore fill site could occur, several pre-construction projects were identified, including the relocation of the Simpson Kraft log haul-out facility. This Memorandum describes underwater surveys conducted after the facility was completed and before log haul-out operations began. The survey was designed to document and characterize debris located beneath the facility and the log rafting area.

The log haul-out facility is located on the east[1] side of the mouth of the middle waterway. The facility consists of a ramp and rails extending from the waterway to the base of the haul road, and a 300-ft long float 125 ft north of the ramp and parallel to the shoreline (Figure 1). A fabricated gangway spans from the shoreline to the float. The float is fixed to several steel pile and is the eastern extent of the log rafting area. A line of pile spaced approximately 40 ft apart runs parallel to the float 6 ft to the water ward side. These pile extend another 300 ft northward beyond the end of the float (Figure 1). Immediately south (landward) of the new log ramp there is a line of four pile extending perpendicular to shore that mark the southern extent of the facility.

This memorandum summarizes observations from pre-operations (baseline) dive and shoreline surveys conducted by three biologists on April 20, 2004.

Field Methods

Field activities consisted of substrate characterizations surveys along underwater (SCUBA) transects parallel to the shore/log raft at 20-ft intervals and a walking shoreline survey at -1 ft MLLW. A measuring tape was extended perpendicular to shore along the axis of the four southern pile to mark the southern end of the diver transects. This end of each transect was permanently marked with steel reinforced bar (rebar) stakes, painted orange and flagged with orange and yellow survey tape, placed at 20-ft intervals. In order to capture effects from the proposed log rafting area, transects were set with the shallowest transect (Transect 1, 20 ft) shoreward of the float, one immediately water ward of the piles adjacent to the float (Transect 2, 40 ft), and the remaining three in the waterway (Transects 3 [60 ft], 4 [80 ft] and 5 [100 ft]). Divers swam the first transect (2) together from north to south, and set a second measuring tape

[1] Cardinal directions refer to project N, S, E, and W, with the N/S axis parallel to the float and shoreline. The northward compass bearing for transects was 30° west of north.

at the north end perpendicular to shore to temporarily mark that end of each transect. Transects were approximately 875 ft in length (150 ft beyond of the last log-rafting pile). Divers recorded general conditions along each transect, including substrate type, presence of wood or other debris, and vegetation (see attached data sheets).

For the walking shoreline transect, a biologist walked the -1 ft MLLW contour (or deep enough to visually survey that contour) during low water for the sampling day. The survey included the area from the four-pile line north to three pile from the end of the rafting area north of the float, where the -1 ft MLLW contour turns east and no longer runs parallel to the rafting pile (see Figure 1). The same observations were recorded as for the diver surveys, including substrate type, presence of wood or other debris, and vegetation (see attached data sheet). The contour was determined based on water depth relative to predicted tide height, e.g., predicted tide of 0.5 ft MLLW resulted in identification of the -1 ft MLLW contour at a depth of 1.5 ft.

Survey Observations

Underwater Surveys

Substrate along the first three transects from the south end of the study area to between four and five pile from the north end of the float can be generally characterized as large quarry spalls and riprap (Photo 1). The segment between Transect 1 and the shore is more gravelly. Transect 4 marks the transition between the areas of very coarse substrate (quarry spalls/riprap) to the finer substrate (gravel/mud) typical of Transect 5, although quarry spalls are common along the initial 100 ft of Transect 4. North of the quarry spall/riprap area, substrate across all five transects is more typically fine sediment (mud, silt), with some gravel (Photo 2).

One exception to these general substrate characteristics is the area immediately around the base of the log haul-out ramp, which is muddier but still has some riprap. This area extends no further water ward than Transect 4 and no farther north than the beginning of the float. Another exception is an area along Transect 2 from the 6th pile north of the end of the float to immediately north of the last pile, where there is a great deal of concrete rubble over the finer mud/silt sediment.

In waterway cross-section, the substrate slopes steeply away from shore across Transects 1 to 3, and is flatter across Transects 4 and 5. It also slopes somewhat toward the mouth of the waterway, particularly at the end of Transects 4 and 5. At a finer resolution, the substrate is not uniformly flat, but generally is comprised of hummocks up to 4 ft high.

Wood debris was observed along all five transects (Photos 3 & 4). Generally, wood debris decreases away from shore, with significantly less wood (and other debris) on Transects 4 and 5. Wood debris included broken pile, pile stubs, processed wood waste, tree stumps, and bark. Dredge cuts were observed on Transects 1 and 3 where vertical walls left by the clamshell exposed thick areas of processed wood waste up to 50 ft in length. A large area of wood waste approximately 20 ft long by 10 ft wide and 2 ft deep was observed on Transect 2; another area extended from the end of the float to the 2nd pile further north on Transect 1. In this same area at least eight exposed pile stubs were observed. There was also one very large section of pier

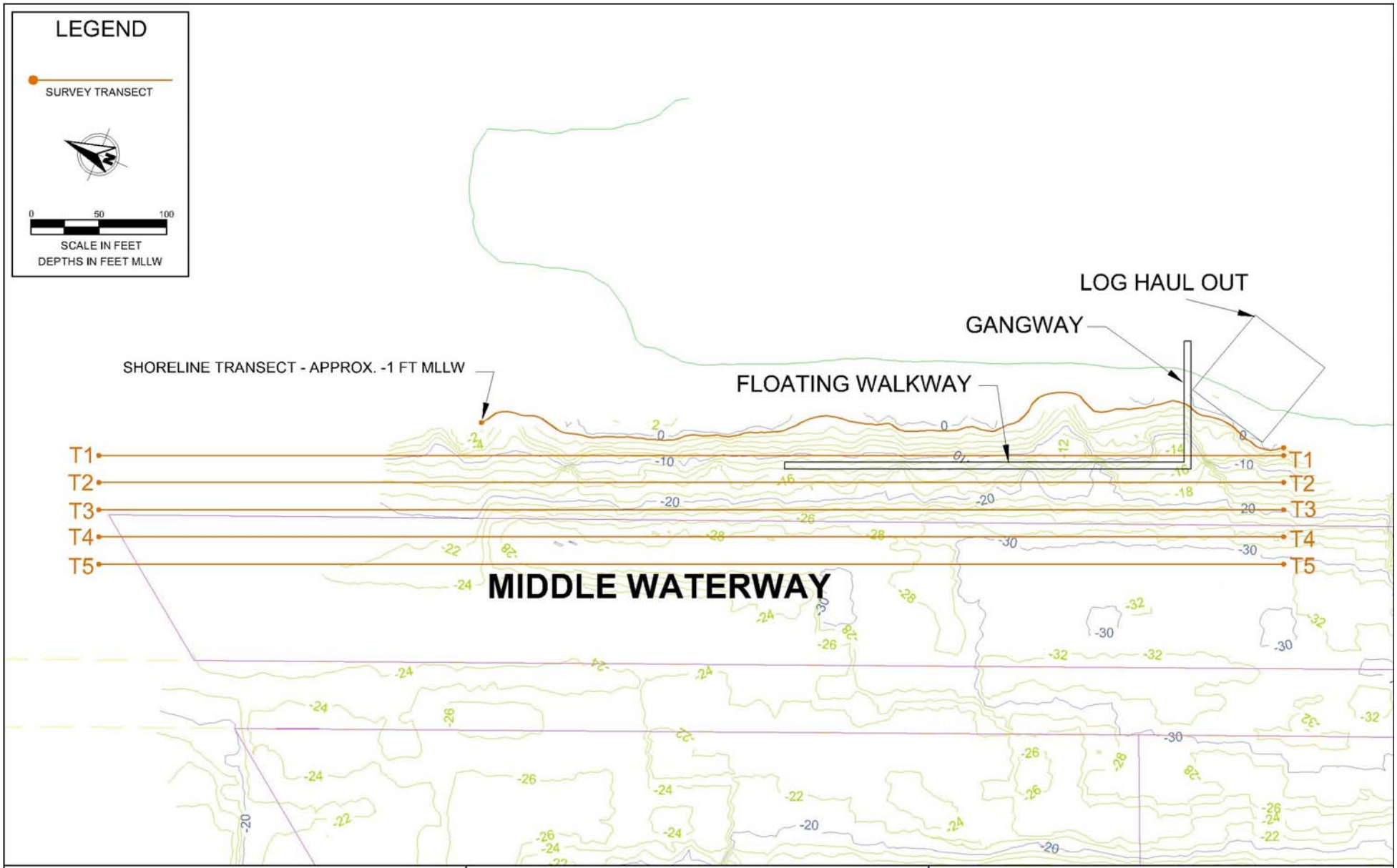
decking immediately north of the last pile on this transect. At least 15-20 broken pile, from 3 ft to >12 ft long, were observed on Transects 1 to 3. Areas of bark up to 2 ft wide by 4 ft long were present but not common on Transects 1 to 3. Sparse wood debris was present on Transects 4 and 5. A number of tires also were observed in the survey area.

The underwater survey did not include quantitative observations of biota, but sea anemones (*Metridium giganteium*, others) and sea stars were present and distributed across much of the area, particularly on pile and very coarse substrate. Starry flounder (*Platichthys stellatus*), English sole (*Parophrys vetulus*), and coon stripe shrimp (*Pandalus danae*) also were observed. Macroalgae was very sparse (Photo 4).

Walking Survey (-1.0 ft MLLW)

Between the transects and float ramp, immediately around the log haul-out ramp, the substrate was mostly quarry spalls with some silty sand or gravel. There was no macroalgae, but some filamentous algae and a fine layer of silt. Along the float, the substrate was mostly sand with sparse gravel and a fine layer of silt. There generally was no macroalgae, although some *Laminaria* spp. was present lying on the substrate, mostly likely broken off of the float; fine, filamentous algae was present at -1 ft MLLW. There was little or no wood waste along the log haul-out ramp or float, although a few individual, small pieces (<1 ft long) were observed. No other debris was observed. The slope dropped steeply below -1 ft MLLW along this section of the contour. The substrate was generally coarser above the contour (gravelly sand), and finer below it (sand, silty sand). The top of the beach in this area was armored with quarry spalls.

North of the float the slope of the beach was much shallower, particularly above the -1 ft MLLW contour. Substrate in this area was generally silty sand with sparse to common cobbles and gravel on top. Further north there were also large pieces of quarry spalls or small riprap, as well as sparse abandoned cable or rebar. There was more wood waste in this area, but it was not common. Waste was generally processed wood less than 2 ft to 3 ft long. Differences in substrate grain size above and below -1 ft MLLW were not as clear as in the steeper beach area near the float. The walking survey terminated three pile from the end of the log rafting area, where the -1 ft contour bends east away from the rafting facility toward a large shallow area northeast of the float.

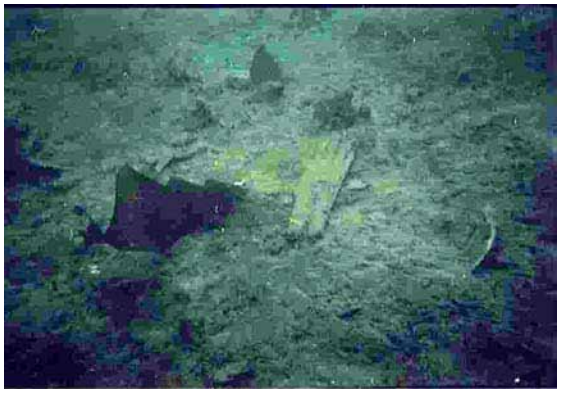


GRETTE ASSOCIATES, LLC 2111 NORTH 30TH STREET TACOMA, WA 98403 PH (253) 573-9300	**SIMPSON TACOMA LAND CO.** SIMPSON MIDDLE WATERWAY LOG HAUL FACILITY PRE-OPERATIONS (BASELINE) SURVEY	FIGURE 1 SURVEY TRANSECT LOCATIONS LOCATION: COMMENCEMENT BAY AT: MIDDLE WATERWAY CITY: TACOMA COUNTY: PIERCE STATE: WA OCTOBER 2004

Photograph 1. Riprap and quarry spalls typical of Transects 1-3

Photograph 2. Fine mud/silt substrate typical of Transect 5 and the northern portion of the study area.

Photograph 3. Wood waste exposed by dredge cut.



Photograph 4. Wood waste and sparse macroalgae in the survey area

Attachment G-2

Simpson 2005 Log Haul Monitoring Report

TECHNICAL MEMORANDUM

To: Dave McEntee, Simpson Timber Company — April 27, 2005

From: Grette Associates, LLC — File No.: 316.002

Re: Simpson Middle Waterway Log Haul Facility 2005 Survey

Introduction

This Memorandum describes underwater surveys conducted on March 18, 2005, approximately one year after the baseline survey at the above referenced log haul-out facility. The survey was designed to document and characterize bottom conditions relative to wood debris accumulation beneath the facility and the log rafting area. This memorandum also summarizes observations from shoreline surveys at the head of Middle Waterway conducted by biologists on March 18, 2005.

The log haul-out facility is located on the east[1] side of the mouth of the Middle Waterway, and consists of a ramp and rails extending from the waterway to the base of the haul road, and a 300-ft long float north of the ramp and parallel to the shoreline (Figure 1). A gangway spans from the shoreline to the float. The float is fixed to several steel piles and is the eastern extent of the log rafting area. A line of piles runs parallel to and 6 ft waterward of the float; the piles are spaced approximately 40 ft apart and extend 300 ft north beyond the end of the float (Figure 1). Immediately south of the log ramp there is a line of four piles extending perpendicular to shore that mark the southern extent of the facility.

Field Methods

Field activities consisted of debris characterization surveys along underwater (SCUBA) transects parallel to the shore/log raft spaced at 20-ft intervals, and a photo survey at the head of the waterway. For the SCUBA transects, a measuring tape was extended perpendicular to shore along the axis of the four southern piles to mark the southern end of the diver transects. Transect endpoints were located by finding previously installed steel reinforced bar (rebar) stakes, painted orange and flagged with orange and yellow survey tape. Transects were approximately 875 ft in length. Divers recorded general conditions along each transect, including type and amount of wood or other debris, substrate type, and vegetation (see attached data sheets).

For the photo survey, a biologist walked the head of Middle Waterway during low water. Photos were taken of the extent of wood debris at the head of the waterway to document wood accumulation in that area.

Survey Observations

Survey conditions on March 18 were satisfactory (Photo 1). Visibility on Transects 2 and 3 (below the float and log raft) was reduced compared to those closer to the center of the waterway due to a diminished availability of ambient light.

---

[1] Cardinal directions refer to project N, S, E, and W, with the N/S axis parallel to the float and shoreline. The northward compass bearing for transects was 30° west of north.

Underwater Surveys

Wood debris was observed along the southern half of all five transects. Generally, wood debris decreased away from shore, with more wood within the log lift area. Where present, wood debris was composed primarily of submerged logs and bark sheets.

Debris along Transect 1 was sparse except in two areas. From 10 to 55 ft, debris cover was 100% and in some areas exceeded 18 inches (in) depth (Photo 2). There was sparse debris (<5%) under the gangplank, and no debris between 90 and 380 ft, except for two 15-in diameter logs at 340 ft (Photo 3). The mud substrate at the north end of the transect was largely free of wood debris (Photo 4), except from 380 to 420 ft where divers observed dense wood debris in the form of 2-in by 24-in bark sheets. The remainder of the 875 foot transect had no wood debris.

Debris at the start of Transect 2 was light, less than 10% cover. However, within the log lift area (from 30 to 94 ft) logs and bark debris were encountered, with bark debris approximately 20-in thick. The density of debris began to decrease at 94 ft, with less than 20% cover at 195 ft, sparse cover (<5%) at 360 ft, and no debris at 420 ft. Divers observed 20-in diameter logs on the substrate at 130 and 165 ft. The exposed substrate was composed of riprap for the length of the transect, with some areas of scatted, single layer wood debris on top (Photo 5). The remainder of the 875 foot transect had no wood debris. Logs were again piled at the base of the log lift (Photo 6), from the start of Transect 3 to 80 ft. Between 80 and 120 ft, logs and debris were almost continuous and less than 3-in deep. Between 120 to 300 ft, debris accumulations appeared to decrease from 25% to sparse cover. Debris increased again to 20% cover from 300-380 ft, but no debris was observed beyond 380 ft, except for a 22-in diameter log at 430 ft. The exposed substrate was riprap from 0 to 490 ft, and mud substrate from 490-600 ft.

The riprap substrate at the start of Transect 4 had sparse wood debris (<5%), however at 5 ft along the transect tape and within the log lift area, heavy dense bark debris and 12 to 18-in diameter logs were observed, with denser debris toward shore. By 125 ft, bark debris was smaller and less dense, and fewer logs were observed. Along the toe of the shoreline slope, the substrate changed from riprap to mud and divers observed several 2 to 18-in diameter logs. At 215 ft, debris coverage was approximately 30%, decreasing to 15% at 280 ft, and 5% at 325 ft. Substrate composition returned to riprap at 240 ft. At 330 ft, a 10 to 12-in diameter log was encountered. The remainder of the 875 foot transect had no wood debris.

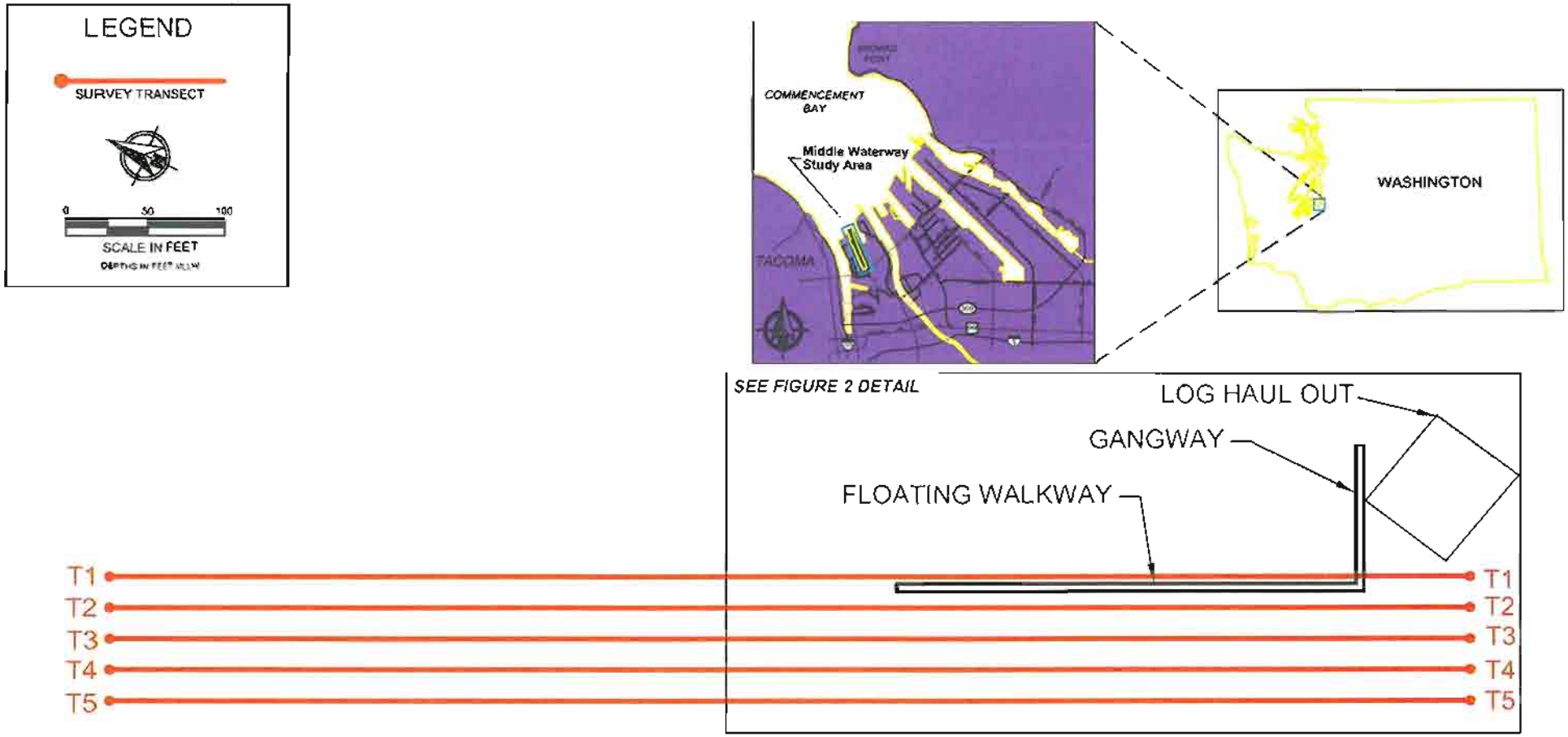
Very little debris was observed on Transect 5. From 0 to 30 ft, divers observed few logs and debris less than 6 in deep. From 30 to 50 ft, wood debris was 12 to 18 in deep and included scattered logs. From 80 to 100 ft, debris was composed of bark sheets. At 150 ft, the density of wood debris decreased to 70% cover and 3.5 in deep. Beyond 200 ft, wood debris on the riprap and mud substrate quickly decreased from 20% to 0% cover.

Baseline survey results indicated that maximum deposition of wood debris was approximately 2 ft deep in an area 20 ft long by 10 ft wide on Transect 2, and areas of bark up to 2 ft wide by 4 4 ft long were present but not common on Transects 1 to 3. Current survey results indicated that maximum accumulation depth did not change, but overall debris accumulations were deeper and more widely distributed than during baseline surveys. For example, heavy wood debris was

observed near the start of both Transects 4 and 5; debris accumulation on these transects had previously been described as sparse. Although debris was more widely distributed, the pattern of deposition remained the same; that is, debris accumulation in both baseline and current surveys was concentrated in the log lift area and the area at the end of the float on Transect 1.

Head of Middle Waterway Photo Survey

Sparse wood debris was observed over most of the exposed tide flats on March 18. Debris was generally composed of wood chips, bark sheets, and small branches (Photo 45). The debris was occasionally buried in the mud substrate, as were several decaying pile in the middle of the tide flat (Photo 39). Some large logs were observed along the high water line (e.g., Photo 29 and Photo 38), including fixed restoration area habitat features. Patches of heavier debris accumulation were observed in high water areas along the eastern bank of the Waterway (Photo 54) above the goose exclusion grids and marsh plantings. However, these structures did not necessarily appear to trap the debris. Additional photos from this area are included in the attached CD.

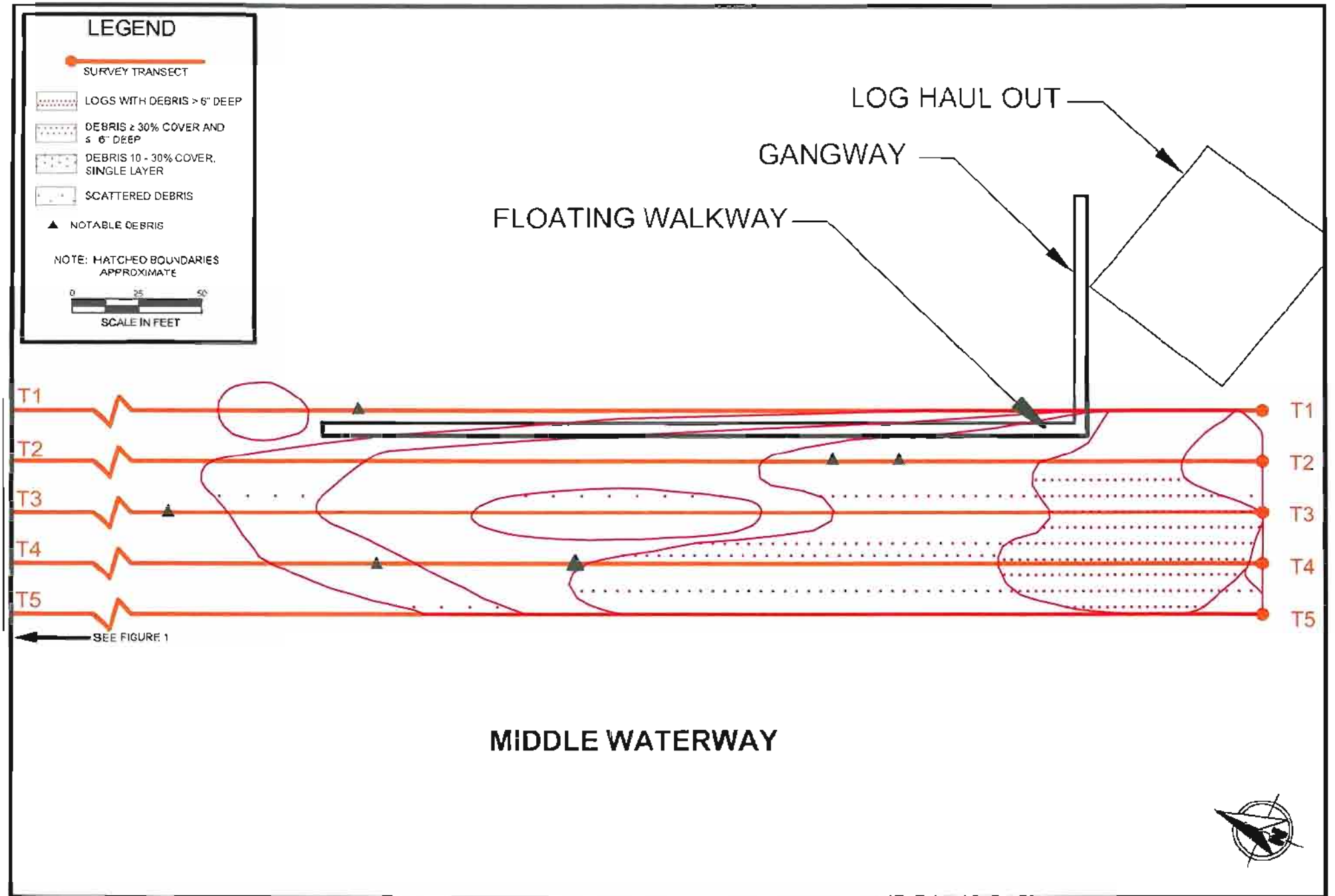


MIDDLE WATERWAY

SIMPSON TACOMA LAND CO.
SIMPSON MIDDLE WATERWAY
LOG HAUL FACILITY

GRETTE ASSOCIATES, LLC

FIGURE 1
SURVEY TRANSECT LOCATIONS
APRIL 2005



SIMPSON TACOMA LAND CO.
SIMPSON MIDDLE WATERWAY
LOG HAUL FACILITY

GRETTE ASSOCIATES, LLC

FIGURE 2
DEBRIS DISTRIBUTION
APRIL 2005

Photo 1. Simpson Log Haul-Out area on March 18, 2005 (looking south).

Photo 2. Bark sheets south of gangplank on Transect 1.

Photo 3. Submerged logs on Transect 1.

Photo 4. Gravel and mud substrate at north end of Transect 1.

Photo 5 Sparse, single layer wood debris over riprap substrate.

Photo 6 Submerged logs in Log Lift Area.

Photo 29. Logs and sparse wood debris on the flats of Middle Waterway, facing north.

Photo 38. Sparse wood debris on the flats of Middle Waterway facing east.

Photo 39. Wood pile in the middle of tide flat at Middle Waterway.

Photo 45. Sparse debris at head of Middle Waterway. Debris types observed were wood chips, bark sheets, and small branches.

Photo 54. Denser debris accumulations at slope toe along east side of Middle Waterway.