Final
20 November 2015

Fourth Five-Year Review

Naval Base Kitsap
Keyport, Washington

Department of the Navy
Naval Facilities Engineering Command Northwest
1101 Tautog Circle
Silverdale, WA 98315

EXECUTIVE SUMMARY

As lead agency for environmental cleanup of Naval Base Kitsap (NBK) Keyport, Washington, the U.S. Navy has completed the fourth 5-year review of the remedial actions at Operable Unit (OU) 1 and OU 2 conducted pursuant to Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act and the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations Part 300). The purpose of this 5-year review is to ensure that the remedial actions selected in the Records of Decision (ROD) for OU 1 and OU 2 and the remedy instituted at Site 23 during the post-ROD removal action at NBK Keyport remain protective of human health and the environment. A 5-year review is required for this site because contaminants remain in place above concentrations that would allow unlimited site use and unrestricted exposure. This fourth 5-year review was prepared in accordance with U.S. Department of Defense, U.S. Navy, and U.S. Environmental Protection Agency (EPA) guidance.

The Navy has fully implemented the remedies at OUs 1 and 2 in accordance with the RODs, and the remedies have been operating for 15 years at OU 1 and 20 years at OU 2. The components of the remedies for OUs 1 and 2 are functioning as intended by the RODs. Some concerns have been identified as a result of this fourth 5-year review and this report identifies issues and follow-up recommendations that address potential problems and uncertainties. The Navy has fully implemented the removal action at Site 23, and institutional controls are in place at this site and monitored regularly.

Chemical of concern (COC) concentration trends at both OUs 1 and 2 are tracked and evaluated through regular monitoring. Overall COC concentrations are trending downward or stable, and the plume footprints have contracted since the time of the ROD, indicating progress towards meeting remedial action objectives. At OU 2 Area 2 in particular, all COC concentrations are now consistently below the remediation goals (RGs). Natural attenuation processes are functioning to reduce COC concentrations at both OUs 1 and 2, while known exposures are prevented by institutional controls. Sentinel wells are monitored at OU 1 to provide an early warning of any plume migration, which would trigger contingent remedial action. Results from sentinel wells indicate that the COC plume in groundwater at OU 1 is relatively stable. Based on current EPA and Washington State Department of Ecology (Ecology) vapor intrusion guidance, additional investigation is needed at OU 1 east of Bradley Road and OU 2 Area 8 at buildings within 100 feet of trichloroethene (TCE) concentrations of 5 µg/L to assess potential vapor intrusion exposures and address identified data gaps.

At OU 1, phytoremediation at the south plantation has not been as effective as originally anticipated when it was evaluated during remedy selection. COC concentrations along the southern edge of the south phytoremediation plantation remain elevated and consistently exceed the RG at the adjacent surface water station MA12. The ROD stated that "because of the likelihood that residual DNAPLs [dense nonaqueous-phase liquids] are present in the high CAH-[chlorinated aliphatic hydrocarbon] concentration areas of the landfill, the groundwater cleanup time frame may be very long (e.g., decades)." EPA and Ecology have expressed concerns that it will extend beyond their current expectation time frame of 30 to 50 years.

The Navy has taken action on all 10 recommendations from the third 5-year review. Action regarding 7 of the 10 recommendations is complete, and work is continuing into this 5-year review period on the remaining 3 recommendations.

The remedy at OU 1 is protective in the short term. Exposure pathways that could result in unacceptable risks are being controlled and monitored while further information is obtained. The office worker exposures to potential COCs in indoor air at buildings east of Bradley Road are protective in the short term because the mass of contamination is over 100 feet away from the occupied buildings, and most of the buildings are large and well ventilated. Damage to the landfill cap is limited and remains protective. In addition, an investigation of the former landfill to study the feasibility of optimizing the remedial action at the south plantation will be conducted. To ensure future long-term protectiveness, further information will be obtained by implementing Recommendations 2 and 3 presented in Section 8. Recommendation 2 calls for repair of damage to the landfill cap, and Recommendation 3 calls for performing the initial step of the vapor intrusion evaluation, including soil gas sampling adjacent to occupied buildings within 100 feet of monitoring wells with TCE concentrations exceeding 5 μg/L.

The remedy has been implemented and performed as intended by the ROD at Area 2. The remedy implemented at OU 2 Area 2 is protective of human health and the environment because RGs have been met for TCE and risk-based levels (Model Toxics Control Act Method B cleanup level) have been met for cis-1,2-dichloroethene in groundwater, and exposure pathways that could result in unacceptable risks are being controlled and monitored.

The remedy implemented at OU 2 Area 8 is protective in the short term. Exposure pathways that could result in unacceptable risks are being controlled and monitored while further information is obtained. The office worker exposures to potential COCs in indoor air at buildings are protective in the short term because the occupied buildings within 100 feet of the contaminant plume are large and well ventilated. To ensure future long-term protectiveness, further information will be obtained by performing the initial step of the vapor intrusion evaluation, including soil gas sampling adjacent to occupied buildings within 100 feet of monitoring wells with TCE concentrations exceeding 5 μg/L, sampling marine surface water, sediment, and clam tissue to generate new data representative of current COC levels from the intertidal zone, and completing human health and ecological risk assessments (as required by the ROD) on the new data generated.

The remedy implemented at Site 23 is protective. Exposure pathways that could result in unacceptable risks are being controlled and monitored through institutional controls that are inspected regularly.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name (from WasteLAN): Naval Undersea Warfare Engineering Station (4 Waste Areas)		
EPA ID (from WasteLAN): WA1170023419		
Region: 10	**State:** WA	**City/County:** Keyport/Kitsap

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** 6/27/2000 (OU 1)

REVIEW STATUS
Lead agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** United States Navy
Author name (Federal or State Project Manager): Carlotta Cellucci
Author affiliation: Naval Facilities Engineering Command Northwest
Review period: July 2009 – June 2014
Date of site inspection: September 4, 2014
Type of review: Statutory
Review number: 4 (Fourth)
Triggering action date: December 2010
Due date *(five years after triggering action date)*: December 2015

Issues/Recommendations	
OU(s)/Site(s) Without Issues/Recommendations Identified in the Five-Year Review:	
OU 2, Area 2	
Site 23	
Issues and Recommendations Identified in the Five-Year Review:	
OU(s): Sitewide	**Issue Category:** Monitoring
	Issue: Changes to LTM are recommended in this 5-year review report, and the reporting limit for 1,4-dioxane is not low enough to meet the MTCA Method B value of 0.44 µg/L.
	Recommendation: Revise the OU 1 and OU 2 LTM plans in collaboration with EPA, Ecology, and the Suquamish Tribe based on the 5-year review recommendations. Include in the plans the use of a laboratory analytical method that can achieve a reporting limit of 0.4 µg/L for 1,4-dioxane in groundwater to meet the MTCA Method B value of 0.44 µg/L.

Five-Year Review Summary Form (Continued)

<table>
<tr><th>Affect Current Protectiveness</th><th>Affect Future Protectiveness</th><th>Implementing Party</th><th>Oversight Party</th><th>Milestone Date</th></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>Ecology</td><td>12/31/2016</td></tr>
<tr><td rowspan="3">OU(s): Sitewide</td><td colspan="4">Issue Category: Monitoring - Reporting</td></tr>
<tr><td colspan="4">Issue: Ecology requested more rigorous LTM trend graphs for all areas. The use of one value to represent all reporting limits unrealistically biases the trend graphs.</td></tr>
<tr><td colspan="4">Recommendation: LTM trend graphs will be completed according to Ecology's guidance on remediation by natural attenuation of petroleum-contaminated groundwater. It is recommended that the actual reporting limits are used in the trend graphs, rather than using one value to represent all reporting limits. For those reporting limits that are unrealistically biasing trends, it is recommended that the nondetected result be removed in consultation with Ecology.</td></tr>
<tr><th>Affect Current Protectiveness</th><th>Affect Future Protectiveness</th><th>Implementing Party</th><th>Oversight Party</th><th>Milestone Date</th></tr>
<tr><td>No</td><td>No</td><td>Federal Facility</td><td>Ecology</td><td>12/31/2016</td></tr>
<tr><td rowspan="3">OU(s): 1</td><td colspan="4">Issue Category: Operations and maintenance</td></tr>
<tr><td colspan="4">Issue: Several deficiencies in the landfill cover were identified.</td></tr>
<tr><td colspan="4">Recommendation: Perform landfill cover repairs. Ensure that future institutional control inspections of the landfill are comprehensive.</td></tr>
<tr><th>Affect Current Protectiveness</th><th>Affect Future Protectiveness</th><th>Implementing Party</th><th>Oversight Party</th><th>Milestone Date</th></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>Ecology</td><td>12/31/2018</td></tr>
<tr><td rowspan="3">OU(s): 1</td><td colspan="4">Issue Category: Changed site conditions – ROD assumptions regarding exposure</td></tr>
<tr><td colspan="4">Issue: Evaluation against current vapor intrusion guidance has identified potential data gaps regarding worker exposure to potential VOCs in indoor air at facility buildings near OU 1 Area 1.</td></tr>
<tr><td colspan="4">Recommendation: Perform the initial step of a vapor intrusion evaluation, including soil gas sampling adjacent to occupied buildings within 100 feet of groundwater wells exhibiting TCE concentrations exceeding 5 µg/L.</td></tr>
<tr><th>Affect Current Protectiveness</th><th>Affect Future Protectiveness</th><th>Implementing Party</th><th>Oversight Party</th><th>Milestone Date</th></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>Ecology</td><td>12/31/2018</td></tr>
<tr><td rowspan="2">OU(s): 1</td><td colspan="4">Issue Category: Changed site conditions – Remedy performance</td></tr>
<tr><td colspan="4">Issue: Phytoremediation at OU 1 is not as effective at the south plantation as expected by regulators and stakeholders. The ROD requirements are being met, conditions are not worse than at the time of the ROD, and the ROD found that conditions at that time were protective. However, the restoration time frame selected in the ROD exceeds Ecology and EPA's current expectations of 30 to 50 years and surface water ARARs at station MA12 are consistently exceeded.</td></tr>
</table>

Five-Year Review Summary Form (Continued)

	Recommendation: a. Continue additional investigation to refine the conceptual site model regarding contaminant distribution at the south plantation and around well MW1-17. b. Clarify remedial action objectives as intended by the ROD, including the surface water remediation goals and points of compliance for marsh water. c. Evaluate the feasibility of optimizing the remedial action at the south plantation to shorten the restoration time frame.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	Ecology	12/31/2018
OU(s): 1	**Issue Category:** Monitoring			
	Issue: PCB data from seep SP1-1, and in sediment at two stations, imply that PCB concentrations may be increasing.			
	Recommendation: Collect additional sediment samples at and in the vicinity of seep SP1-1 during the Phase II investigation and use the data to assess whether expanded, ongoing PCB monitoring should be initiated and risk assumptions reviewed.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	Ecology	12/31/2016
OU(s): 2 **Area 8**	**Issue Category:** Changed site conditions – ROD assumptions regarding exposure			
	Issue: Evaluation against current vapor intrusion guidance has identified potential data gaps regarding worker exposure to potential VOCs in indoor air at facility buildings.			
	Recommendation: Perform the initial step of a vapor intrusion evaluation, including soil gas sampling adjacent to occupied buildings within 100 feet of groundwater wells exhibiting TCE concentrations exceeding 5 µg/L.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	Ecology	12/31/2018
OU(s): 2 **Area 8**	**Issue Category:** Changed site conditions – remedy performance			
	Issue: The human health and ecological risk assessments for intertidal sediment required by the ROD have been completed. However, the risk assessments were not approved by regulators and stakeholders.			
	Recommendation: In conjunction with EPA, Ecology, and the Suquamish Tribe, collect necessary data and complete the human health and ecological risk assessments for intertidal sediment. Assess the need to implement contingent groundwater control actions based on the results of the risk assessments.			

Five-Year Review Summary Form (Continued)

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Federal Facility	Ecology	12/31/2017

Protectiveness Statement(s)

Operable Unit: 1 — *Protectiveness Determination:* Protective in the short term — *Addendum Due Date:* N/A

Protectiveness Statement: The remedy at OU 1 is protective in the short term. Exposure pathways that could result in unacceptable risks are being controlled and monitored while further information is obtained. The office worker exposures to potential COCs in indoor air at buildings east of Bradley Road are protective in the short term because the mass of contamination is over 100 feet away from the occupied buildings, and most of the buildings are large and well ventilated. Damage to the landfill cap is limited and remains protective. In addition, an investigation of the former landfill to study the feasibility of optimizing the remedial action at the south plantation will be conducted. To ensure future long-term protectiveness, further information will be obtained by implementing Recommendations 2 and 3 presented in Section 8. Recommendation 2 calls for repair of damage to the landfill cap, and Recommendation 3 calls for performing the initial step of the vapor intrusion evaluation, including soil gas sampling adjacent to occupied buildings within 100 feet of monitoring wells with TCE concentrations exceeding 5 µg/L.

Operable Unit: 2 — *Protectiveness Determination:* Protective in the short term — *Addendum Due Date:* N/A

Protectiveness Statement: The remedy at OU 2 is protective in the short term.

The remedy has been implemented and performed as intended by the ROD at Area 2. The remedy implemented at OU 2 Area 2 is protective of human health and the environment because RGs have been met for TCE and risk-based levels (MTCA Method B cleanup level) have been met for cis-1,2-DCE in groundwater, and exposure pathways that could result in unacceptable risks are being controlled and monitored.

The remedy implemented at OU 2 Area 8 is protective in the short term. Exposure pathways that could result in unacceptable risks are being controlled and monitored while further information is obtained. The office worker exposures to potential COCs in indoor air at buildings are protective in the short term because the occupied buildings within 100 feet of the contaminant plume are large and well ventilated. To ensure future long-term protectiveness, further information will be obtained by performing the initial step of the vapor intrusion evaluation, including soil gas sampling adjacent to occupied buildings within 100 feet of monitoring wells with TCE concentrations exceeding 5 µg/L, sampling marine surface water, sediment, and clam tissue to generate new data representative of current COC levels from the intertidal zone, and completing human health and ecological risk assessments (as required by the ROD) on the new data generated.

Sitewide Protectiveness Statement (if applicable)

Protectiveness Determination: Protective in the short term — *Addendum Due Date: N/A*

Protectiveness Statement:
The overall sitewide remedies are protective in the short term. Exposure pathways that could result in unacceptable risks are being controlled and monitored while further information is obtained. To ensure future long-term protectiveness, further information will be obtained at OU 1 and OU 2 Area 8.

Signature sheet for the Naval Base Kitsap Keyport fourth five-year review report.

______________________________ ______________________________

T. Zwolfer
Captain, U.S. Navy
Commanding Officer, Naval Base Kitsap

Date

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

APPENDICES

CONTENTS (Continued)

FIGURES

CONTENTS (Continued)

TABLES

ABBREVIATIONS AND ACRONYMS

ARAR	applicable or relevant and appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	ambient water quality criteria
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
COC	chemical of concern
COI	chemical of interest
CRA	contingent remedial action
CSM	conceptual site model
CVOC	chlorinated volatile organic compound
DCA	dichloroethane
DCE	dichloroethene
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
FS	feasibility study
g/day	gram per day
Health District	Kitsap County Health District
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IC	institutional control
kg	kilogram
LTM	long-term monitoring
MCL	maximum contaminant level
µg/kg	microgram per kilogram
µg/L	microgram per liter
$\mu g/m^3$	microgram per cubic meter
mg/kg	milligram per kilogram
mg/L	milligram per liter
MLLW	mean lower low water
MTCA	Model Toxics Control Act
MW	monitoring well
Navy	U.S. Navy
NAVFAC NW	Naval Facilities Engineering Command Northwest

ABBREVIATIONS AND ACRONYMS (Continued)

NBK	Naval Base Kitsap
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	operation and maintenance
OM&M	operation, maintenance, and monitoring
OU	operable unit
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PHA	public health assessment
ppm	parts per million
PQL	practical quantitation limit
PUD	Public District Utility (Kitsap County)
RAB	Restoration Advisory Board
RAO	remedial action objective
redox	oxidation reduction
RG	remediation goal
RI	remedial investigation
ROD	Record of Decision
SAP	sampling and analysis plan
SIM	selected ion monitoring
SMS	sediment management standards
SQS	sediment quality standard
SVOC	semivolatile organic compound
TCA	trichloroethane
TCE	trichloroethene
TLV	threshold limit value
TPH	total petroleum hydrocarbons
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compound
WAC	Washington Administrative Code

1.0 INTRODUCTION

This report presents the results of the fourth 5-year review performed for the Naval Base Kitsap (NBK) Keyport National Priorities List site (Figure 1-1). The purpose of a 5-year review is to determine whether the remedies selected for implementation in the Record of Decision (ROD) for a site are protective of human health and the environment. The methods, findings, and conclusions of 5-year reviews are documented in 5-year review reports, which identify any issues found during the review and provide recommendations to address them.

The U.S. Navy (Navy), the lead agency for cleanup at NBK Keyport, prepared this 5-year review report pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] Part 300). CERCLA Section 121 states the following:

> If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

The NCP 40 CFR §300.430(f)(4)(ii) states the following:

> If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

The Naval Facilities Engineering Command Northwest (NAVFAC NW) has conducted this 5-year review of the remedial actions implemented at NBK Keyport. The review was initiated in June 2014 using data generated from July 2009 through June 2014.

This is the fourth 5-year review for NBK Keyport. The triggering action for this review was the execution of the third 5-year review by the Navy on December 30, 2010. Contaminants have been left at NBK Keyport above levels that allow for unlimited use and unrestricted exposure.

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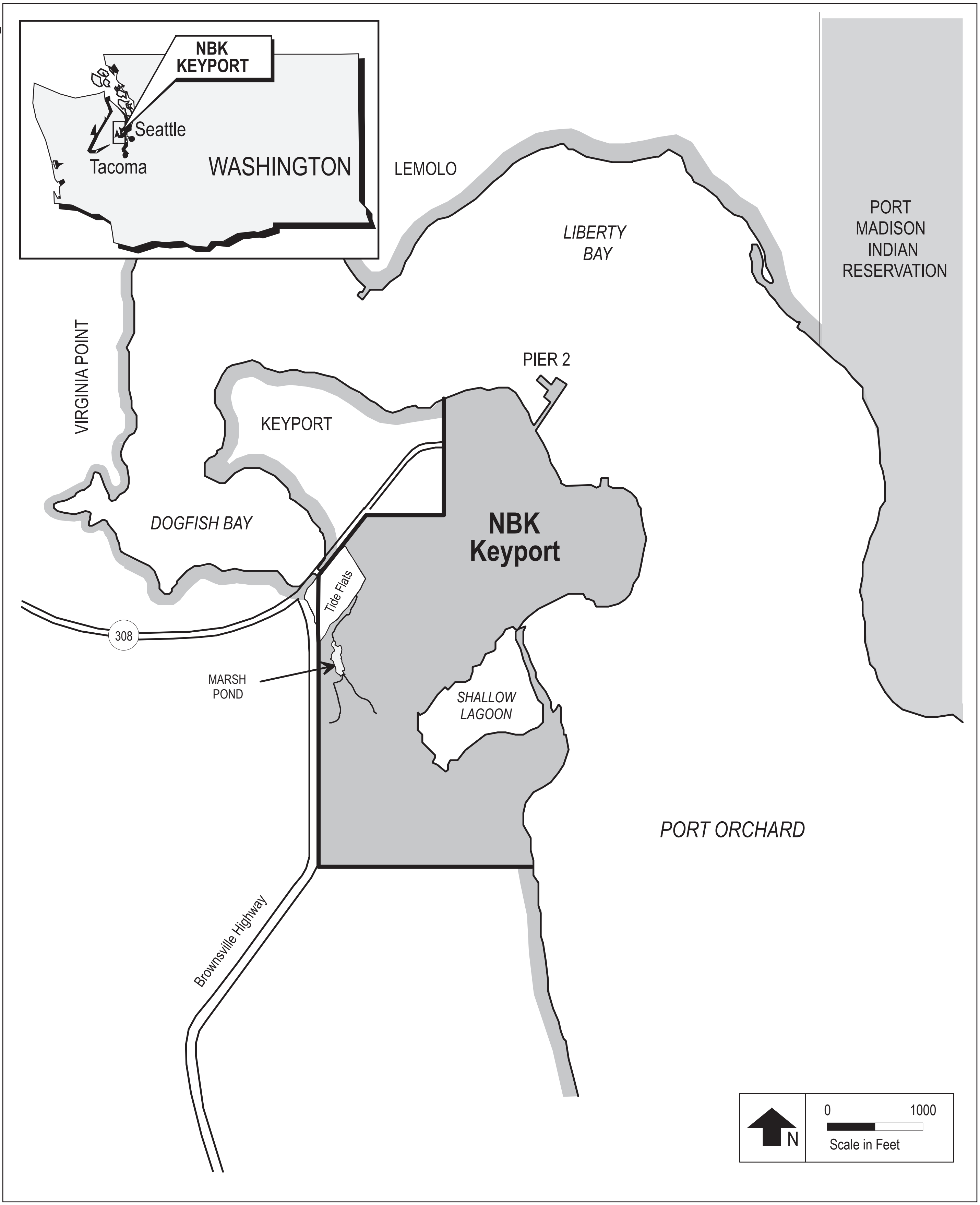

U.S. NAVY

Figure 1-1
Vicinity Map

NBK Keyport
FOURTH
FIVE-YEAR REVIEW

The RODs documenting the remedies implemented at NBK Keyport Operable Unit (OU) 1 and OU 2 were signed after October 17, 1986. Therefore, this is considered a statutory, rather than a policy, review.

This report was prepared as part of the CERCLA 5-year review process using U.S. Department of Defense, Navy, and U.S. Environmental Protection Agency (EPA) guidance (USDoD 2012 and 2014, U.S. Navy 2011b and 2013c, and USEPA 2001, 2012, and 2014a).

This report covers the remedies selected in the signed RODs for OU 1 and OU 2 (U.S. Navy, USEPA, and Ecology 1994 and 1998).

OU 1 consists of Area 1, the former landfill. The remedial action objectives (RAOs) are paraphrased below using summary statements (see the OU 1 ROD for the complete language of the RAOs), and implemented remedial actions for OU 1 were as follows:

- Prevent human exposure to groundwater as drinking water by institutional controls (ICs).
- Reduce volatile organic compound (VOC) concentrations in groundwater by phytoremediation (planting of two plantations).
- Prevent human exposure to landfill vapors by removal of buildings located above the landfill.
- Prevent human exposure to soil and landfill waste by placement of an asphalt cover over the landfill.
- Prevent VOCs in groundwater from entering surface water by upgrading the tide gate.
- Prevent unacceptable risks to humans through ingestion of seafood and aquatic organisms because of sediment exposure by removing from the marsh sediment containing polychlorinated biphenyls (PCBs).

OU 2 consists of the following areas:

- Area 2 – Van Meter Road Spill/Drum Storage Area
- Area 3 – Otto Fuel Leak Area (no further action; not subject to 5-year review)
- Area 5 – Sludge Disposal Area (no further action; not subject to 5-year review)
- Area 8 – Plating Shop Waste/Oil Spill Area
- Area 9 – Liberty Bay (no further action; not subject to 5-year review)

The OU 2 ROD specified that only Areas 2 and 8 are subject to the 5-year review. No further action was selected for Area 3, and confirmation sampling was required at Areas 5 and 9 in the ROD. Because confirmation sampling (U.S. Navy 1996a and 1996b) at both areas indicated contamination did not exceed any of the remediation goals (RGs), no further action was required for Areas 5 and 9. Therefore, Areas 3, 5, and 9 meet unrestricted use cleanup levels and, as such, are not subject to this 5-year review.

The RAOs are paraphrased below using summary statements (see the OU 2 ROD for the complete language of the RAOs) and implemented remedial actions for OU 2 were as follows:

- Area 2:
    - Prevent human health exposures to trichloroethene (TCE) and vinyl chloride in soil and groundwater by pathways such as ingestion of groundwater, inhalation of volatiles while showering, or ingestion of soil or vegetables grown in the soil. ICs were put in place to prevent residential use of the site and potable use of the groundwater.
    - Restore the groundwater to drinking water quality. Groundwater wells were installed to monitor natural attenuation of VOCs to safe drinking water levels.
- Area 8:
    - Prevent human exposure to soil and groundwater as drinking water. Hot spot soil removal was conducted, and ICs were put in place to prevent residential use and potable use of the groundwater.
    - Restore the groundwater to drinking water quality. Groundwater wells were installed to monitor natural attenuation of VOCs and metals to safe drinking water levels.
    - Protect sediment and biota quality offshore of Area 8 in Liberty Bay from contaminants in groundwater that could accumulate over the long term and cause future adverse impacts or human health risks. Conduct long-term monitoring (LTM) of groundwater, seeps, and sediment and tissue in the intertidal zone of Area 8. Assess risks to human health and the environment using the sediment and tissue monitoring data. Implement contingent groundwater control actions if Area 8 groundwater is demonstrated to be a significant source of the chemicals that cause risk in sediments or tissue.

An additional area, Site 23 (located near Area 8), was investigated after the OU 2 ROD was signed and was included in the ICs plan for NBK Keyport, making it subject to the 5-year review process. The risks remaining at the site after completion of a time-critical removal action were demonstrated to be protective of human health and the environment with ICs (U.S. Navy 2000b). The Navy performed the time-critical removal action under CERCLA as a part of the Building 21 demolition under an Action Memorandum signed in July 1999, and results are reported in the first 5-year review (U.S. Navy 2000b).

The Site 23 RAOs are paraphrased below using summary statements (see the Site 23 closure report [U.S. Navy 2000d] for complete language), as follows:

- Reduce the likelihood of migration of any subsurface contaminants in the area of (former) Building 21, thereby reducing the potential risk to human health and the environment.
- Prevent human exposures to COCs in soil and groundwater by pathways such as ingestion of groundwater, inhalation of volatiles while showering, dermal contact with soil, or ingestion of soil.

This document is organized as follows, based on EPA 5-year review guidance (USEPA 2001):

- **Section 1, Introduction**: Purpose, authority, areas included and review status, trigger action, and dates of data reviewed for the current 5-year review
- **Section 2, Site Chronology**: Important site events and relevant dates
- **Section 3, Background**: Site description, land use, history of contamination, initial response, and basis for the remedial action
- **Section 4, Remedial Actions:** RAOs, remedy description, remedy implementation, operations and maintenance, and monitoring
- **Section 5, Progress Since Last Five-Year Review**: Status of recommendations and follow-up actions from the last 5-year review
- **Section 6, Five-Year Review Process**: Review team, community notification and involvement, document review, data review, results of site inspection, and results of interviews

- **Section 7, Technical Assessment**: Functionality of remedy, continued validity of ROD assumptions, new information, technical assessment, identified issues, and current and future protectiveness evaluation
- **Section 8, Recommendations and Follow-up Actions**: Recommended improvements to identified issues and noted schedule, responsible party, and agency with authority
- **Section 9, Certification of Protectiveness**: Protectiveness statement for each OU
- **Section 10, Next Review**: Date of the next 5-year review
- **Section 11, References**: References used in the 5-year review
- **Appendix A, Frequently Referenced Documents**: Frequently referenced documents cited within the 5-year review (provided on CD)
- **Appendix B, Cumulative Data for OU 1 (Area 1) and OU 2 (Areas 2 and 8)**
- **Appendix C, Groundwater Concentrations at OU 1 (Area 1) and OU 2 (Areas 2 and 8)**
- **Appendix D, Trend Graphs for Groundwater Data at OU 1 (Area 1) and OU 2 (Areas 2 and 8)**
- **Appendix E, Site Inspection Checklists**
- **Appendix F, Interview Responses**
- **Appendix G, Navy Response to Ecology's and Suquamish Tribe's Comments on the Draft Report**

2.0 SITE CHRONOLOGY

This section summarizes dates of major events such as the initial discovery of contamination, National Priorities List listing, decision and enforcement documents, remedial and removal actions, construction completion, and prior 5-year reviews for Area 1 at OU 1, Areas 2 and 8 at OU 2, and Site 23 (Figure 2-1). Figure 2-2 illustrates the substantive events in the chronology of NBK Keyport. Additional text is provided in the third 5-year review included in Appendix A, and all 5-year review documents are available on the EPA website http://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=1001102. Post-ROD activities at the site are described in Sections 4 and 6 of this report.

U.S. NAVY

0 400 800
SCALE IN FEET

Figure 2-1
Locations of OU 1, OU 2, and Site 23 Areas

NBK Keyport
FOURTH FIVE-YEAR
REVIEW

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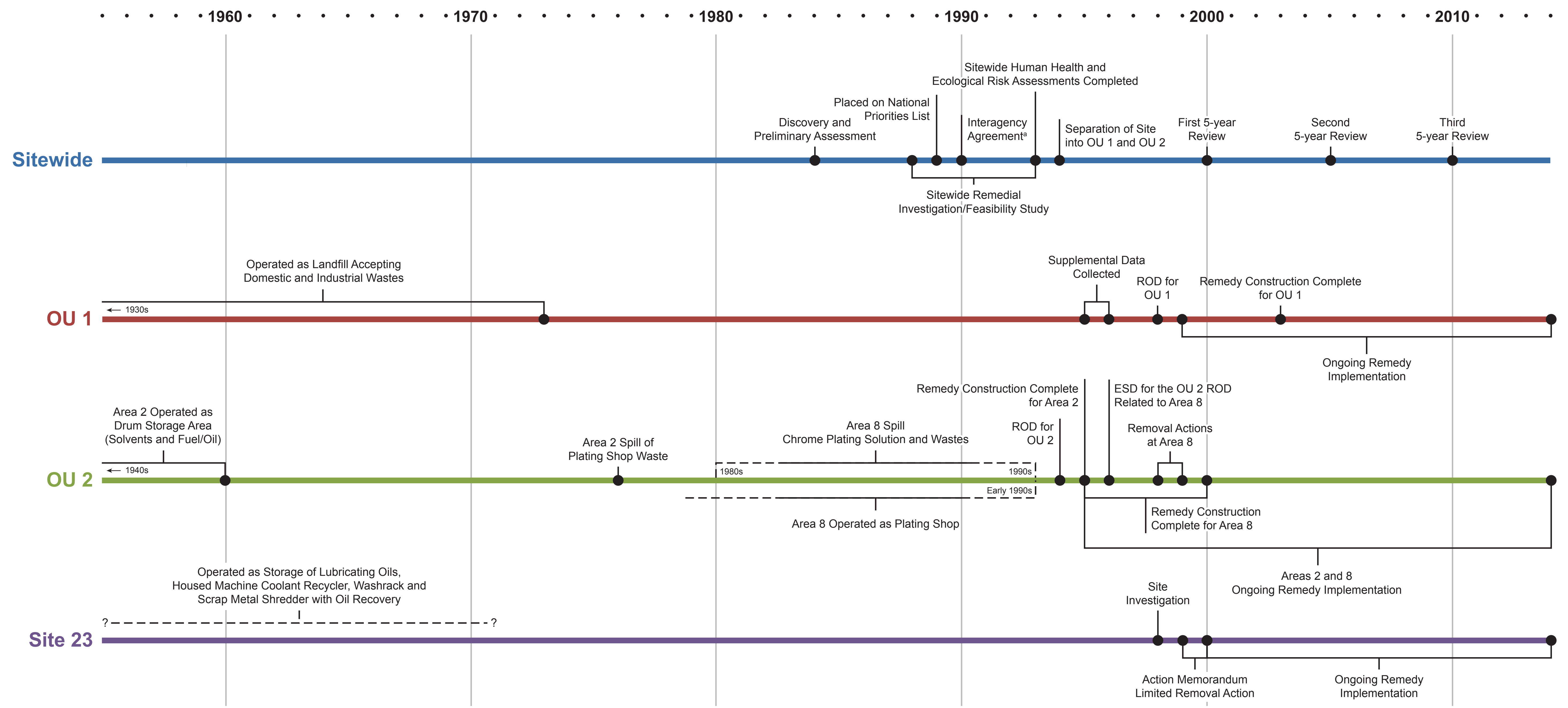

[a] Navy, U.S. Environmental Protection Agency, and Washington State Department of Ecology

Notes:
OU - operable unit
ROD - Record of Decision
ESD - Explanation of Significant Differences

U.S. NAVY

NBK Keyport
FOURTH
FIVE-YEAR REVIEW

Figure 2-2
Chronology of Events at OU 1, OU 2 and Site 23

3.0 BACKGROUND

NBK Keyport occupies 340 acres (including tidelands) adjacent to the town of Keyport in Kitsap County, Washington, on a small peninsula in the central portion of Puget Sound. The Keyport property was acquired by the Navy in 1913, with property acquisition continuing through World War II. The property was first used as a quiet-water range for torpedo testing. The first range facility was located in Port Orchard Inlet southeast of the site.

During the early 1960s, Keyport's role was expanded to include manufacturing and fabrication such as welding, metal plating, carpentry, and sheet metal work. Further expansion in 1966 consisted of a new torpedo shop, and, in 1978, the functions broadened to include various undersea warfare weapons and systems engineering and development activities. Operations currently include engineering, fabrication, assembly, and testing of underwater weapons systems.

NBK Keyport is bordered by Liberty Bay on the east and north and Port Orchard Inlet on the southeast (Figure 1-1). The topography of the site rises gently from the shoreline to an average of 25 to 30 feet above mean sea level and then rises steeply to approximately 130 feet above mean sea level at the southeast corner of the site.

Marine or brackish water bodies on and near the site consist of Liberty Bay, Dogfish Bay, the tide flats, a marsh, and the shallow lagoon. Freshwater bodies include two creeks draining into the marsh pond and two creeks that discharge into the shallow lagoon.

The terrestrial soil in the Keyport area generally includes coarse-grained glacial deposits and finer grained nonglacial deposits. Most of NBK Keyport is underlain by a thick nonglacial silt and clay formation informally known as the Clover Park Unit. This unit is commonly about 100 feet thick and is an aquitard separating the unconfined aquifer above (referred to as the "upper aquifer") and the intermediate aquifer beneath it. The intermediate aquifer and the deep regional drinking water aquifer are separated by a low-permeable interglacial deposit aquitard (U.S. Navy 1993a).

A remedial investigation (RI) (U.S. Navy 1993a) was conducted between 1988 and 1993 and completed in October 1993 for six areas (1, 2, 3, 5, 8 and 9). The baseline human health and ecological risk assessments evaluated risks at these six areas based on the data collected from 1989 through 1992 during the two phases of the RI (U.S. Navy 1993b and1993c). The feasibility study (FS) for these areas was completed in November 1993 (U.S. Navy 1993d). Data gaps were identified upon regulatory review, and further site characterization and data collection were performed in 1995 and 1996 to supplement the RI and satisfy these data gaps.

3.1 OU 1

OU 1 consists of Area 1, the former base landfill, which comprises approximately 9 acres in the western part of the base next to a wetland area and the tide flats that flow into Dogfish Bay (Figure 3-1). Most of the landfill area was formerly part of the wetland that now borders the landfill to the west and south. This wetland area drains northward into the tide flats of Dogfish Bay through a culvert under Keys Road. A tide gate has been installed at this culvert to control tidal inundation of the wetlands and landfill soils. The tide flats are connected to Dogfish Bay by a narrow channel through structural fill material that forms the foundation of the Highway 308 causeway and bridge. Land use is as a military installation, and public access is restricted. Currently the paved central portion of the landfill is used intermittently for motorcycle training and as a parking lot. Remedial monitoring activities are conducted periodically at the two plantations. Adjacent to the former landfill east of Bradley Road are occupied buildings with office space and industrial uses.

Current hydrogeologic conditions result in groundwater flow from both the upper and intermediate aquifers to the adjacent surface water. The groundwater flow direction for the upper aquifer is depicted on Figure 3-2 and the intermediate aquifer on Figure 3-3. The water table underlies Area 1 at an approximate depth of 4 to 10 feet below ground surface (bgs).

The landfill was the primary disposal area for domestic and industrial wastes generated by the base from the 1930s until 1973, when the landfill was closed. A burn pile for trash and demolition debris was located at the north end of the landfill from the 1930s to the 1960s. Unburned or partially burned materials from this pile were buried in the landfill or pushed into the marsh. A trash incinerator was operated at the north end of the landfill from the 1930s to the 1960s, and incinerator ash was disposed of in the landfill. Burning continued at the landfill until the early 1970s. The base of the landfill is unlined and the top is covered with areas of grass, trees, concrete, and asphalt. Data generated to date indicate that the unlined landfill is an ongoing source of groundwater contamination.

The RI/FS process and human health and ecological risk assessments for OU 1 were completed in 1993. A focused FS was completed in 1997 for OU 1 (U.S. Navy 1997a). The additional data collected in 1995 and 1996 to supplement the RI were used to evaluate two new pathways, as summarized in the human health risk section of the ROD. The two pathways evaluated were risks to current and future seafood harvesters in the tide flats and Dogfish Bay and current and future off-site residential domestic use of groundwater from the intermediate aquifer. The following are the key exposure pathways for Area 1:

- Groundwater as drinking water by residents
- Seafood ingestion by visitors, nearby residents, and subsistence users
- Downgradient surface water and sediment impacts to ecological health

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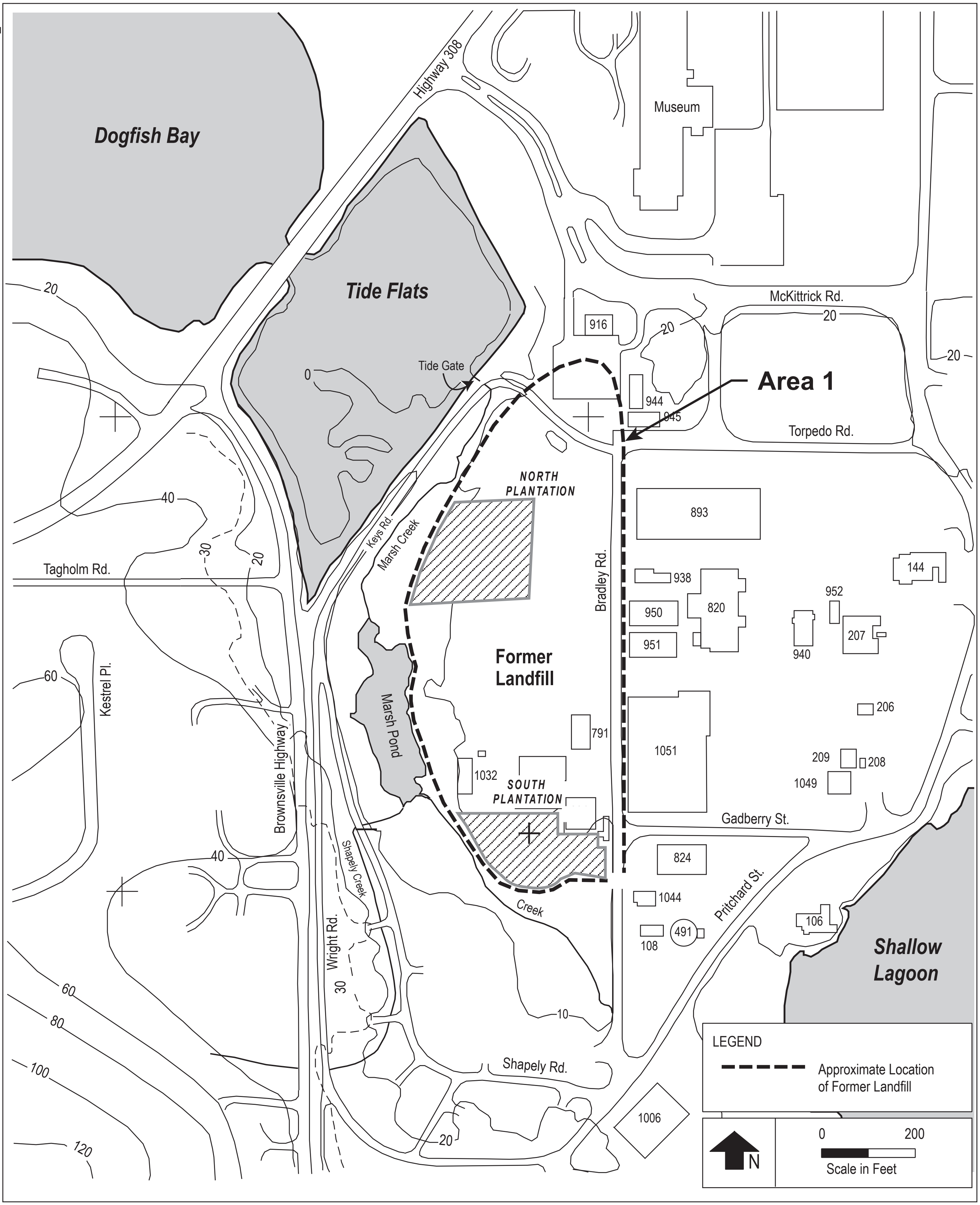

U.S. NAVY

Figure 3-1
OU 1 Site Map

NBK Keyport
FOURTH
FIVE-YEAR REVIEW

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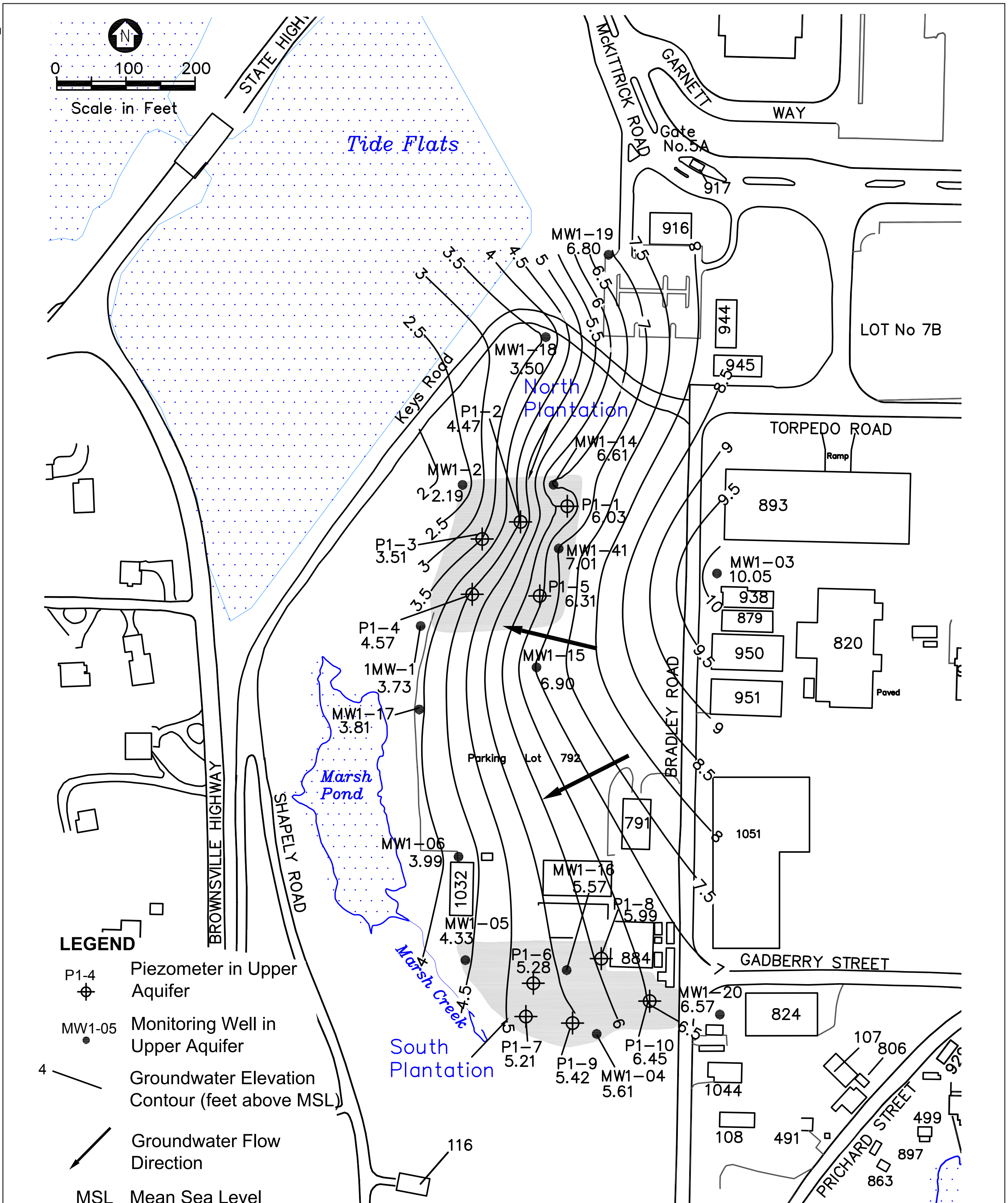
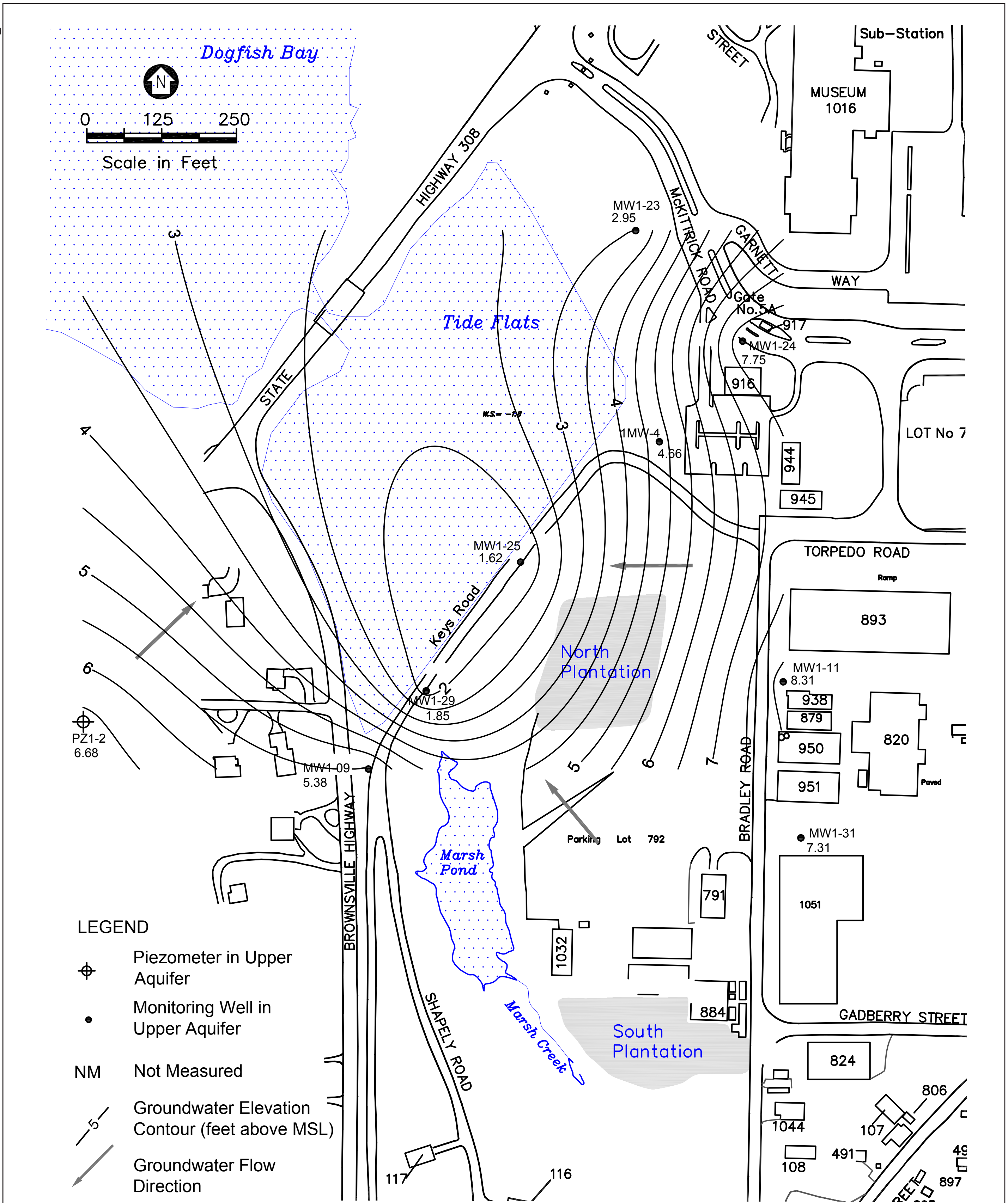


Source: OU 1 LTM Report (U.S. Navy 2014a)

U.S. NAVY	**Figure 3-2** **OU 1 Upper Aquifer Groundwater Contours**	NBK Keyport FOURTH FIVE-YEAR REVIEW



Source: OU 1 LTM Report (U.S. Navy 2014a)

U.S. NAVY

Figure 3-3
OU 1 Intermediate Aquifer Groundwater Contours

NBK Keyport
FOURTH
FIVE-YEAR REVIEW

Based on unacceptable risks because of these pathways, two classes of contaminants were identified as chemicals of concern (COCs) for Area 1: chlorinated aliphatic hydrocarbons (a class of VOCs) and PCBs. The VOCs were identified as COCs because of the drinking water and seafood ingestion pathways and PCBs because of their potential to bioaccumulate, possibly impacting the seafood ingestion pathway. Other pathways evaluated in the risk assessment include worker exposure to vapors from landfill gas and exposure to landfill soil. Risk estimates indicated that direct exposure to the COCs within the landfill could cause human health risk above acceptable risk levels.

Figure 3-4 is the conceptual site model (CSM) for OU 1, and it summarizes all the human health pathways evaluated at the time of the ROD. Additional detail regarding OU 1 Area 1 can be found in the third 5-year review included in Appendix A.

3.2 OU 2

The backgrounds for Areas 2, Van Meter Road Spill/Drum Storage Area, and Area 8, Plating Shop Waste/Oil Spill Area are discussed below. Additional detail regarding OU 2 can be found in the third 5-year review included in Appendix A.

3.2.1 Area 2 – Van Meter Road Spill/Drum Storage Area

Area 2 is located in the southwest corner of NBK Keyport (Figure 2-1). It is bounded to the north and east by Westfall Road, to the west by Keys Road, and to the south by a sharp topographic rise. Van Meter Road essentially bisects the area in a north-south direction. Area 2 is composed of three distinct sites: the Van Meter Road spill area, the former Building 734 drum storage area just west of Van Meter Road, and former Building 957 drum storage area immediately east of Van Meter Road (Figure 3-5). Land use is as a military installation, and public access is restricted. Currently the site is used for inert materials storage and intermittently for industrial purposes.

The groundwater flow direction for the upper aquifer is depicted on Figure 3-6. The water table underlies Area 2 at a depth of approximately 4 to 8 feet bgs. The hydrology of the intermediate aquifer has not been well defined in Area 2.

Two unpaved areas associated with the two drum storage areas were active from the 1940s through the 1960s. These two areas were reportedly used to store all chemicals (including solvents and fuel/oil) used at NBK Keyport during this time period. In 1976, approximately 2,000 to 5,000 gallons of plating shop wastes spilled from a tanker truck on the pavement near Van Meter Road and impacted a nearby stream (U.S. Navy 1984). It was also estimated that between 4,000 and 8,000 gallons of these chemicals were discharged to the two unpaved areas as a result of spills and leaks (U.S. Navy 1984).

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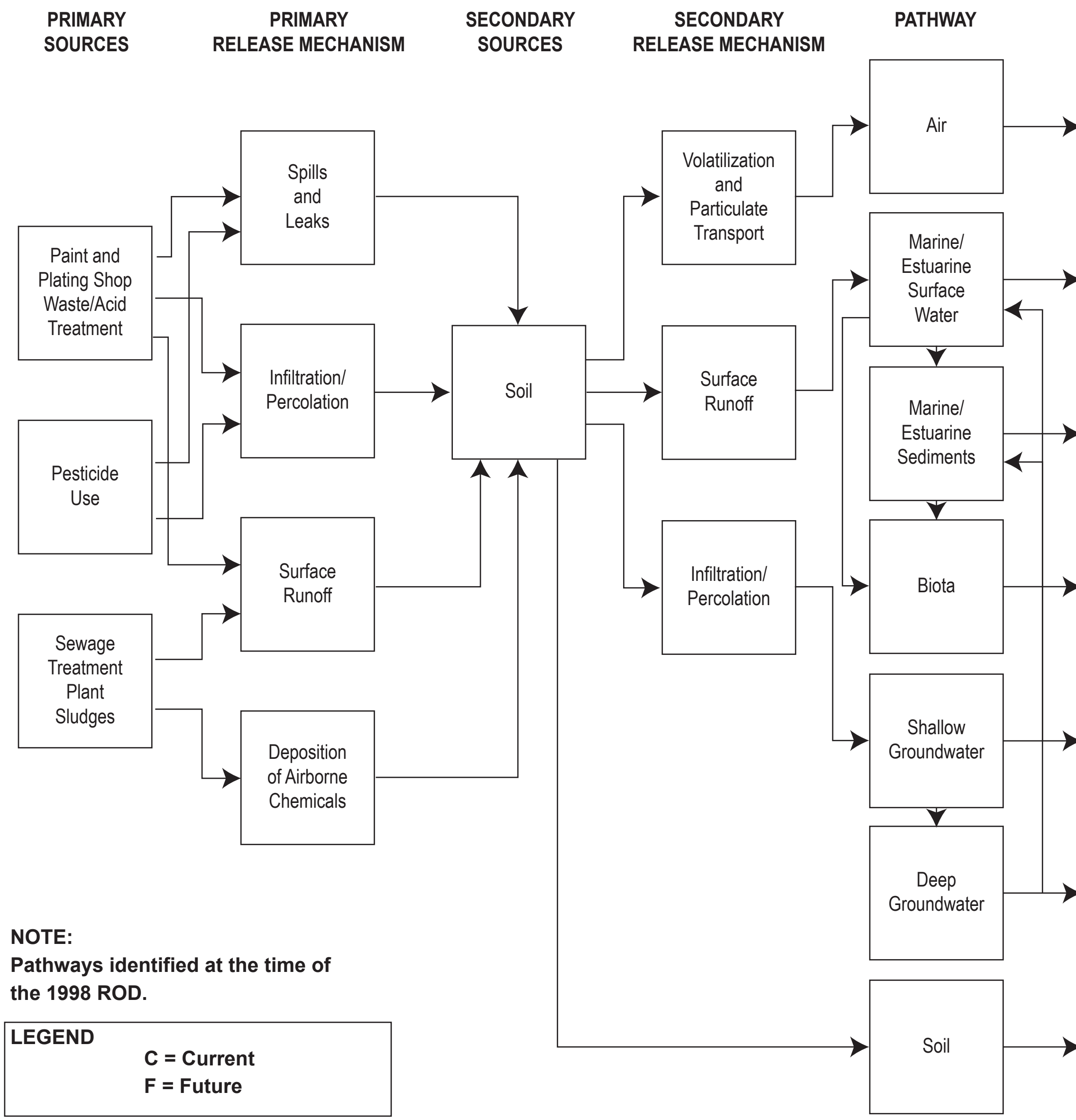


Pathway	EXPOSURE ROUTE	WORKERS	VISITORS	NEARBY RESIDENTS	SUBSISTENCE USERS
Air	Inhalation	C,F	—	—	—
Marine/Estuarine Surface Water	Ingestion	—	C,F	C,F	—
	Dermal Contact	—	C,F	C,F	—
Marine/Estuarine Sediments	Ingestion	—	C,F	C,F	—
	Dermal Contact	—	C,F	C,F	—
Biota	Ingestion	—	C,F	C,F	C,F
Shallow Groundwater	Ingestion	—	—	F	—
	Inhalation	—	—	F	—
	Dermal Contact	—	—	—	—
Deep Groundwater	Ingestion	—	—	F	—
	Inhalation	—	—	F	—
	Dermal Contact	—	—	—	—
Soil	Ingestion	C,F	—	—	—
	Dermal Contact	C,F	—	—	—

(RECEPTORS: WORKERS, VISITORS, NEARBY RESIDENTS, SUBSISTENCE USERS)

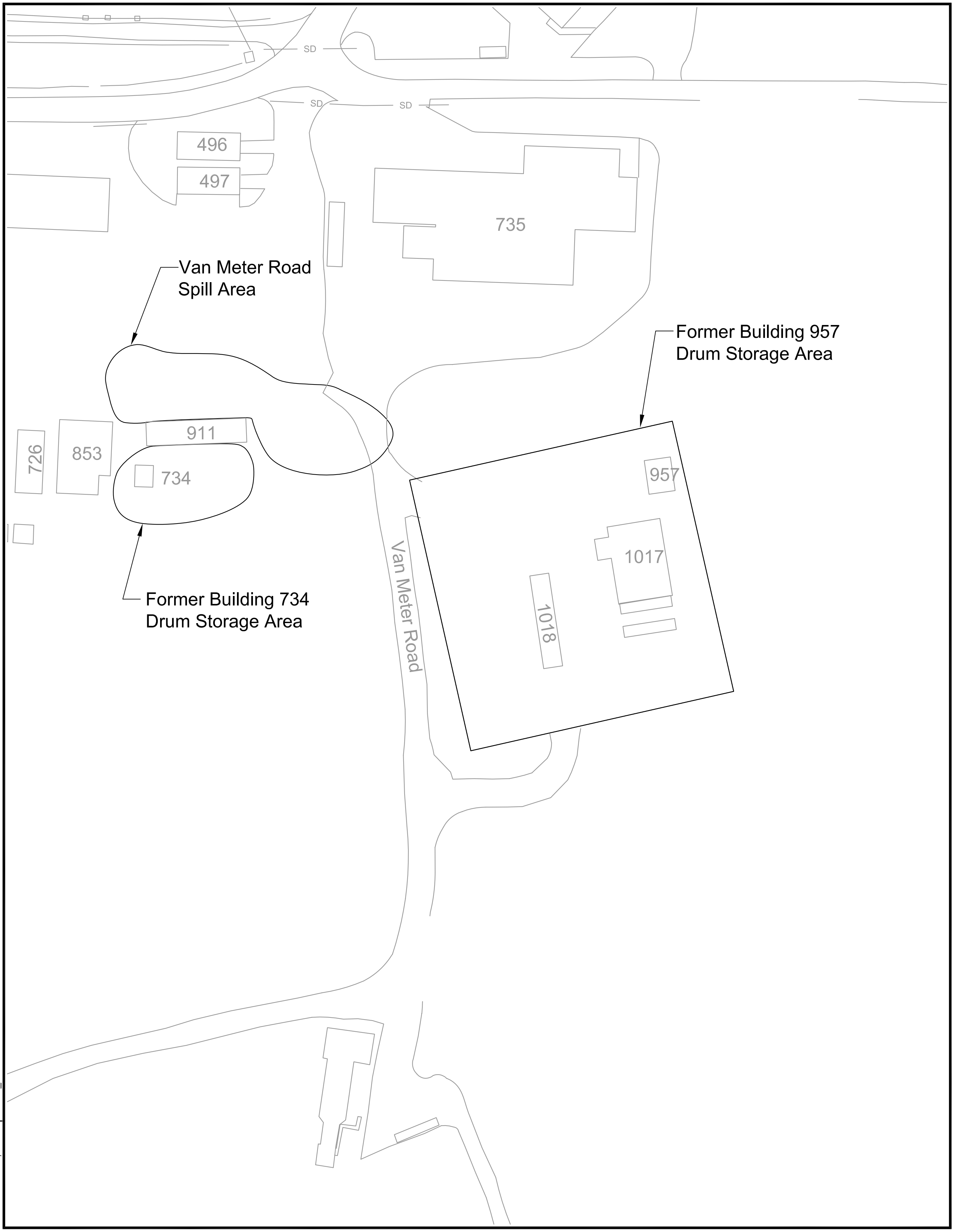
NOTE:
Pathways identified at the time of the 1998 ROD.

LEGEND
C = Current
F = Future

U.S. NAVY

Figure 3-4
OU 1 ROD Conceptual Site Model

NBK Keyport
FOURTH
FIVE-YEAR REVIEW



U.S. NAVY

0 50 100
SCALE IN FEET

Figure 3-5
OU 2 Area 2

NBK Keyport
FOURTH FIVE-YEAR
REVIEW

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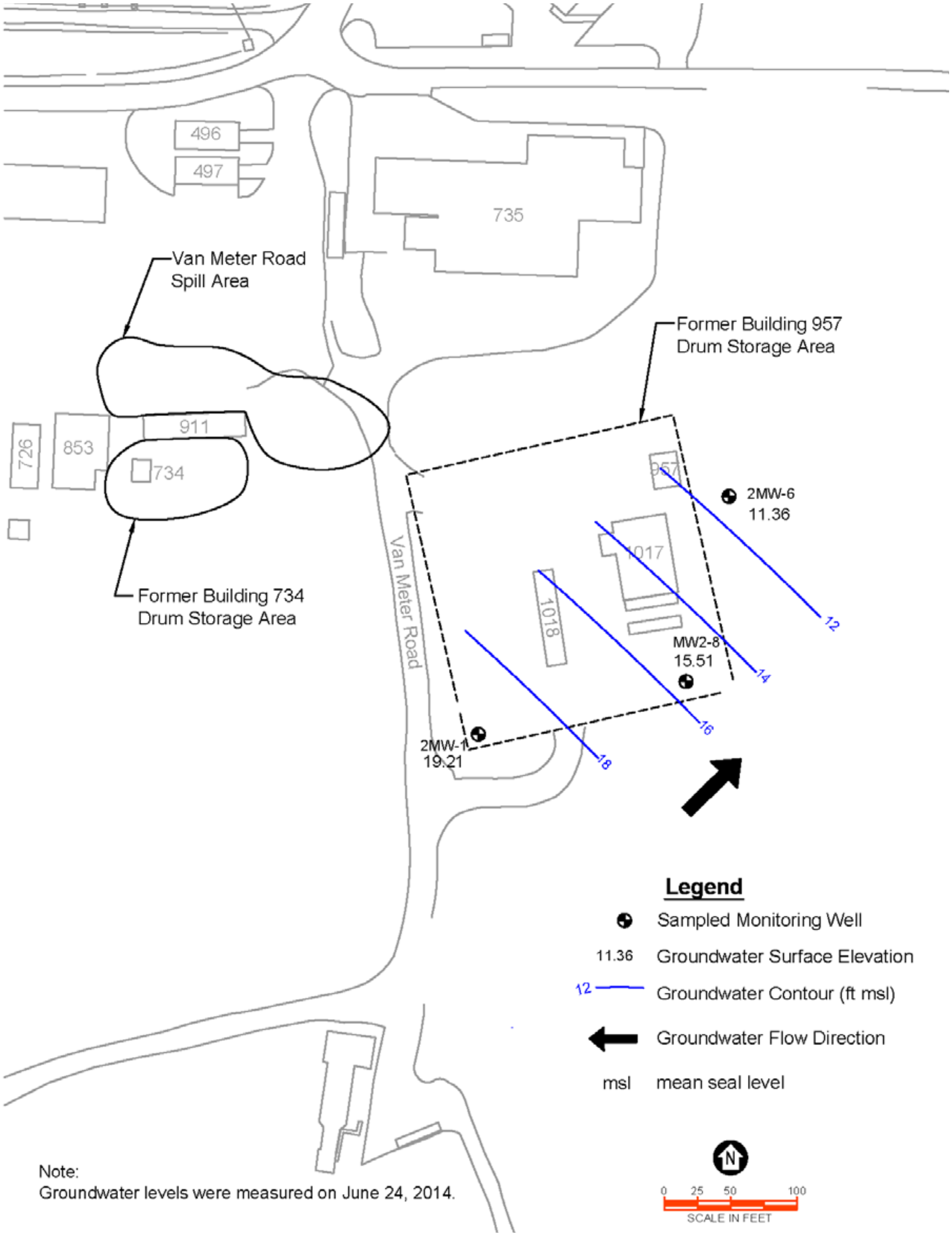

Source: Area 2 LTM Report (U.S. Navy 2014c)

U.S. NAVY	**Figure 3-6** OU 2 Area 2 Upper Aquifer Groundwater Contours	NBK Keyport FOURTH FIVE-YEAR REVIEW

The RI/FS process and human health and ecological risk assessments for OU 2, Area 2 were completed in 1993. The ecological risk assessment did not identify any significant risk to terrestrial or aquatic organisms at any of the three sites at Area 2. For the drum storage areas, human health risks were identified for the hypothetical scenario of future resident exposure to soil and groundwater, but did not identify any significant risk to current workers. TCE and vinyl chloride were identified as the COCs based on the risk analyses. Other chemicals did not present significant additional risk (U.S. Navy, USEPA, and Ecology 1994). No significant human health risk was identified at the Van Meter Road plating shop waste spill.

In summary, no current human health or ecological risk was identified. Future hypothetical residential risks from exposures to soil, groundwater, and produce were the drivers for action at Area 2. The CSM for Area 2 shown on Figure 3-7 summarizes all the human health pathways evaluated at the time of the ROD.

3.2.2 Area 8 – Plating Shop Waste/Oil Spill Area

Area 8 occupies about 1 acre on the eastern portion of NBK Keyport and surrounds the location of the former plating shop (Building 72) (Figures 2-1 and 3-8). Building 72 was demolished in 1999 and replaced by an asphalt-paved parking area. The site is located in a heavily industrialized part of the facility bordered by Liberty Bay to the south and east (Figure 3-8). The area is predominantly flat and almost entirely paved or covered by buildings. Land use is as a military installation, and public access is restricted. The area is used for parking and has occupied buildings with office space and industrial uses.

The groundwater flow direction for the upper aquifer at Area 8 is depicted on Figure 3-9. The water table underlies Area 8 at a depth of approximately 10 feet bgs. The hydrology of the intermediate aquifer has not been well defined in Area 8.

Past releases at Area 8 include spillage of chrome plating solution containing VOCs onto the ground; discharge of plating wastes into a utility trench; and leakage of plating solutions through cracks in the plating shop floor, waste disposal pipes, and sumps during plating shop operation. Petroleum hydrocarbons (diesel and heavy oil) were also released to the environment from leaky underground storage tanks and underground concrete vaults located within Area 8. Semivolatile organic compounds (SVOCs) associated with the petroleum release were detected in soil at low concentrations below Washington State Model Toxics Control Act (MTCA) Method B cleanup levels based on soil ingestion, protection of drinking water, and protection of surface water.

The RI/FS process and human health and ecological risk assessments for OU 2 Area 8 were completed in 1993. The baseline risk assessment found acceptable human health risks for the current industrial exposure scenario and unacceptable human health risk for the hypothetical future residential scenario. For groundwater, VOCs and metals (arsenic, cadmium, and

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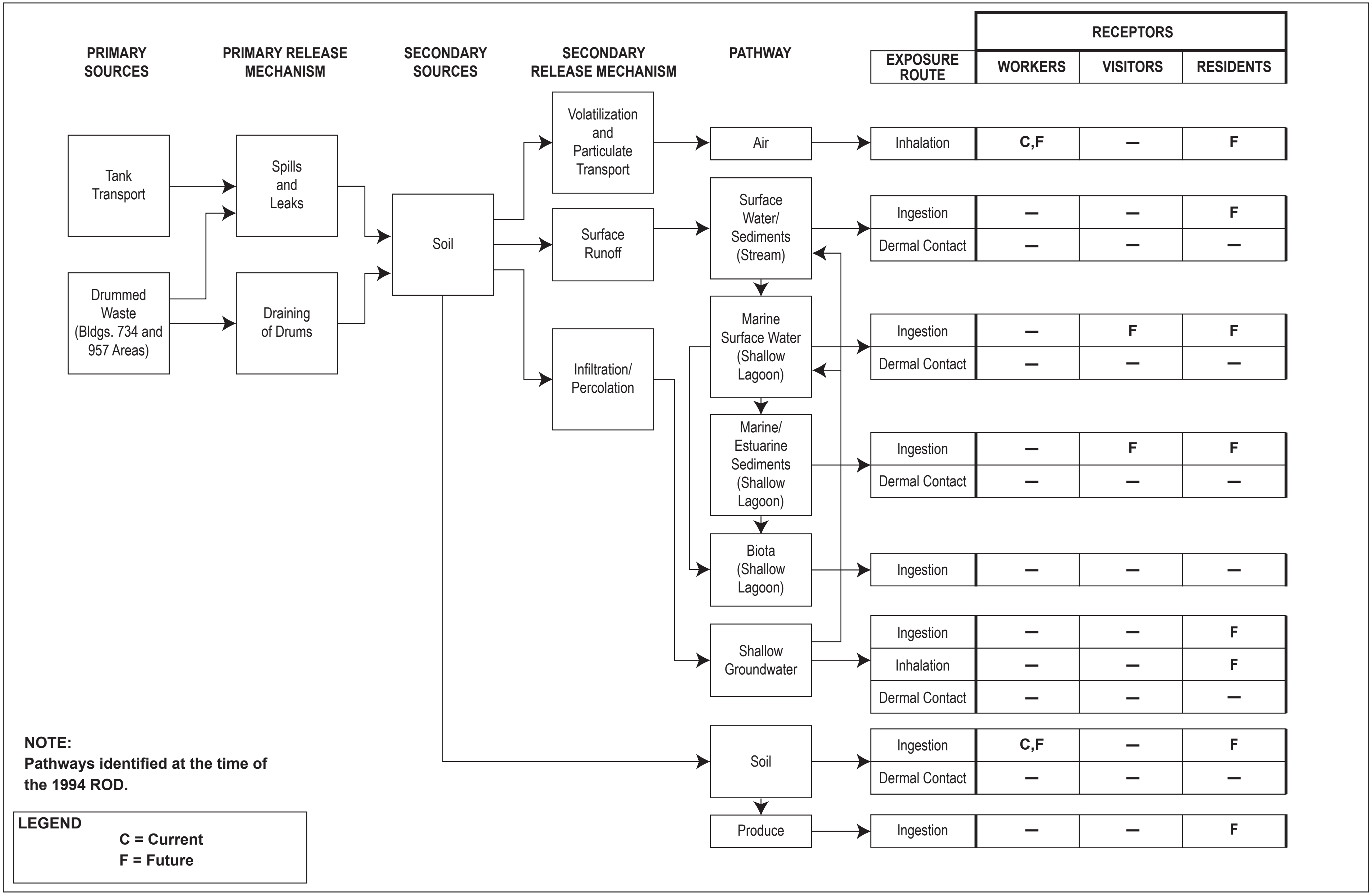

U.S. NAVY

Figure 3-7
OU 2 ROD Area 2 Conceptual Site Model

NBK Keyport
FOURTH
FIVE-YEAR REVIEW

chromium) were identified as COCs based on residential use of groundwater as drinking water and inhalation during household use. For subsurface soil, arsenic and cadmium were identified as major contributors to risk to a resident based on ingestion of produce grown in the soil.

The principal source of VOCs in groundwater was believed to be solvents used in Building 72 or other adjacent buildings. The source of metals in groundwater is likely from the impacted subsurface soil from plating activities in Building 72. The source of inorganic chemicals in soil is believed to be the result of the metal plating activities associated with Building 72, except for low concentrations of detected arsenic that were suspected to be related to background concentrations. As a result, arsenic was dropped as one of the COCs at the site.

Petroleum hydrocarbons and aromatic compounds identified as heavy fuel oils were detected in groundwater samples from locations around Buildings 181 and 804. VOCs, SVOCs, and total petroleum hydrocarbon (TPH) as diesel in soil were also characterized in 1998 and 1999. The source of these compounds was believed to be the former fuel storage vaults at these two buildings. The remediation of TPH-contaminated soil and associated risk assessment were conducted under the underground storage tank program as an independent action under MTCA regulations (WAC 173-340-450), as reported in the independent remedial action report (U.S. Navy 2000c). The risk assessment concluded no unacceptable risk to human health from residual petroleum hydrocarbons in soil and groundwater existed at the site. Washington State Department of Ecology (Ecology) requested monitoring to verify petroleum-related chemicals were not migrating off site at measurable concentrations. Monitoring for TPH-heavy oil at wells MW8-2 and MW8-9 and Seep A was completed in 2000 and 2004 (U.S. Navy 2005a). No petroleum compounds were detected at these locations (U.S. Navy 2005a and 2005c). Visual inspections along the beach and the shallow seawater showed no sign of petroleum impacts in 2004 (U.S. Navy 2005c). Based on the absence of petroleum hydrocarbons, the second 5-year review recommended discontinuing petroleum monitoring (U.S. Navy 2005a). This petroleum independent action is not discussed in further detail in this 5-year review.

No ecological risk was identified for terrestrial organisms, because of a lack of significant habitat at Area 8. Based on the RI data, which included seep samples and Liberty Bay surface water, the ecological risk assessment indicated that the shallow groundwater discharging to Liberty Bay had not caused significant risk to marine organisms under current site conditions. However, the risk assessment concluded that as Area 8 groundwater continues to discharge into Liberty Bay, the groundwater contamination could lead to an accumulation of contaminants in sediments and/or biota, resulting in future risks to human health and the marine environment.

In summary, no current human health or ecological risk was identified in association with OU 2 Area 8. The drivers for action at Area 8 were future hypothetical residential risks from exposure to soil, groundwater, and produce, and the potential for human health and ecological exposure from contaminants discharging to Liberty Bay impacting marine sediment and tissue. The CSM

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U.S. NAVY

NBK Keyport
FOURTH FIVE-YEAR
REVIEW

Figure 3-8
OU 2 Area 8

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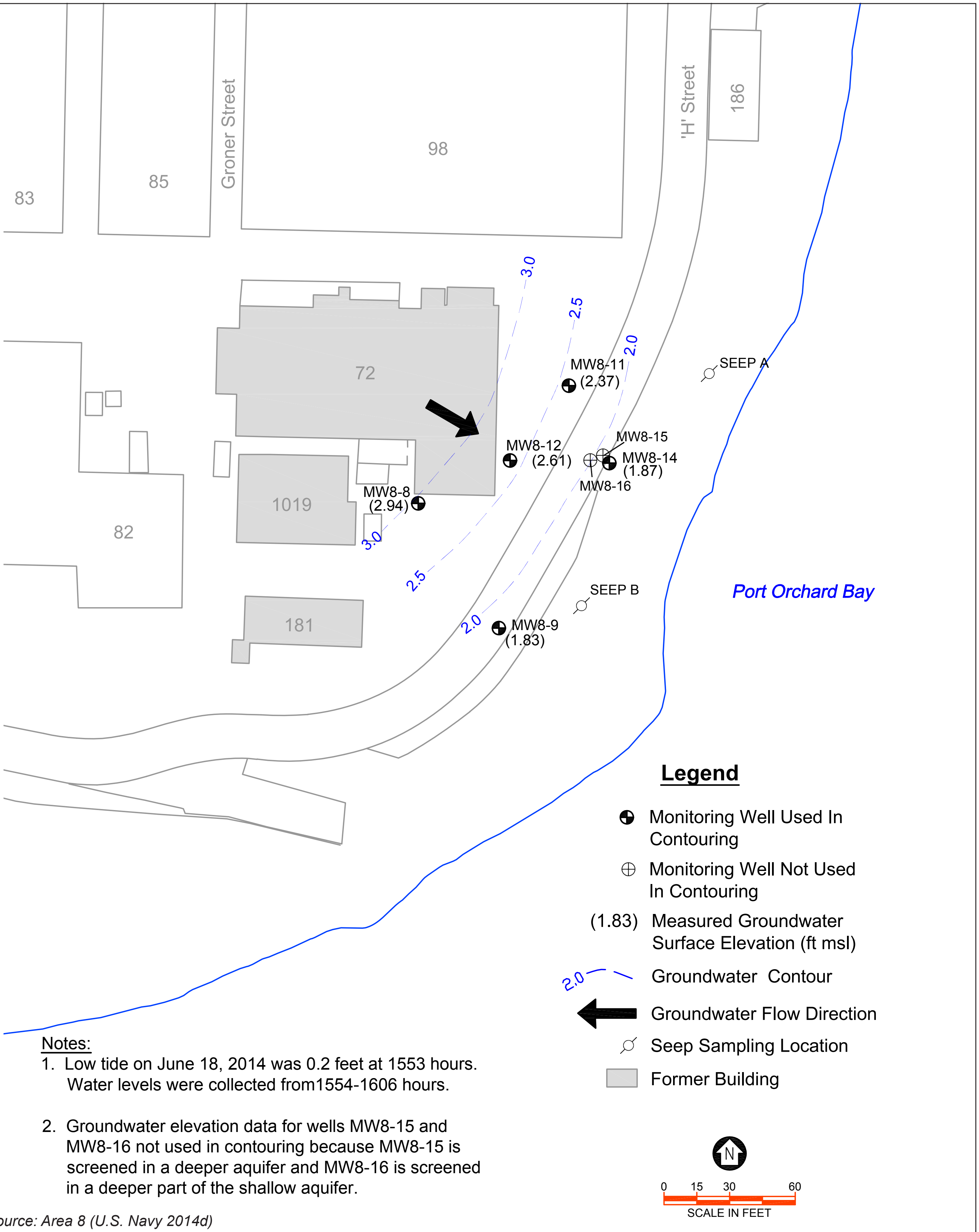


Notes:

1. Low tide on June 18, 2014 was 0.2 feet at 1553 hours. Water levels were collected from1554-1606 hours.
2. Groundwater elevation data for wells MW8-15 and MW8-16 not used in contouring because MW8-15 is screened in a deeper aquifer and MW8-16 is screened in a deeper part of the shallow aquifer.

Source: Area 8 (U.S. Navy 2014d)

U.S. NAVY	Figure 3-9 OU 2 Area 8 Upper Aquifer Groundwater Contours	NBK Keyport FOURTH FIVE-YEAR REVIEW

for Area 8 shown on Figure 3-10 summarizes all the human health pathways evaluated at the time of the ROD.

3.3 SITE 23

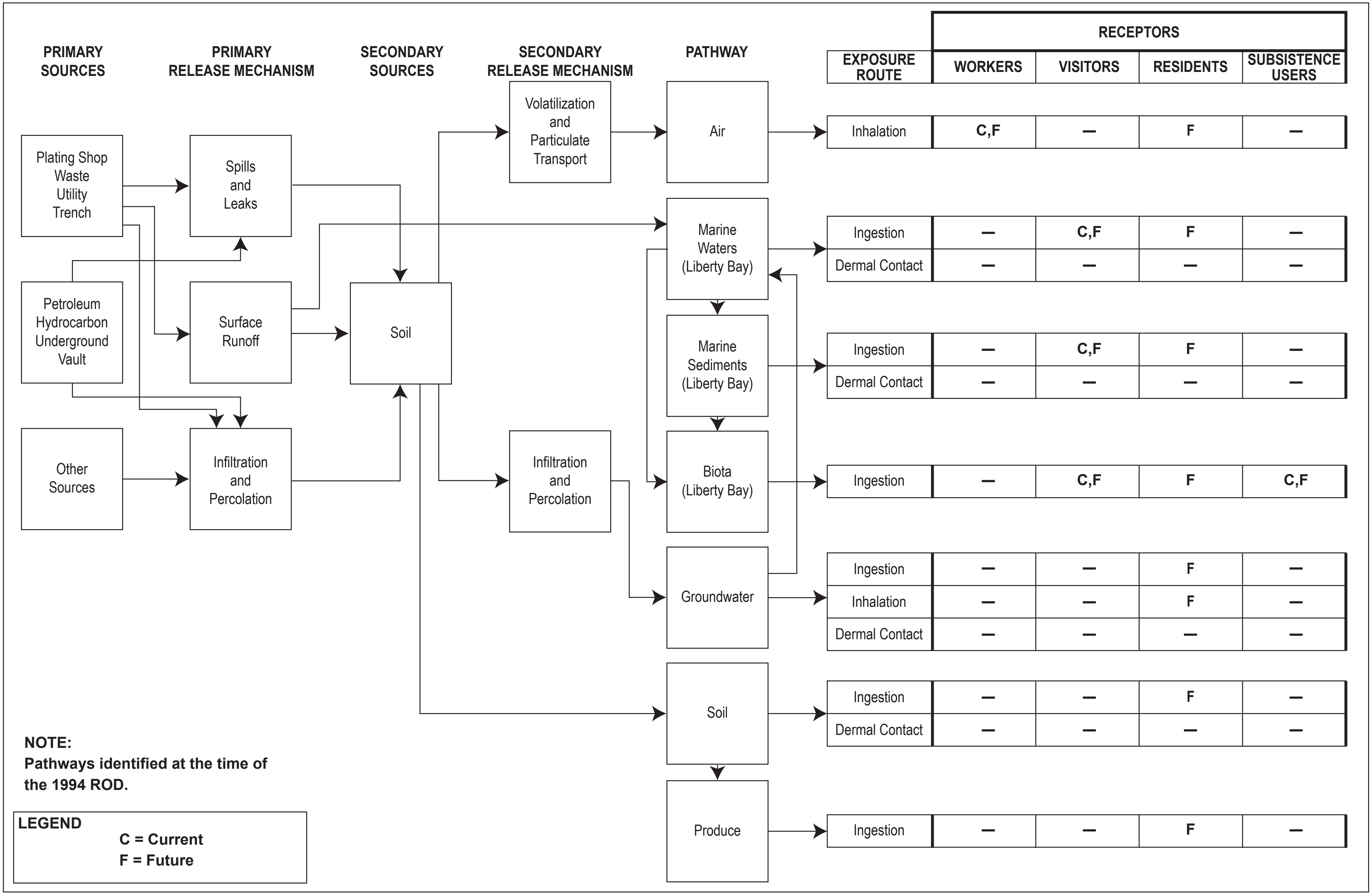
Site 23 (Figure 2-1) includes former Building 21 and the immediate surrounding area, which was located in the industrial area of Naval Undersea Warfare Center Keyport west of remaining Building 15. Building 21, constructed in the 1940s, had been used to store lubricating oil and housed a filtering system for petroleum-based machining coolants. Immediately east of Building 21 was an enclosed wash rack that had two 2,000-gallon tanks for collecting and storing waste lubricants and rinsate from the cleaning of equipment. Immediately north of Building 21 and the wash rack was an open canopy under which was equipment used to shred scrap metals and separate machining oil from the metals. There were also unconfirmed reports that drums containing unspecified materials had been buried around Building 21. In June 1998, a limited field investigation identified the presence of oil and diesel-range TPH in excess of MTCA cleanup levels adjacent to and under Building 21.

The groundwater flow direction for the upper aquifer at the site is toward the east-northeast, as determined during the 1993 RI. The water table underlies Site 23 at a depth of approximately 10 feet bgs. The hydrology of the intermediate aquifer has not been well defined in this area.

In 1999, the Navy performed a time-critical removal action at Building 21 in accordance with CERCLA, which was conducted pursuant to an action memorandum signed in July 1999 (U.S. Navy 1999e). The objective of this action was to remove contaminated soil and buried drums beneath and around Building 21, thereby reducing the likelihood of migration of subsurface contamination and potential risks to human health and the environment. The TPH-contaminated soil encountered during the removal action was excavated, treated, and disposed of according to Ecology's interim TPH policy and MTCA (U.S. Navy 1999e).

Although Site 23 was not included as one of the original sites to be investigated at Naval Undersea Warfare Center Keyport and was not included in the OU 2 ROD, the results of this time-critical removal action are included in this 5-year review because the removal action was performed under CERCLA and ICs are in place for this site.

After the demolition of Building 21, soil excavation and removal was conducted in five areas at Site 23. TPH-contaminated soil was excavated from the center of each area to all four sides until field test results indicated the tested sidewall or bottom had less than 1,000 mg/kg TPHs. The bottom was excavated until the groundwater table was reached. Confirmation samples were then collected from the sidewalls and excavated bottoms of each of the five areas before backfilling with clean imported fill. Excavated soil was transported to a temporary stockpile area located on



EXPOSURE ROUTE	RECEPTORS: WORKERS	VISITORS	RESIDENTS	SUBSISTENCE USERS
Inhalation	C,F	—	F	—
Ingestion	—	C,F	F	—
Dermal Contact	—	—	—	—
Ingestion	—	C,F	F	—
Dermal Contact	—	—	—	—
Ingestion	—	C,F	F	C,F
Ingestion	—	—	F	—
Inhalation	—	—	F	—
Dermal Contact	—	—	—	—
Ingestion	—	—	F	—
Dermal Contact	—	—	—	—
Ingestion	—	—	F	—

NOTE:
Pathways identified at the time of the 1994 ROD.

LEGEND
C = Current
F = Future

U.S. NAVY

Figure 3-10
OU 2 ROD Area 8 Conceptual Site Model

NBK Keyport
FOURTH
FIVE-YEAR REVIEW

the facility, sampled, characterized, and transported off site to a low-temperature thermal desorption facility for treatment and disposal. Overall, 355 tons of soil were treated and disposed of at the off-site facility (U.S. Navy 2000d).

Although confirmation samples indicated that soil concentrations were below MTCA Method C commercial and industrial risk-based cleanup criteria, they were higher than MTCA Method A cleanup criteria for residential use. Since soils did not meet the unrestricted use/unlimited exposure threshold, ICs were instituted at the site to maintain the asphalt cover, restrict contact with soils or groundwater, and restrict the use of groundwater from potable use at the site.

4.0 REMEDIAL ACTIONS

The RODs for NBK Keyport required remedial actions for Area 1 in OU 1 and Areas 2 and 8 in OU 2. This section summarizes the ROD-specified RAOs, ROD-specified remedies, remedy components and implementation, and current ongoing operation, maintenance, and monitoring (OM&M) requirements for Area 1 in OU 1 and Areas 2 and 8 in OU 2. Because cleanup activities at Site 23 were performed as a removal action rather than a remedial action and only IC inspections were conducted at Site 23 during this 5-year review period, Site 23 is only discussed in Section 4.4. Information previously presented in the third 5-year review is not repeated here. Instead, detailed information can be obtained by reviewing Section 4 of the third 5-year review (U.S. Navy 2010a), the RODs for OU 1 and OU 2, and the Explanation of Significant Differences for OU 2 Area 8, which are included in Appendix A or can be accessed on the following EPA website:

http://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=1001102

This 5-year review focuses on remedy implementation activities between July 2009 and June 2014, as well as OM&M information for this same time period. The work plan for OU 1 and OU 2 was revised in 2004, 2006, 2007, and 2012 (U.S. Navy 2004, 2006a, 2007a, 2012h) incorporating the results of the third 5-year review.

Annual OM&M costs after the first 3 years were estimated in the RODs to total approximately $258,000 per year. The actual annual OM&M costs for this 5-year review period are summarized in Table 4-1. Fiscal years 2010 through 2014 ranged from $221,000 to $300,000 per year and averaged $267,000. The actual costs are near the costs expected in the ROD.

Table 4-1
Summary of Annual OM&M Costs for OU 1 and OU 2

Year	OU 1	OU 2		OU 1 and OU 2 Combined Total
	Area 1	Area 2	Area 8	
2010	$222,000	$3,000	$75,000	$300,000
2011	$216,820	$2,930	$73,250	$293,000
2012	$191,660	$2,590	$64,750	$259,000
2013	$163,540	$2,210	$55,250	$221,000
2014	$194,620	$2,630	$65,750	$263,000
Average Annual OM&M Cost 2010–2014	$197,580	$2,670	$66,750	$267,000
Estimated 1994 Value Annual OM&M Cost in ROD	$168,000	$63,000 (first 3 years) $32,000 (after 3 years)	$95,000 (first 3 years) $58,000 (after 3 years)	$258,000 (after 3 years)

Table 4-1 (Continued)
Summary of Annual OM&M Costs for OU 1 and OU 2

Notes:
Costs were estimated based on taking 74 percent of total for Area 1, 1 percent of total for Area 2, and 25 percent of total for Area 8.
OM&M - operation, maintenance and monitoring
OU - operable unit
ROD - Record of Decision

4.1 OU 1 AREA 1

4.1.1 Remedy Selection

The impacted media, COCs, RGs, RAOs, and description of the remedy components and status are summarized in Table 4-2. Further information on remedy selection can be obtained by reviewing Section 4.1 of the third 5-year review (U.S. Navy 2010a) included in Appendix A or on the EPA website http://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=1001102.

Table 4-2
Summary of Remedial Actions, OUs 1 and 2, NBK Keyport

Medium	COC Requiring Action	RGs	RAOs[a]	Remedy Component/ Remedy Status
OU 1 Area 1				
Soil, waste, vapor	VOCs	None	• Prevent human exposure to soil and landfill waste. • Prevent human exposure to landfill vapor. • Prevent unacceptable risks to humans from soil and air above state MTCA B levels.	• Upgrade and maintain the landfill cover – Initial upgrade construction is complete and maintenance ongoing. • ICs: ongoing
Groundwater	1,1-DCA 1,2-DCA 1,1-DCE cis-1,2-DCE trans-1,2-DCE PCE 1,1,1-TCA TCE VC PCBs	800 µg/L 5 µg/L 0.5 µg/L 70 µg/L 100 µg/L 5 µg/L 200 µg/L 5 µg/L 0.5 µg/L 0.04 µg/L 0.44 µg/L	• Prevent human exposure to groundwater as drinking water. • Prevent unacceptable risks to humans and aquatic organisms due to migration of groundwater into adjacent aquatic environments.	• Treat VOC hot spots in the landfill by phytoremediation: ongoing, including additional site characterization at south plantation for remedy optimization • Conduct LTM, including phytoremediation monitoring, intrinsic bioremediation monitoring, and risk and compliance monitoring

Table 4-2 (Continued)
Summary of Remedial Actions, OUs 1 and 2, NBK Keyport

Medium	COC Requiring Action	RGs	RAOs[a]	Remedy Component/ Remedy Status
	New COC identified after ROD; RG not established: 1,4-Dioxane	(MTCA Method B Screening Level)	.	ongoing LTM until RGs are met • ICs: ongoing • Take contingent remedial actions for off-base domestic wells, if necessary: ongoing monitoring
Surface water	1,1-DCA 1,2-DCA 1,1-DCE cis-1,2-DCE trans-1,2-DCE PCE 1,1,1-TCA TCE VC PCBs	None 59 µg/L 1.9 µg/L None 33,000 µg/L 4.2 µg/L 41,700 µg/L 56 µg/L 1.9 µg/L 0.04 µg/L	• Prevent unacceptable risks to humans due to ingestion of seafood. • Prevent unacceptable risks to aquatic organisms due to surface water exposure.	• Upgrade the tide gate: construction complete • Conduct LTM: ongoing until RGs are met
Sediment	1,1-DCA 1,2-DCA 1,1-DCE cis-1,2-DCE trans-1,2-DCE PCE 1,1,1-TCA TCE VC PCBs	State Sediment Quality Standards/ Bioassays[b]	• Prevent unacceptable risks to humans due to ingestion of seafood as defined by concentrations in littleneck clams (see tissue). • Prevent unacceptable risks to aquatic organisms due to sediment exposure.	• Remove PCB-contaminated sediments from seep: completed • Upgrade the tide gate: construction complete • Conduct LTM: ongoing LTM to ensure that contaminant concentrations have not increased from the time of the ROD
Tissue[c]	1,1-DCA 1,2-DCA 1,1-DCE cis-1,2-DCE trans-1,2-DCE PCE 1,1,1-TCA TCE VC PCBs	304 mg/kg 0.33 mg/kg 0.051 mg/kg 30 mg/kg 61 mg/kg 0.59 mg/kg 61 mg/kg 2.8 mg/kg 0.016 mg/kg 0.015 mg/kg	• Prevent exposure to humans due to ingestion of seafood above a cumulative incremental cancer risk of 1 x 10^{-5} or above a noncancer hazard index of 1.0. • Prevent exposure to aquatic organisms above the ecological risk-based screening levels (Appendix J of U.S. Navy 1997a).	• Upgrade the tide gate: construction complete • Conduct LTM: ongoing LTM to ensure that contaminant concentrations have not increased from the time of the ROD

Table 4-2 (Continued)
Summary of Remedial Actions, OUs 1 and 2, NBK Keyport

Medium	COC Requiring Action	RGs	RAOs[a]	Remedy Component/ Remedy Status
OU 2 Area 2				
Groundwater	TCE VC	5 µg/L 0.1 µg/L	• Prevent human exposure to groundwater as drinking water and inhalation of volatiles while showering. • Reduce concentrations of contaminants in groundwater to drinking water quality.	• Install additional upgradient wells to confirm no upgradient source of COCs exists: construction complete • Conduct LTM: RGs have been met. However, ongoing LTM is recommended until achieve risk-based level for vinyl chloride. • ICs: ongoing
Soil	Arsenic Benz(a)pyrene Beryllium Vinyl chloride	None	• Prevent human exposure to soil or vegetables grown in soil (residential).	• ICs: ongoing
OU 2 Area 8				
Soil	Arsenic[d] Cadmium Chromium VOCs SVOCs	MTCA Method B soil cleanup levels	• Prevent human exposure to soil. • Protect groundwater and surface water quality from soil containing COCs.	• Soil hot spot removal: construction complete • ICs: ongoing
Groundwater	Cadmium Chromium III[e] Chromium VI[e] Chromium (total) 1,1-DCE cis-1,2-DCE PCE 1,1,1-TCA TCE	5 µg/L 16,000 µg/L 80 µg/L 50 µg/L 7 µg/L 70 µg/L 5 µg/L 200 µg/L 5 µg/L	• Prevent human exposure to groundwater as drinking water. • Protect sediments and surface water quality offshore of Area 8 in Liberty Bay from contaminants in groundwater that could cause future adverse impacts or human health risks.	• Install additional monitoring wells: construction complete • Conduct LTM of groundwater, seeps, sediment, and tissue in the intertidal zone of Area 8: ongoing until achieve RGs • ICs: ongoing • Assess risks to human health and the environment using the sediment and tissue monitoring data: ongoing • Implement contingent groundwater control actions if Area 8 groundwater is demonstrated to be a significant source of the

Table 4-2 (Continued)
Summary of Remedial Actions, OUs 1 and 2, NBK Keyport

Medium	COC Requiring Action	RGs	RAOs[a]	Remedy Component/ Remedy Status
				chemicals that cause risk in sediments or tissue: risk assessments to be completed

[a]The RAO statements included in this table are summary versions of the RAO statements from the OU 1 and OU 2 RODs. Please refer to the RODs for the complete text of each RAO statement.
[b]Washington State Sediment Quality Standards (SQS) value of 12 mg/kg for PCBs was set at the time of the signed ROD. Current SQS values are applicable to all other COCs as established in the ROD. Bioassays will be performed if chemical results fail the SQS as established on page 95 of the ROD.
[c]RGs are risk-based concentrations for protection of ingestion of seafood (assumptions in Appendix B of the ROD).
[d]Concentrations were found to be below background, so contaminant was dropped from COC list.
[e]Trivalent and hexavalent chromium (chromium III and VI, respectively) dropped from COC list as discussed in Section 4.3.3.

Notes:
COC - chemical of concern
DCA - dichloroethane
DCE - dichloroethene
ICs - institutional controls
LTM - long-term monitoring
µg/L - microgram per liter
MTCA - Model Toxics Control Act
PCBs - polychlorinated biphenyls
RGs - remediation goals
ROD - Record of Decision
SVOCs - semivolatile organic compounds
TCA - trichlorethane
TCE - trichloroethene
VC - vinyl chloride
VOC - volatile organic compound

4.1.2 Remedy Implementation

The remedy for Area 1 has been implemented, construction is complete for all elements, operation, maintenance, and monitoring activities are ongoing, and ICs are in place. The remedy included the following components:

- Upgraded the asphalt landfill cover in January 2005 to prevent exposure from contact with soil, debris, and vapors
- Planted two phytoremediation plantations of hybrid poplar trees in April 1999, referred to as the “north” and “south” plantations, designed to work in concert with monitored natural attenuation to remove and treat VOC-contaminated groundwater and reduce the long-term potential for VOC migration from the site
- Installed 3 wells (MW1-41 and 2 irrigation wells), 10 piezometers, and 2 lysimeters in 1999 to monitor groundwater concentrations and water levels

- Initiated the LTM program beginning in 1999 and continuing through 2014, including phytoremediation monitoring, risk and compliance monitoring, and intrinsic bioremediation monitoring

- Prepared a contingent remedial action (CRA) plan that was finalized in March 2003 (U.S. Navy 2003a) and revised in February 2012 (U.S. Navy 2012i): It specified the conditions under which the Navy will implement additional remedial actions if the identification of significant contaminant concentrations are found to be migrating from OU 1 to water supply wells in the area. The 2012 revision addressed recommendations from the third 5-year regarding the addition of 1,4-dioxane.

- Upgraded the tide gate in November 1999 (U.S. Navy 1999c) to improve the control of tidal flow between the tide flats and the marsh, thereby ensuring that the landfill is protected from tidal inundation that could erode its banks or adversely affect contaminant mobilization

- Removed PCB-contaminated sediment from the marsh in 1999 (U.S. Navy 1999c) to prevent PCB-contaminated sediment from potentially migrating to the tide flats and Dogfish Bay

- Initiated ICs in 2000 and continuing through 2014 to prevent undue exposure to landfill contaminants in the future, including tide gate inspections, preventing installation of drinking water wells, preventing interference with the remedial activities, and preventing development or activity that would disturb the landfill, tide flat, or adjoining marsh and shoreline in a manner that could lead to unacceptable risks to human health (see Section 4.4 for ICs details)

4.1.3 Operation and Maintenance

Since the third 5-year review was completed in 2010 (U.S. Navy 2010a), the Navy has continued operation and maintenance (O&M) of the OU 1 remedy.

The O&M at Area 1 consists of the following:

- Phytoremediation tree health maintenance
- Tide gate inspection and maintenance

Phytoremediation O&M activities that were begun immediately after planting the trees have been continued over the last 5-year review period. The primary objective is to establish and maintain mature, healthy stands of trees to maximize contaminant uptake by the trees. Plantation inspections are scheduled to occur eight times per year. Additional maintenance activities occur as necessary, such as pesticide and herbicide application, to maintain healthy stands of trees.

Tide gate inspection and maintenance occurs four times per year and has been performed since the tide gate was upgraded in 1999.

4.1.4 Monitoring

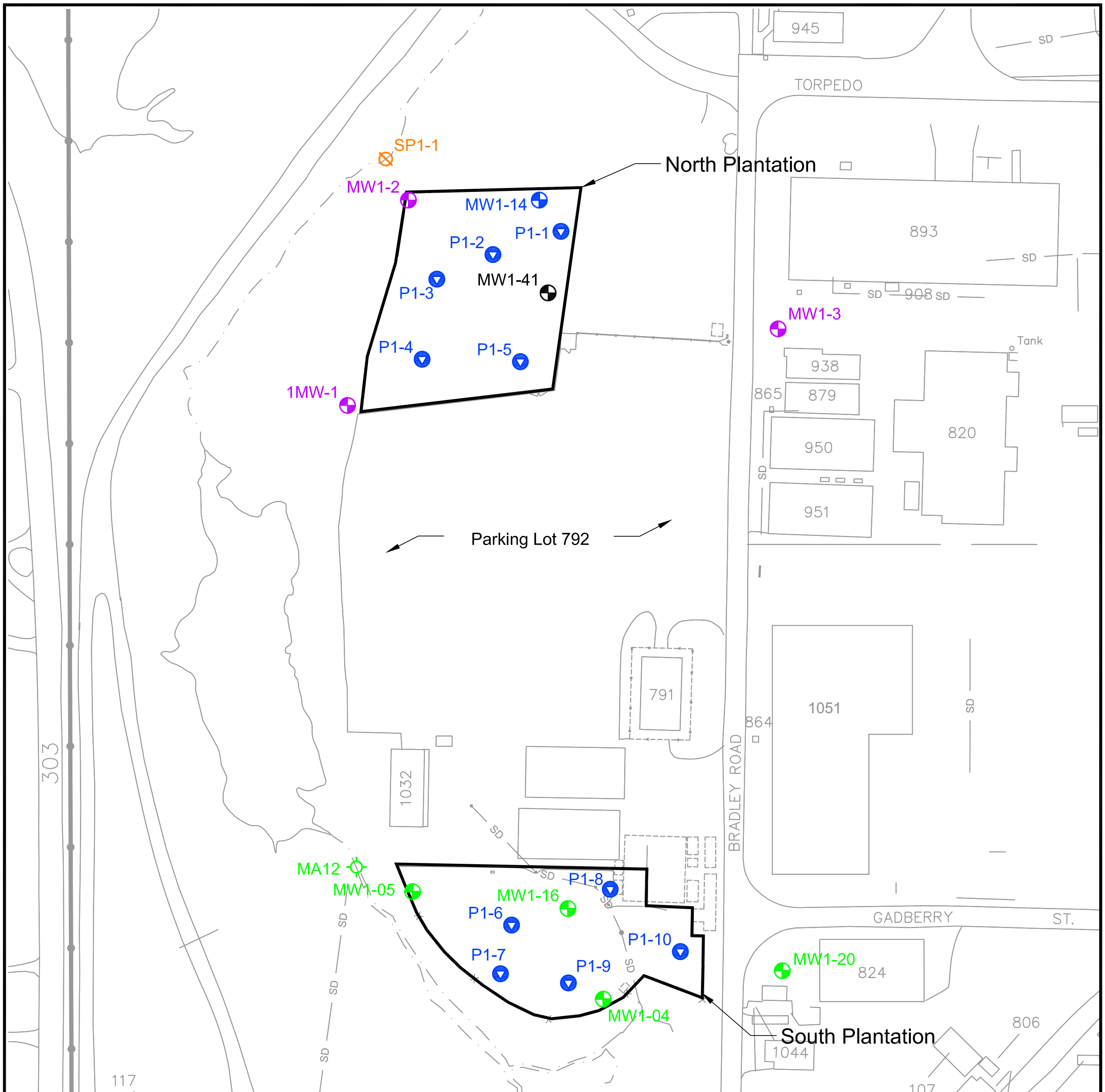
Since the third 5-year review was completed in 2010 (U.S. Navy 2010a), the Navy has continued monitoring the OU 1 remedy by chemical analysis of various media and groundwater elevation level measurements. There are four monitoring programs, including phytoremediation, risk and compliance (also referred to as LTM), CRA, and intrinsic bioremediation, which are discussed in the sections below.

Phytoremediation

Phytoremediation monitoring activities since the last 5-year review have included the following:

- Periodic groundwater elevation measurements in upper aquifer monitoring wells and piezometers in and around the plantations
- Periodic groundwater sampling and chemical analysis from wells primarily in and around the plantations
- Periodic surface water and seep sampling and chemical analysis from stations in the vicinity of the plantations

Periodic groundwater elevation measurements in monitoring wells and piezometers throughout Area 1 occurred quarterly through 2011. The third 5-year review recommended reducing phytoremediation water-level measurements to once every 5 years to match the ROD-specified frequency. However, since most phytoremediation wells are also used for LTM and groundwater monitoring is conducted every 2 years, the Navy concluded that it was most efficient to sample wells and collect groundwater elevations throughout Area 1 concurrently. These groundwater elevation measurements have been used to assess changes to the groundwater flow pattern in the shallow aquifer attributable to the phytoremediation plantations. Groundwater elevations are collected from all monitoring well locations, and piezometer locations as shown on Figure 4-1. Piezometers and passive diffusion samplers (a.k.a., peepers) are used to monitor intrinsic bioremediation at Area 1, so are discussed under the intrinsic bioremediation monitoring section.



Color Coding Notes:
- Green symbol indicates sampled once per year.
- Purple symbol indicates sampled once every two years.
- Orange symbol indicates sampled once every 5 years.
- Black symbol indicates location no longer sampled.
- Blue symbol indicates groundwater elevation measurements only.

OU 1 Analytical Requirements:
Groundwater, seep water, and surface water are analyzed for VOCs.

Legend:
- Piezometer
- Monitoring Well (Shallow Depth)
- Seep Sampling Station
- Surface Water Sampling Station

Sampling Location Note:
Groundwater elevations are collected from all monitoring well locations and piezometer locations once every two years.

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Figure 4-1
Phytoremediation Sampling Locations at OU 1

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All Area 1 phytoremediation chemical analysis monitoring activities since the last 5-year review were performed in accordance with the regulator-approved LTM work plan (U.S. Navy 2012h) and are based on recommendations in the third 5-year review to reduce monitoring frequency in the north plantation. Figure 4-1 depicts the frequency of chemical analysis sampling in various media currently conducted at Area 1 for phytoremediation monitoring. The current monitoring frequency exceeds the requirements specified in the ROD. The current frequency was requested by Ecology, and the Navy concurred based on increasing VOC concentrations in groundwater wells in the south plantation during the 2009 sampling event. The most recent phytoremediation monitoring results are discussed in Section 6.4 and tabulated in Appendix B.

Risk and Compliance Monitoring

LTM for assessing risk and compliance was described in the ROD as consisting of groundwater level measurements and groundwater, seep, marine sediment, and tissue sampling. The overall objective of the LTM program is to monitor trends in chemical concentrations and evaluate whether the selected remedy meets the RAOs and remains protective of human health and the environment (U.S. Navy 2012h). LTM data are also used to monitor the need for CRAs under the CRA plan (U.S. Navy 2003a and 2012i).

Activities under the LTM program since the last 5-year review have consisted of the following:

- Periodic groundwater elevation measurements in upper and intermediate aquifer monitoring wells and piezometers throughout Area 1
- Groundwater sampling and chemical analysis of monitoring wells screened within the upper, intermediate, and deep aquifers (deep aquifer wells discussed under the CRA program section)
- Sampling and chemical analysis of surface water locations and a seep
- Sampling and chemical analysis of sediment locations

Those locations where groundwater elevations are measured, current sampling locations, and frequency of sampling for each of these media are summarized on Figure 4-2. All Area 1 risk and compliance monitoring activities since the last 5-year review were performed in accordance with the regulator-approved LTM work plan (U.S. Navy 2012h). The Area 1 risk and compliance monitoring program remained unchanged. Details regarding groundwater elevation monitoring and chemical analysis monitoring of media are discussed below. The details regarding piezometers and peepers are discussed under the intrinsic bioremediation monitoring section.

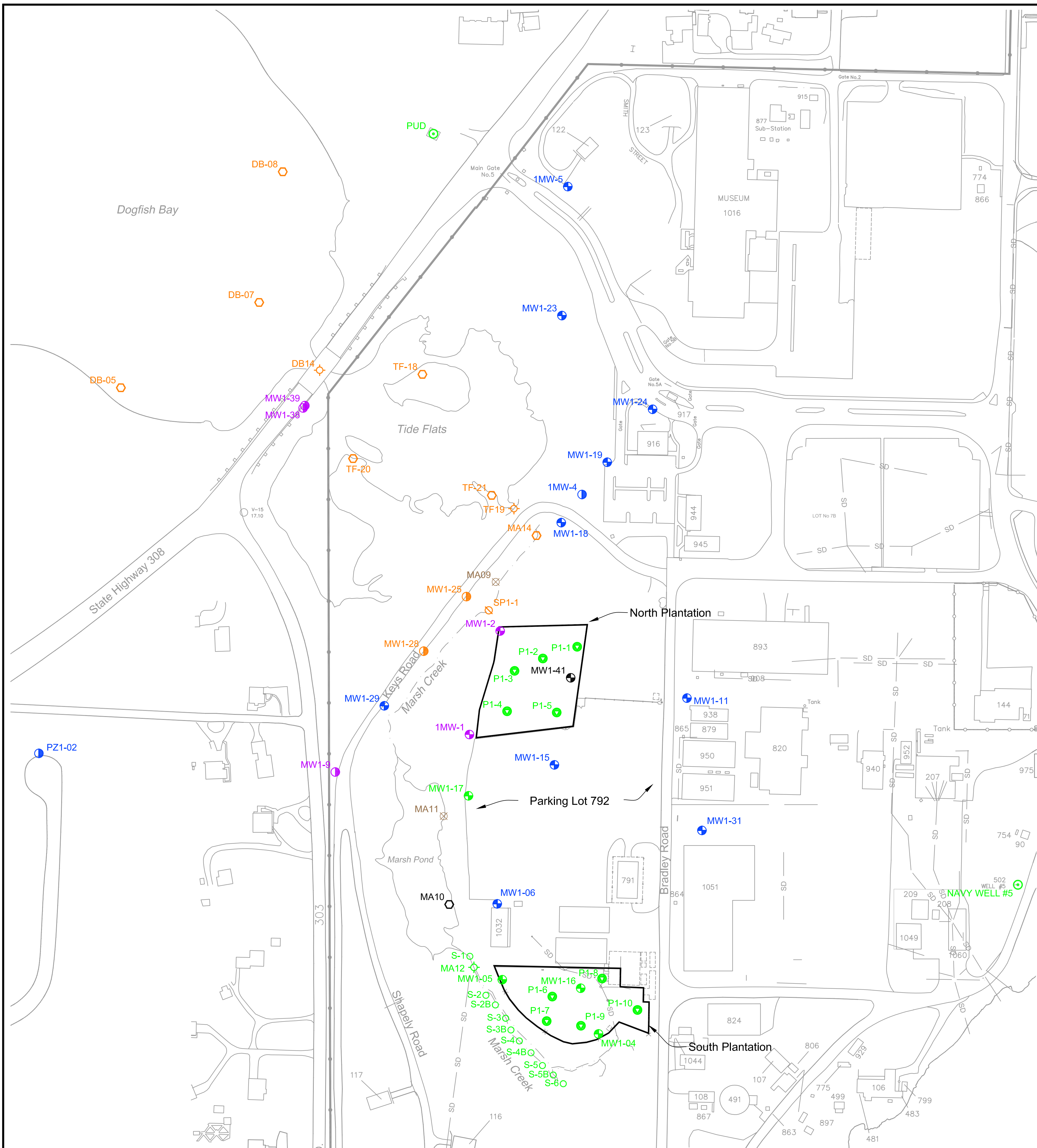
Groundwater Elevations. Groundwater level measurements are being performed once every 2 years. This exceeds the ROD requirement of once every 5 years, but was requested by Ecology. Given that this frequency coincided with the monitoring schedule and would not result in significant additional costs, the Navy concurred. As stated in the phytoremediation section, starting in 2012 groundwater level measurement data from LTM wells were collected concurrently with data from phytoremediation wells. These data are used to estimate groundwater gradient and flow directions beneath and downgradient of the former landfill in both the upper and intermediate aquifers. Monitoring well and piezometer locations where groundwater elevation was measured are shown on Figure 4-2.

Chemical Analysis Monitoring. All Area 1 risk and compliance chemical analysis monitoring activities since the last 5-year review were performed in accordance with the regulator-approved LTM work plan (U.S. Navy 2012h) and are based on regulator-approved recommendations in the third 5-year review. Figure 4-2 depicts the locations and frequency of chemical analysis sampling in various media currently conducted at Area 1 for risk and compliance monitoring. The current monitoring frequency exceeds the requirements specified in the ROD for groundwater, surface water, and seep sampling, as requested by Ecology and with Navy concurrence, based on increasing VOC concentrations in groundwater wells in the south plantation during the 2009 sampling event. The frequency of sediment sampling meets the ROD-specified frequency of once every 5 years. Details regarding each media that is monitored are discussed below. The most recent risk and compliance monitoring results are discussed in Section 6.4 and tabulated in Appendix B.

Groundwater sampling monitors the extent and magnitude of VOC contamination in the upper, intermediate, and deep aquifers beneath and downgradient of the former landfill. In addition to VOCs, wells MW1-9, MW1-38, and MW1-39 are also sampled to monitor for 1,4-dioxane. The analytical results are compared to the groundwater RGs established in the ROD (based on drinking water and seafood ingestion pathways), and the long-term groundwater contamination trends are tracked to evaluate if the remedy is working as expected and/or if RGs have been met.

Surface water, including one seep, is sampled periodically, as specified in the ROD, to monitor the fate, transport, and natural attenuation of VOCs in surface water. These sampling stations are located in a series aligned upstream to downstream, beginning in the marsh pond adjacent to the landfill, through the outlet channel to the tide flats, and out to Dogfish Bay. Surface water samples are analyzed for VOCs, and seep samples are analyzed for VOCs and PCBs.

Sediment locations are distributed throughout the marsh, tide flats, and Dogfish Bay to monitor the fate and transport of contaminants migrating from the landfill through the marsh pond. Sediment samples from these locations are analyzed for metals. Analysis of PCBs, pesticides, and SVOCs was discontinued based on regulator-approved recommendations in the third 5-year review.



Color Coding Notes:

- Green symbol indicates sampled once per year.
- Purple symbol indicates sampled once every two years.
- Orange symbol indicates sampled once every five years.
- Brown symbol indicates surface water sampled once per year and sediment sampled once every five years.
- Black symbol indicates location no longer sampled.
- Blue symbol indicates groundwater elevation measurements only.

Sample Location Notes:

1. MA10 is a historical sampling location. It is not part of the current monitoring program.
2. All piezometer locations, P1-1 through P1-10, are sampled on an annual basis by USGS as part of the intrinsic bioremediation monitoring program and not as part of the risk and compliance monitoring program.
3. All passive-diffusion locations, S-1 through S-6, are sampled on an annual basis by USGS as part of the intrinsic bioremediation monitoring program and not as part of the risk and compliance monitoring program.
4. Groundwater elevations are collected from all piezometer locations and all shallow and intermediate aquifer monitoring wells once every two years, except MW1-28, MW1-38, and MW1-39.

Analytical Requirement Notes:

1. Groundwater is analyzed for VOCs in all shallow aquifer wells.
2. Groundwater is analyzed for VOCs in all intermediate aquifer wells; groundwater is also analyzed for 1,4-dioxane in wells MW1-9, MW1-38, and MW1-39 only.
3. Groundwater is analyzed for VOCs and 1,4-dioxane in all deep aquifer wells
4. Seep water is analyzed for VOCs and PCBs.
5. Surface water is analyzed for VOCs.
6. Sediment is analyzed for metals.

Legend:

- Piezometer
- Monitoring Well (Shallow Depth)
- Monitoring Well (Intermediate Depth)
- Water Supply Well (Deep Depth)
- Surface Water Sampling Station
- Seep Sampling Station
- Sediment Sampling Station
- Sediment and Surface Water Sampling Station
- Passive-Diffusion Sampler Site

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Figure 4-2
Risk and Compliance Long-Term Monitoring Sampling Locations at OU 1

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Shellfish tissue sampling has also been discontinued based on the regulator-approved recommendations in the third 5-year review. RGs have been met for VOCs and PCBs, and only low detected concentrations of pesticides and metals remain in shellfish tissue (U.S. Navy 2010a).

Contingent Remedial Action Monitoring

As discussed above, the CRA monitoring program was implemented in conjunction with the risk and compliance and phytoremediation monitoring programs. CRA monitoring includes sampling wells downgradient of the landfill to monitor for migration of contamination toward off-base domestic wells. All Area 1 CRA monitoring activities since the last 5-year review were performed in accordance with the regulator-approved LTM work plan (U.S. Navy 2012h). The Area 1 CRA monitoring program remained unchanged during this 5-year review period, other than the addition of 1,4-dioxane analysis as specified in the revised CRA plan (U.S. Navy 2012i) and based on a recommendation in the third 5-year review. The current CRA plan provides a decision matrix for comparison of specific VOC and 1,4-dioxane concentrations in groundwater samples from "sentinel" wells (MW1-09, MW1-38, MW1-39, Navy Supply Well #5, and the off site Public Utility District [PUD] well) to trigger values that would trigger additional action to protect human health, such as hooking up affected properties to the public water supply or installing a new drinking water well at the affected properties to tap a deeper aquifer.

Wells included in CRA monitoring are MW1-09, MW1-38, MW1-39, Navy Supply Well #5, and the PUD well. Figure 4-2 depicts the locations and frequency of chemical analysis sampling in groundwater conducted at Area 1 for CRA monitoring. Groundwater samples collected under this program are analyzed for VOCs and 1,4-dioxane.

Intrinsic Bioremediation Monitoring

The purpose of the intrinsic bioremediation monitoring, as paraphrased from the ROD, is to periodically assess that intrinsic biodegradation conditions at the landfill source zones remain favorable for degradation of VOCs and assess whether phytoremediation affects those conditions. As described in the summary data assessment report (U.S. Navy 1997b) and the ROD for OU 1 (U.S. Navy, USEPA, and Ecology 1998), groundwater oxidation reduction (redox) conditions at the site appear to be generally favorable for complete degradation of chlorinated VOCs into their harmless byproducts—carbon dioxide, water, and chloride. The favorable conditions identified are strongly reducing groundwater beneath the source area (which is favorable for reductive dechlorination of TCE and some dichloroethene [DCE]), followed by mildly reducing groundwater downgradient of the source area (which is favorable for direct oxidation of DCE and vinyl chloride). Because phytoremediation activities could potentially affect redox conditions at the site, the ROD specified that performance monitoring should include the redox conditions beneath the plantations to check for potential adverse effects from phytoremediation. The ROD also allowed for an evaluation of natural attenuation processes in the event that the phytoremediation component of the remedy was discontinued.

The Navy began a cooperative effort with the U.S. Geological Survey (USGS) in 1995 to investigate various natural attenuation mechanisms at OU 1 (USGS 2003). The investigations performed under this cooperative effort have been used to meet the OU 1 ROD goals related to natural attenuation evaluation. Field and laboratory studies conducted from 1996 through 2000 showed that natural attenuation and biodegradation of VOCs in shallow groundwater at OU 1 are substantial (U.S. Navy 1997a, Bradley et al. 1998, and USGS 2002). In 2010, the USGS reported that biodegradation of VOCs from 2001 to 2010 continued showing decreased concentrations throughout much of the site, except a localized area in the southern part of the south plantation. The results of the last 5 years (2010 to 2014) of monitoring have been similar, with decreasing COC concentrations beneath the north plantation and persistent high and highly variable COC concentrations in the "hot spot" beneath the south plantation (Dinicola 2014). The latest final USGS reports with groundwater VOC data and biodegradation compounds (USGS 2012 and 2013) are included in Appendix A.

Since the third 5-year review in 2010, the USGS has continued to monitor the geochemistry of OU 1 groundwater to verify that conditions remain favorable for VOC biodegradation. The USGS also measured groundwater elevations during each sampling event. The following wells and piezometers were measured annually for groundwater elevation and sampled annually for groundwater analysis of geochemical constituents (redox parameters) and ethane and ethene during 2010 to 2014:

- Thirteen monitoring wells (1MW-1, MW1-2, MW1-3, MW1-4, MW1-5, MW16, MW1-17, MW1-20, MW1-25, MW1-28, MW1-38, MW1-39, and MW1-41) (Intermediate aquifer background well MW1-33 has been abandoned.)

- Nine piezometers (P1-1, P1-3, P1-4, P1-5, P1-6, P1-7, P1-8, P1-9, and P1-10)

The following wells and piezometers were analyzed for VOCs in groundwater during 2010 to 2014:

- Annually in nine piezometers (P1-1, P1-3, P1-4, P1-5, P1-6, P1-7, P1-8, P1-9, and P1-10)

- Once every other year in four wells (MW1-25, MW1-28, MW1-38, and MW1-39)

Although USGS did not analyze for VOCs in samples collected from wells 1MW-1, MW1-2, MW1-4, MW1-5, and MW1-16, these wells were sampled annually under the phytoremediation monitoring program. VOCs were also measured annually from 2010 to 2014 at 10 passive diffusion (peepers) sampling locations (S-1, S-2, S-2B, S-3, S-3B, S-4, S-4B, S-5, S-5B, and S-6). Ethane and ethene were measured once in 2005 at the 10 peeper locations. Peeper data are summarized in the 2013 USGS report in Appendix A and for select years on isoconcentration figures in Appendix C. All sampling locations are shown on Figure 4-2.

The ROD specifies monitoring of north plantation wells 1MW-1 and MW1-2 and south plantation wells MW1-4, MW1-5, and MW1-16 for VOCs and redox parameters once every year for the first 5 years and once every 5 years thereafter. For the intermediate aquifer wells, MW1-25, MW1-28, and MW1-39, the ROD-specified monitoring for VOCs and redox parameters once every 2 years for years 1 through 5 and once every 5 years thereafter. The ROD does not specify any monitoring of piezometers, passive diffusion sampling locations, or surface water locations. As a result, the current intrinsic bioremediation monitoring program exceeds the requirements in the ROD with regard to number of locations and frequency of monitoring. However, the Navy, Ecology, and EPA agreed to this additional monitoring to assess long-term biodegradation trends.

4.2 OU 2 AREA 2

4.2.1 Remedy Selection

The impacted media, COCs, RGs, RAOs, and description of the remedy components and status are summarized in Table 4-2. Further information on remedy selection can be obtained by reviewing Section 4.2 of the third 5-year (U.S. Navy 2010a) included in Appendix A or on the EPA website http://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=1001102.

4.2.2 Remedy Implementation

The remedy for Area 2 has been implemented, construction is complete for all elements, monitoring activities are ongoing, and ICs are in place. The remedy includes the following components:

- Installation and sampling of three new wells by the LTM program starting in 1995 and continuing through 2014
- Initiating ICs starting in 2000 and continuing through 2014 to prevent residential land use and construction of domestic wells (see Section 4.4 for ICs details)

As part of remedy implementation, two monitoring wells (2MW-4 and 2MW-5) were installed in upgradient locations to assess whether there were additional VOCs sources, and well 2MW-6 was installed downgradient to track migration of VOCs. After evaluating the results from the first round of sampling in 1995, which included wells 2MW-1, 2MW-3, 2MW-4, 2MW-5, and

2MW-6, three wells (2MW-1, 2MW-5, and 2MW-6) were selected for sampling during subsequent monitoring between 1996 and 1999. Following a discussion with Ecology in 2000, the upgradient well (2MW-5) was dropped from the program and replaced with MW2-6 (a well established in 1990 during the RI). VOCs were not detected at well MW2-6 during the 2000 sampling event. Therefore, the Navy and Ecology agreed to replace MW2-6 with MW2-8 (a well established in 1990 during the RI) beginning with the 2001 sampling event. Based on the sampling conducted, no additional upgradient source has been identified. Vinyl chloride, a TCE breakdown product, was detected in the downgradient well 2MW-6 upon initial sampling, demonstrating VOC migration. However, concentrations of vinyl chloride in well 2MW-6 have been below the associated RG since 2007.

4.2.3 Monitoring

Based on the regulator-reviewed and -approved 5-year review recommendations and revised LTM work plan (U.S. Navy 2012h), sampling is conducted once every 2 years at three monitoring wells (2MW-1, 2MW-6, and MW2-8) for VOCs. The current monitoring frequency meets the requirements specified in the ROD. Groundwater monitoring frequency and locations are shown on Figure 4-3. The results of monitoring conducted since the third 5-year review are summarized in Section 6.4 and tabulated in Appendix B.

Sampling groundwater wells for 1,4-dioxane was added as a one-time sampling event in the 2006 work plan, with sampling occurring in 2007. 1,4-Dioxane was either not detected above the laboratory reporting limit or was detected below a level of concern, so no further 1,4-dioxane sampling was performed.

4.3 OU 2 AREA 8

4.3.1 Remedy Selection

The impacted media, COCs, RGs, RAOs, and description of the remedy components and status are summarized in Table 4-2. Further information on remedy selection can be obtained by reviewing Section 4.2 of the third 5-year review (U.S. Navy 2010a) included in Appendix A or on the EPA website http://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=1001102.

4.3.2 Remedy Implementation

The remedy for Area 8 has been implemented, construction is complete for all elements, monitoring activities are ongoing, and ICs are in place. The remedy includes the following components:

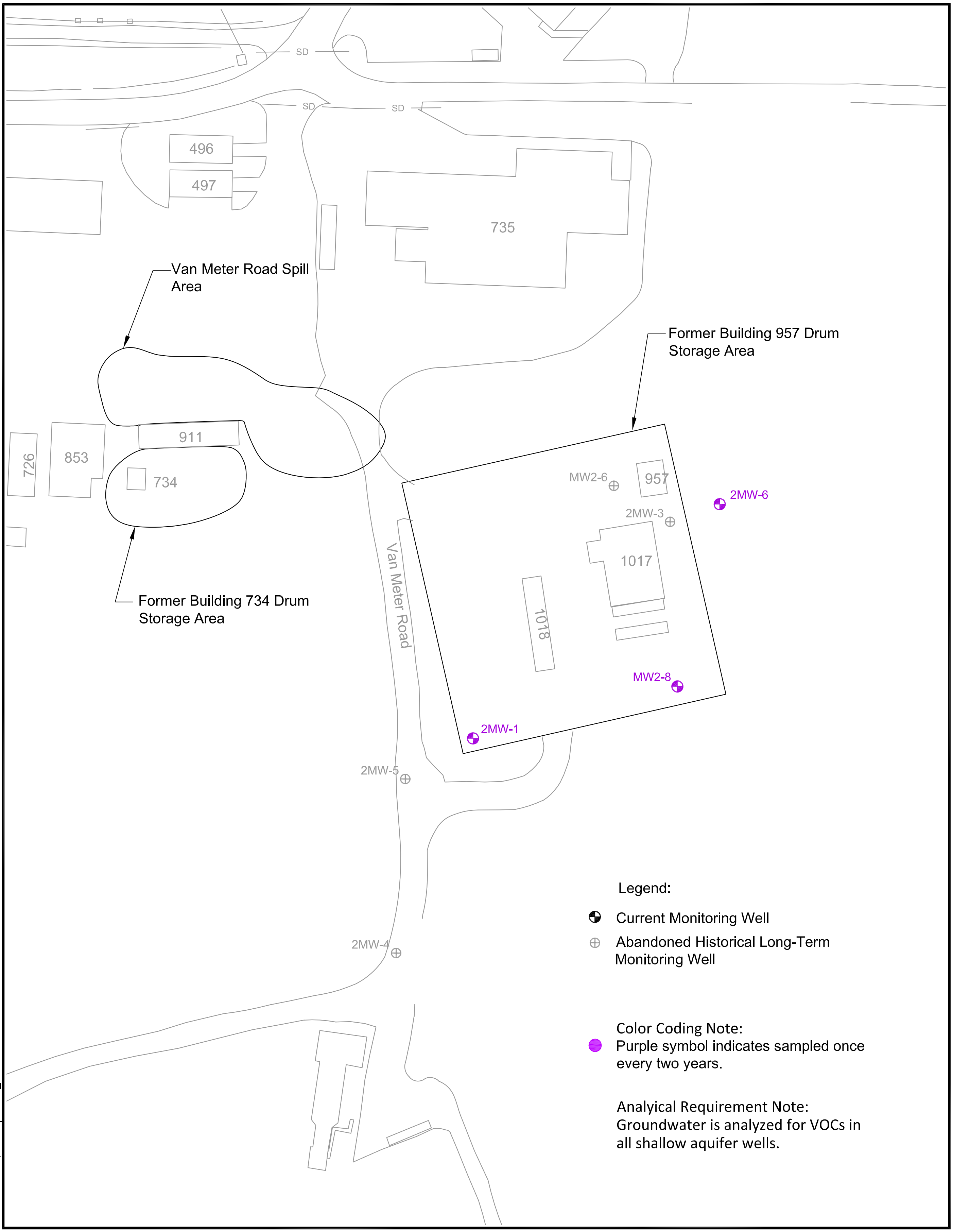

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Figure 4-3
Groundwater Long-Term Monitoring Locations at OU 2 Area 2

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- Building 72 demolition and hot spot soil removal in July 1998 and March 1999, based on cadmium and chromium concentrations exceeding state MTCA Method B cleanup levels for soil ingestion (80 mg/kg for cadmium and 400 mg/kg for chromium) (U.S. Navy 1999d)

- Initiating ICs in 2000 to prevent exposure to soil and groundwater during hypothetical future residential land use (see Section 4.4 for ICs details)

- Installation and LTM monitoring of four new wells starting in 1995 through 2014

- Initiating LTM monitoring of sediment and tissue in the intertidal zone of Area 8 in 1996 and every 4 years thereafter, including 2000, 2004, 2008, and 2012 (sediment only)

- Assessing human health and ecological risks based on tissue and sediment data

- Implementing contingent groundwater control actions if Area 8 groundwater is demonstrated to be a significant source of the chemicals that accumulate in sediments or tissue: Contingent groundwater control actions have not been implemented. The Navy is in the process of collecting additional sediments and tissue data (2015) and further evaluating human and ecological risks in intertidal sediment and clam tissue (planned for 2016/2017). Groundwater controls will be implemented if significant contaminant concentrations are found to be migrating from Area 8 that have accumulated in sediment or tissue, resulting in an unacceptable risk to human health or the environment.

In addition to the remedy components listed above, VOCs, SVOCs, and TPH as diesel in soil were also characterized in 1998 and 1999. The monitoring for the independent remedial actions under MTCA for diesel contamination has been completed, as discussed in Section 3. The monitoring of VOCs and SVOCs in groundwater for remedial actions under CERCLA is discussed below.

4.3.3 Monitoring

Monitoring at Area 8 has been conducted since the signing of the ROD and has included groundwater, sediment, and tissue sampling and analysis. During the first round of post-ROD sampling in 1995, groundwater samples were analyzed for SVOCs, VOCs, and inorganics as specified in the ROD. The SVOC results from that sampling round showed only one compound detected above the MTCA Method B cleanup level: bis(2-ethylhexyl)phthalate. Two other detections of SVOCs were extremely low. The first-round post-ROD monitoring report (U.S. Navy 1996c) concluded that SVOCs were not a significant problem in the groundwater at

Area 8, and analysis for SVOCs in groundwater was discontinued with the concurrence of all regulators and stakeholders (Ecology, EPA, and the Suquamish Tribe).

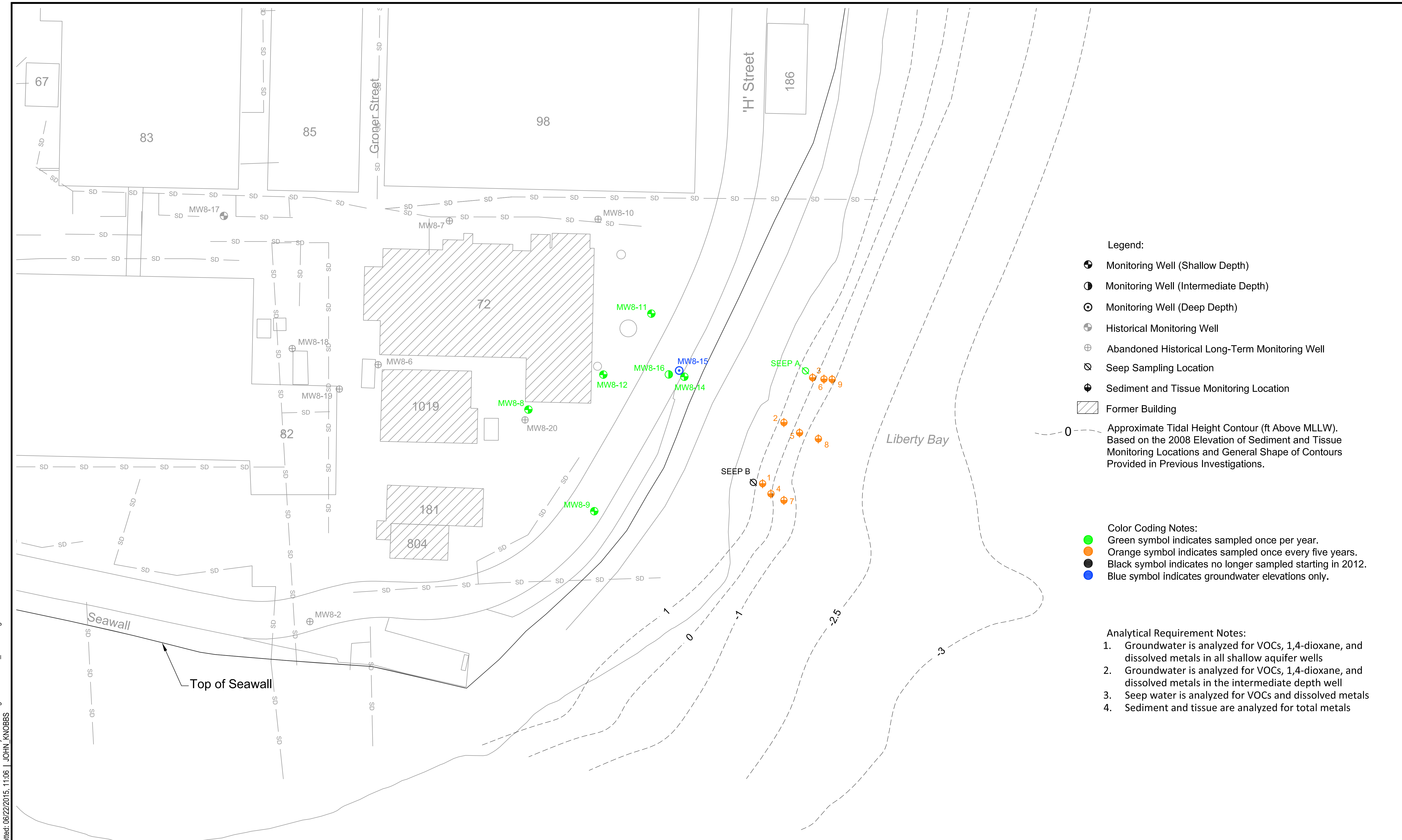
Inorganics, including arsenic, cadmium, chromium (total), hexavalent chromium, copper, lead, mercury, nickel, silver, thallium, zinc, and cyanide were analyzed for in groundwater starting in 1995. Chromium was speciated during initial rounds of groundwater sampling to assess the ratio of trivalent to hexavalent chromium. The data report covering the 2000 sampling event recommended that chromium speciation be discontinued based on the conclusion that measured total chromium values could be assumed to be 100 percent hexavalent chromium (U.S. Navy 2001). This report also recommended that cyanide be removed from the analyte list for tissue, seep, and sediment because it had not been detected in the groundwater samples since 1998. It was agreed by the Navy and Ecology that another round of cyanide sampling would be collected in groundwater from MW8-12 (historically the highest concentrations were observed at this well) in spring 2002 (U.S. Navy 2001). The cyanide concentration at MW8-12 during the 2002 sampling event was found to be well below both groundwater and surface water RGs, so groundwater analysis for cyanide was discontinued.

All Area 8 monitoring activities since the last 5-year review were performed in accordance with the regulator-approved LTM work plan (U.S. Navy 2012h), except tissue sampling. Sediment sampling offshore of Area 8 was conducted in 2012. Although tissue sampling was anticipated to occur at the same time as sediment sampling, it was delayed until the data needs for further refining the extent of contamination and performing ecological and human health risk assessments (HHRAs) could be determined in consultation with regulators and stakeholders. Monitoring frequency and locations are shown on Figure 4-4. The monitoring results conducted since the third 5-year review are summarized in Section 6.4 and tabulated in Appendix B.

4.4 INSTITUTIONAL CONTROLS FOR OU 1 AND OU 2

The first ICs management plan was prepared and finalized on May 19, 2000, to address the requirements outlined in both the OU 1 and OU 2 RODs (U.S. Navy 2000a). The plan was updated to include Site 23 in 2009 (U.S. Navy 2009a). The latest ICs plan was completed in 2012 (U.S. Navy 2012j). In addition, a Regional Land Use Control Instruction covering the Bremerton naval complex, Jackson Park Family Housing, Naval Hospital Bremerton, NBK Bangor, NBK Keyport, and Naval Magazine Indian Island was completed in 2012 (U.S. Navy 2012e).

Annual inspections of the ICs were conducted in June of 2010, 2011, 2012, 2013, and 2014 for OU 1, OU 2, and Site 23 concurrently. Annual inspections have included completion of the inspection checklist provided in the ICs plan (U.S. Navy 2012j) and preparation of a brief narrative report, both of which are submitted to Ecology and EPA. Inspected ICs match the requirements of the OU 1 and OU 2 RODs. Each narrative report summarizes and evaluates the findings of the inspection for each area, OU, and site, discusses any corrective actions needed, and presents conclusions regarding the ongoing effectiveness of the ICs. ICs for OU 1, OU 2, and Site 23 are summarized in Table 4-3. Results of the inspections are included in Section 6.4.5.



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NBK Keyport
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Figure 4-4
Long-Term Monitoring Locations
OU 2 Area 8

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Table 4-3
Summary of Institutional Controls for OU 1, OU 2, and Site 23

Site Name	Land Use Controls Inspected	Engineering Controls
Operable Unit 1		
Area 1, Former Landfill	• Prevent undue exposure to landfill contaminants. • Prevent digging/construction activities that could interfere with the remedial activities. • Prevent development at landfill, tide flat, marsh, and shoreline. • Allow no on-site domestic well construction or use of groundwater (except for environmental monitoring). • Enforce restrictions on occupancy of buildings on landfill (only occasional parking, storage, and occupancy by remedial workers). • Allow no off-site domestic well construction or use of groundwater within 1,000 feet of landfill.	• Maintain tide gate. • Maintain landfill cover. • Maintain shoreline and wetland protection systems. • Maintain facility fencing and signing. • Require dig permit. Monitoring: • Groundwater, surface water, seep, sediment, and tissue monitoring • Phytoremediation operation, maintenance, and monitoring • Risk and compliance monitoring • Intrinsic bioremediation monitoring • Tide gate inspection and maintenance • Contingent remedial action monitoring
Operable Unit 2		•
Area 2, Van Meter Road Spill/Drum Storage Area	• Ensure that site is used for industrial or commercial purposes only (prevent residential use). • Prevent digging/construction activities (disruption of wetlands). • Allow no on-site domestic well construction or use of groundwater (except for environmental monitoring).	• Restrict site access. • Maintain facility fencing and signing. • Require a dig permit. Monitoring: groundwater

Table 4-3
Summary of Institutional Controls for OU 1, OU 2, and Site 23

Site Name	Land Use Controls Inspected	Engineering Controls
Area 8, Former Plating Shop Waste/Oil Spill Area	• Ensure that site is used for industrial or commercial purposes only (prevent residential use). • Allow no on-site domestic well construction or use of groundwater. • Restrict construction activities to Navy only.	No engineering controls (contingent groundwater control action) • Maintain facility fencing and signing. • Require dig permit. Monitoring: • Groundwater long-term monitoring • Sediment and tissue long-term monitoring
Site 23		
None	• Ensure that site is used for industrial or commercial purposes only (prevent residential use). • Prevent digging/construction activities. • Allow no on-site domestic well construction or use of groundwater (except for environmental monitoring).	• Maintain facility fencing and signing. • Maintain asphalt paving. • Require dig permit.

5.0 PROGRESS SINCE LAST FIVE-YEAR REVIEW

This section summarizes the status of recommendations and follow-up actions from the last review, the results of implemented actions, including whether they achieved the intended purpose, and the status of any other prior issues. As listed in Table 5-1, the Navy has completed all of the actions recommended by the last 5-year review with the exception of those expected to be ongoing.

Significant progress has been made by the Navy to address stakeholder and regulator Area 1 site concerns and Area 8 recommendations from the third 5-year review. This includes additional investigations to better characterize and understand contaminant distribution and magnitude and site conditions at Areas 1 and 8, holding workgroup meetings with stakeholders and regulators to develop investigation and assessment plans and providing all related plans and investigation reports for stakeholder and regulatory review and comment resolution to ensure that all parties' concerns are addressed and work being performed will be accepted by all parties. Remaining actions on recommendations from the third 5-year review are under close coordination with stakeholders and regulators and are progressing according to an approved revised timeline.

Table 5-1
Summary of Progress Since Last 5-Year Review

No.	Recommendation/Follow-up Action From Third 5-Year Review (December 2010)	Completion Date	Notes Regarding Completion	Reference
Sitewide				
1	In the next revision of the LTM plan and institutional controls management plan, include language that states that the basis of the remediation goal (i.e., ARARs, PQLs, and risk assessment assumptions) must be reviewed (by regulators) prior to any change in monitoring or institutional controls requirements.	2/29/2012 and 8/9/2012	Updated the Keyport SAP (LTM work plan) for all three areas and the Sitewide ICs plan in 2012 to include the language "the basis of remedial goals must be reviewed prior to any change in monitoring or IC requirements." Completed the Navy's multiple installations IC instruction (includes NBK Keyport) in 2012, which contains the language "coordinate with Ecology and EPA to evaluate potential termination of institutional controls."	U.S. Navy 2012e, 2012h, and 2012j

Table 5-1 (Continiued)
Summary of Progress Since Last 5-Year Review

No.	Recommendation/Follow-up Action From Third 5-Year Review (December 2010)	Completion Date	Notes Regarding Completion	Reference
2	Evaluate ways to improve updates to the community.	Ongoing	A site status summary was prepared and sent to community members with the 5-year review interview forms in December 2014 to better inform the community about progress at the site.	NA
OU 1				
3	Perform the evaluation of natural attenuation and intrinsic bioremediation called for in Section 11.1.6 of the Record of Decision.	11/7/2012	Published results of natural attenuation and intrinsic bioremediation in 2012 and included regulator and stakeholder review and approval	U.S. Navy 2012c
4	Add 1,4-dioxane as an analyte for groundwater wells sampled for evaluation under the CRA plan. Revise the CRA plan to incorporate trigger levels for 1,4-dioxane in sentinel wells.	2/29/2012	Published revised CRA plan in 2012 with trigger levels for 1,4-dioxane Added 1,4-dioxane as an analyte in groundwater wells sampled under the CRA plan	U.S. Navy 2012i
5	In conjunction with EPA, Ecology, and the Suquamish Tribe, revise the LTM plan for OU 1.	2/29/2012	Updated the Keyport SAP (LTM work plan), including OU 1, in 2012 in collaboration with EPA, Ecology, and the Suquamish Tribe	U.S. Navy 2012h
6	In conjunction with EPA, Ecology, and the Suquamish Tribe, develops a SAP to assess chromium concentrations in sediment around location MA11, including an assessment of chromium concentrations in catch basin solids.	12/18/2012	Published SAP in April 2012 in collaboration with EPA, Ecology, and the Suquamish Tribe, and results of study published in chromium sediment evaluation report	U.S. Navy 2012a
OU 2 Area 2				
7	Revise the LTM plan to address potential changes in monitoring.	2/29/2012	Updated the Keyport SAP (LTM work plan), including Area 2, in 2012 to reduce sampling frequency from annual to biennial monitoring	U.S. Navy 2012h
8	Use selected ion monitoring analysis to achieve a PQL of 0.02 µg/L for vinyl chloride in water samples.	2/29/2012	Updated the Keyport SAP (LTM work plan), including Area 2, in 2012 to include EPA Method 8260-SIM analysis to achieve PQL of 0.02 µg/L for vinyl chloride	U.S. Navy 2012h

Table 5-1 (Continiued)
Summary of Progress Since Last 5-Year Review

No.	Recommendation/Follow-up Action From Third 5-Year Review (December 2010)	Completion Date	Notes Regarding Completion	Reference
OU 2 Area 8				
9	Include 1,4-dioxane in the analyte list for groundwater and seep samples during the 2011 LTM sampling event. Evaluate the need for additional monitoring or action related to 1,4-dioxane based on 2011 results.	2/14/2012 and 2/29/2012	Included 1,4-dioxane in the analyte list for sampling, and results included in Spring 2011 LTM report Updated the Keyport SAP (LTM work plan), including Area 8, in 2012 to include 1,4-dioxane in 2012 and later sampling events	U.S. Navy 2012h and 2012k
10	In conjunction with EPA, Ecology, and the Suquamish Tribe, prepare a SAP for sediment and marine tissue at OU 2 Area 8 and perform an additional ecological risk evaluation and HHRA based on the results of the sampling. A. Prepare SAP. B. Conduct sampling. C. Report sampling results. D. Perform ecological risk evaluation and HHRA.	A. Ongoing B. Summer 2015 C. Fall/winter 2015/2016 D. 2016/2017	The ROD requires human health and ecological risk evaluations to be performed on clam tissue after each tissue sampling event (once every 4 years). The most recent clam tissue sampling event was conducted in 2008. The risk assessments were performed using these data. However, regulatory/ stakeholder acceptance was not obtained. Currently the Navy is working in collaboration with EPA, Ecology, and the Suquamish Tribe to prepare a SAP for a marine investigation at Area 8 to gather the data necessary to support an acceptable human health and ecological risk assessment.	NA

Notes:
ARARs - applicable or relevant and appropriate requirements
CRA - contingent remedial action
Ecology - Washington State Department of Ecology
EPA - U.S. Environmental Protection Agency
HHRA - human health risk assessment
LTM - long-term monitoring
µg/L - microgram per liter
NA - not applicable
PQL - practical quantitation limit
SAP - sampling and analysis plan

6.0 FIVE-YEAR REVIEW PROCESS

This section discusses components of the 5-year review process as provided in EPA guidance (USEPA 2001), including establishing a review team and developing a schedule, notifying potentially interested parties, involving the community, and signing and submitting the 5-year review report 5 years after the trigger action date. Data and other site-specific information that form the foundation for the technical assessment of the remedy at the time of the 5-year review are also discussed in this section, including data and document review, site interviews, and site inspection.

This fourth 5-year review report for NBK Keyport was initiated in July 2014, completed using data generated from July 2009 through June 2014, and is due for signing and submittal by December 30, 2015.

6.1 FIVE-YEAR REVIEW TEAM

The review team for the fourth 5-year is composed of representatives from the Navy, EPA, Ecology, and the Suquamish Tribe, with the Navy as the lead agency for the review. Personnel from NAVFAC NW and NBK Keyport represent the Navy. Project managers and other staff from EPA and Ecology (cosignatories of the RODs for NBK Keyport) are part of the review team. In addition, a project manager from the Suquamish Tribe is part of the review team.

A kick-off meeting was conducted on October 14, 2014 with the review team. In preparation for the fourth 5-year review, the following topics were discussed: roles and responsibilities, schedule, status of the issues and recommendations from the third 5-year review, and potential issues to be evaluated during this 5-year review. Subsequent follow-up meetings were conducted to address review team comments on the 5-year review report. All review team members had the opportunity to provide input to this report.

6.2 COMMUNITY NOTIFICATION AND INVOLVEMENT

There are specific requirements pursuant to CERCLA Section 117(a), as amended, for certain reports to be released to the public and the public notified of proposed cleanup plans and remedial actions. The community notification and involvement activities are described below.

6.2.1 History of Community Notification and Involvement

The community has been informed of progress at the site through fact sheets, published public notices, open houses, public meetings, and bus tours of the sites. The proposed plans were circulated for public comment prior to finalization of the RODs. The community had substantial input into the remedy for the former landfill, causing the Navy to re-evaluate the proposed plan and segregate OU 1 from OU 2. Key documents have been made available for review at Navy facilities and at the Kitsap Regional Library in Bremerton, Washington, and the Poulsbo Branch Library in Poulsbo, Washington.

A community relations plan was prepared in 1990 and most recently updated in 2008. In 1988, a Technical Review Committee was established, with representatives from the public and governmental entities. The Technical Review Committee was replaced with a Restoration Advisory Board (RAB) in March 1995. The RAB members included representatives of the Navy, regulatory agencies, civic groups, private citizens, tribal governments, local governments, and environmental activist groups. The RAB was disbanded in October 2004.

6.2.2 Community Notification and Involvement During This Five-Year Review Period

A notice was published by the Navy on September 26, 2014, in the *Central Kitsap Reporter* informing the public that the site is currently undergoing a 5-year review, when, where, and how they could receive information, and how to provide comments on the protectiveness of the remedy. The Navy received no feedback or comments as a result of the public notices. Selected community members were interviewed as part of the site interview process described in Section 6.6.

6.3 DOCUMENT REVIEW

Documents reviewed during this 5-year review were primarily those describing monitoring of the selected remedies during the time period July 2009 to June 2014. The primary documents reviewed are listed below, and all other documents are included in Section 11, References:

- The signed RODs and Explanations of Significant Differences (U.S. Navy, USEPA, and Ecology 1994, 1996, and 1998)
- The first, second, and third 5-year review reports (U.S. Navy 2000b, 2005a, and 2010a)
- The LTM work plan (U.S. Navy 2012h)
- The monitoring reports (U.S. Navy 2010b, 2010c, 2010d, 2010e, 2011a, 2012b, 2012f, 2012g, 2012k, 2012l, 2012m, 2012n, 2012o, 2013a, 2013b, 2014b, 2014c, 2015a, 2015c, and 2015d)
- The intrinsic bioremediation reports (Dinicola 2014, Huffman 2014, and USGS 2012 and 2013)

- The RI report (U.S. Navy 1993a)
- Baseline risk assessments (U.S. Navy 1993b and 1993c)
- The revised O&M plan for phytoremediation at OU 1 (U.S. Navy 2012h)
- The contingent remedial action plan (U.S. Navy 2012i)
- ICs plans (U.S. Navy 2012e and 2012j)

6.4 DATA REVIEW

This section summarizes trends in data collected through the various monitoring programs at NBK Keyport, with emphasis on data collected since the last 5-year review. The monitoring programs are described in Section 4, and the implications of the data with respect to the functionality and protectiveness of the remedies are discussed in Section 7. For OU 1 and OU 2, Appendix B includes the complete set of cumulative data, Appendix C provides isoconcentration contour maps for select COCs in groundwater, and Appendix D shows the trend graphs for select COCs in groundwater, surface water, and seeps.

The data trends are discussed in the sections that follow by OU, area, and medium.

6.4.1 OU 1 O&M Activity Results

O&M at Area 1 consists of phytoremediation tree health inspection and maintenance and tide gate inspection and maintenance. The results of these inspections over this last 5-year review period are presented below.

OU 1 Phytoremediation and Tide Gate Monitoring

Periodic plantation inspections were conducted eight times per year during this 5-year review period (U.S. Navy 2010c, 2011a, 2012f, 2013a, 2014b, and 2015a). Trees at both plantations remained healthy throughout the 5-year review period. Fertilizer and pesticides were applied during the 2009 and 2010 growth seasons only. Starting in 2011, no fertilizer was applied in an effort to encourage deeper root growth. Although no pesticide was applied in 2011 through 2014, no pest infestations occurred. Pest infestations have been non-existent over the past few years, as compared to years prior to the first annual application of pesticide in 2005. Physical weeding greatly reduced the competition to trees from weeds. Watering was conducted periodically on an as-needed basis during the relatively dry periods (June through August) during 2009 to 2013. Irrigation of the plantations was discontinued in mid-2013 in an effort to maximize uptake of upper aquifer groundwater by the trees. Growth throughout this review period was not directly measured, but appeared to be in the range of the modest growth expected, considering the poor condition of soils at the site. No pruning was necessary to control rust, which can form when excessive moisture remains on leaves. Trees did not exhibit any stress from lack of water. No trees died during the five growing seasons, and the canopy remains closed. Additional comments regarding tree health were noted during the site inspection, in Section 6.5, including less tree canopy than previous years and burned leaves.

During this 5-year review period, tide gate inspection and maintenance events were conducted on a quarterly basis according to the project work plan (U.S. Navy 2012h). The purpose of the inspection is to document that the tide gate is working as intended and designed, preventing tidal flooding of the marsh, which could otherwise cause erosion of the landfill and/or adverse effects upon tree health. No tide gate repairs were required during 2010 through 2014. Routine tide gate cleaning and maintenance were conducted. Although some minor cracking was observed in the vacuum break air vent in 2013 and 2014 and minor pitting of metal surfaces was present in 2014, no repairs were required during 2013 and 2014 (U.S. Navy 2014b and 2015a).

Based on reviewing the last 5 years of phytoremediation groundwater elevation data and tide gate monitoring (U.S. Navy 2010b, 2010c, 2010d, 2010e, 2011a, 2012b, 2012f, 2012g, 2012k, 2012l, 2012m, 2012n, 2012o, 2013a, 2013b, 2014b, 2014c, 2015a, 2015c, and 2015d), it is recommended that water level monitoring frequency continue at once every 2 years and tide gate inspection on a quarterly basis. Based on concerns about tree health resulting from the 5-year review site inspection (included in Appendix E), it is recommended that tree health monitoring continue at a frequency of eight times per year.

6.4.2 OU 1 Monitoring Data Results

OU 1 monitoring data include groundwater elevation measurements and chemical analysis monitoring. Groundwater elevation measurements are not tabulated in this report, but are summarized in Appendix A of the 2014 OU 1 LTM report (U.S. Navy 2015a). Data collection results and trends are discussed below, and analytical results are tabulated in Appendix B.

Groundwater Elevation Measurements

Groundwater elevation measurements for OU 1 were collected under two monitoring programs, as originally established in the ROD and described in Section 4:

- Phytoremediation monitoring
- Risk and compliance monitoring

Phytoremediation groundwater elevation data were collected concurrently with risk and compliance groundwater level measurements at a frequency of once every 2 years, according to regulator-reviewed and -approved work plans (U.S. Navy 2012h). The groundwater elevation data are similar to those collected since the inception of phytoremediation at OU 1. Based on current and previous measurements, overall groundwater flow patterns in the upper aquifer have remained relatively constant since observations first began post-RI in 1996. The data do not reveal any discernible effect from the trees on groundwater flow direction or gradient (U.S. Navy 2015a).

The biennial measurements are conducted to monitor groundwater flow direction and hydraulic gradients of the upper and intermediate aquifers. The upper aquifer groundwater flow direction is depicted on Figure 3-2 and the intermediate aquifer groundwater flow is depicted on Figure 3-3 (U.S. Navy 2015a).

The potentiometric surface of the intermediate aquifer identified a moderate horizontal hydraulic gradient in June 2014 toward the tide flats, with little apparent influence from the marsh. Across the central to northern portion of the landfill, the horizontal hydraulic gradient of the intermediate aquifer was found to be comparable to historical values (U.S. Navy 2015a).

The vertical hydraulic data demonstrate consistent recharge from the upper aquifer to the intermediate aquifer on the upgradient side of the landfill and discharge from the intermediate aquifer to the upper aquifer on the cross-gradient to downgradient side (U.S. Navy 2015a).

Based on reviewing the last 5 years of groundwater elevation data (U.S. Navy 2010b, 2010c, 2010d, 2010e, 2011a, 2012b, 2012f, 2012g, 2012k, 2012l, 2012m, 2012n, 2012o, 2013a, 2013b, 2014b, 2014c, 2015a, 2015c, and 2015d), it is recommended that the frequency of water level monitoring continues at once every 2 years.

Near the end of this 5-year review period, the private property owner where piezometer PZ1-02 is located requested that the piezometer be removed. The Navy discussed with EPA, Ecology, and the Suquamish tribe whether or not a replacement location would be needed. They all concurred that a replacement piezometer was no longer required, given that the well was used exclusively for the measurement of groundwater level measurements to establish groundwater flow patterns and that measurements have been collected for 20 years with no appreciable change in groundwater flow patterns.

Groundwater Chemical Analysis Data

Groundwater data for OU 1 were collected under four monitoring programs, as originally established in the ROD and described in Section 4:

- Phytoremediation monitoring
- Risk and compliance monitoring

- CRA monitoring
- Intrinsic bioremediation monitoring

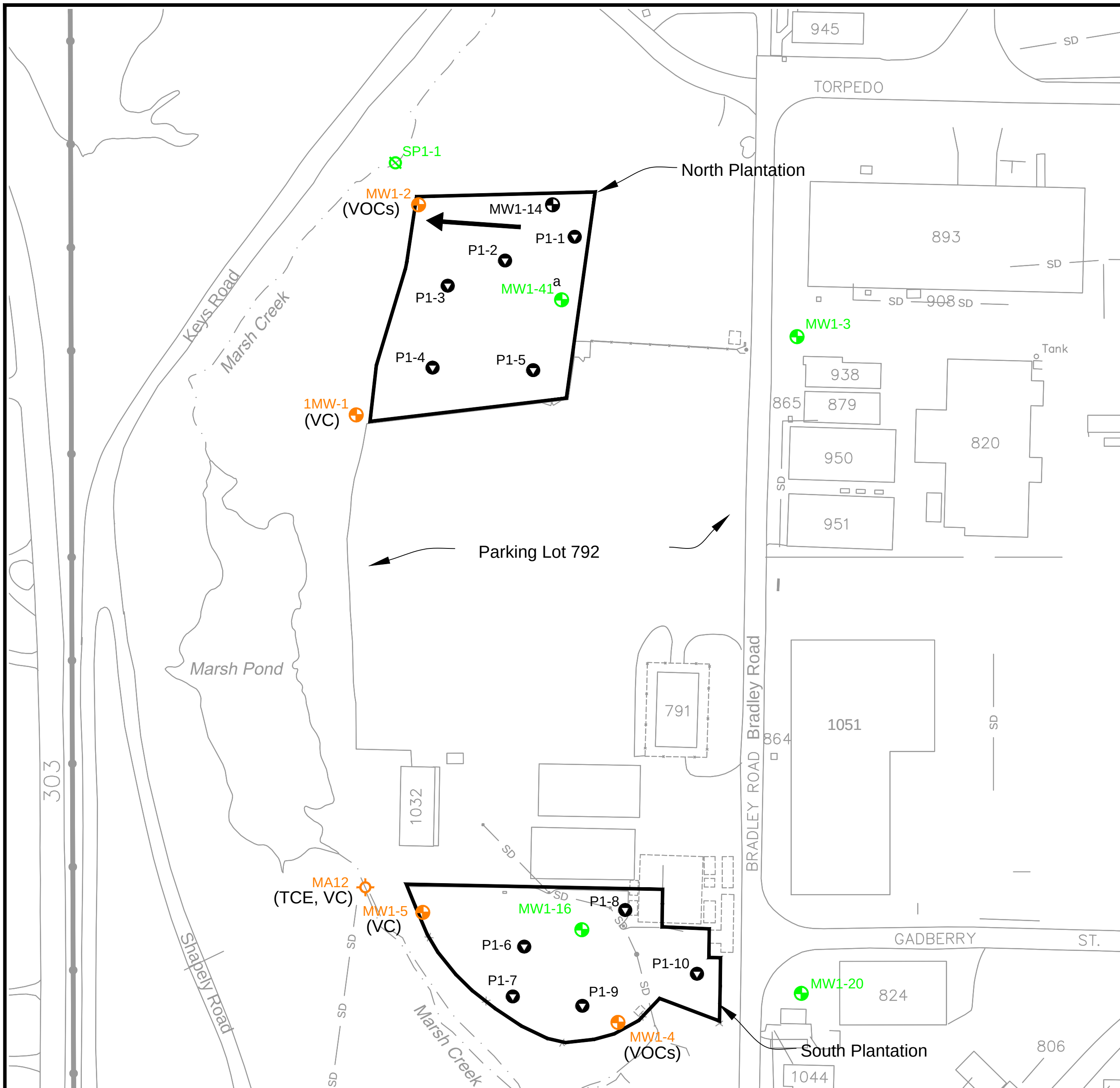
The overall COC trends and distribution in groundwater are discussed in this section. 1,4-Dioxane results are discussed separately in this section from other COC trends because it was added as a post-ROD analyte. Intrinsic bioremediation is discussed separately following the overall trend discussions.

Appendix B lists all historical and recent analytical results for the groundwater monitoring programs. Isoconcentration contour maps for select years and chemicals are provided in Appendix C. Overall trend graphs are included in Appendix D for the north plantation wells (1MW-1 and MW1-02), south plantation wells (MW1-04, MW1-05, and MW1-16) and piezometers (P1-6 through P1-10, sampled by USGS), central landfill well (MW1-17), and an upgradient well (MW1-03).

Phytoremediation Monitoring Data. Figure 6-1 indicates which phytoremediation monitoring locations at OU 1 currently exceed RGs. As listed in Table 6-1, target COCs in the north and south plantations generally exhibited overall stable or decreasing trends. Significant exceedances and trends are discussed further below. Results regarding piezometers and passive diffusion bags (a.k.a., peepers) are discussed under the intrinsic bioremediation monitoring section below.

North Plantation Data Trends. Appendix B Table B-1 contains the compiled, tabulated analytical results for the north plantation groundwater monitoring. As shown on Figure 6-1, north plantation wells exceed VOC RGs except at MW1-41. Although RGs are exceeded, as shown on Table 6-1, the trends over the last 5 years are stable and decreasing. Overall trends for upper aquifer wells over the lifetime of the monitoring are also decreasing and stable and are provided in Appendix D (Figures D-1a and D-2b).

COC concentration trends in the shallow aquifer beneath the North Plantation were also assessed spatially using isoconcentration contour maps prepared for selected COCs (TCE, 1,1-DCE, cis-1,2-DCE, and vinyl chloride). Maps were prepared depicting COC concentrations at four times, 1999/2000, 2004, 2010, and 2014. These maps, presented as Figures C-1 through C-16, demonstrate decreasing TCE and 1,1-DCE concentrations and plume footprint from the time of remedy implementation (1999/2000) to 2014. A clear trend in overall concentrations and plume footprint is much less apparent for cis-1,2-DCE. The overall vinyl chloride concentrations and distribution are interpreted to be similar in 2014 as compared to the time of remedy implementation, based primarily on the similarity of the concentrations at piezometer P1-4.



Color Coding Notes:
- Green symbol indicates no current exceedance of RGs.
- Orange symbol indicates current exceedance of RGs.
- Black symbol indicates location was not sampled.

Abbreviations:
RG - remediation goal
TCE - trichloroethene
VC - vinyl chloride
VOCs - volatile organic compounds

Legend:
- Piezometer
- Monitoring Well (Shallow Depth)
- Seep Sampling Station
- Surface Water Sampling Station
- Sediment and Surface Water Sampling Station
- a Last Sampled in 2011

Analytical Results Notes:
1. Groundwater, seep water, and surface water were analyzed for VOCs.
2. Drinking water and surface water RGs are based on protection of human health.

U.S. NAVY	0 75 150 SCALE IN FEET	**Figure 6-1 2014 Phytoremediation Monitoring Locations at OU 1**	NBK Keyport FOURTH FIVE-YEAR REVIEW

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Table 6-1
Summary of Data Trends in Groundwater, Surface Water, and Seeps at OU 1

Location	Chemical	Maximum Concentration in Last 5 Years (µg/L)	Drinking Water RG[a] (µg/L)	Surface Water RG[b] (µg/L)	Exceeds Drinking Water RG?	Exceeds Surface Water RG?	Trend of Last 5 Years[c]	Overall Trend[d]
North Plantation								
1-MW-1	TCE	0.17 J	5	56	No	No	Stable	Stable
	1,1-DCE	0.46 J	0.5	1.9	No	No	Stable	Decreasing
	trans-1,2-DCE	67	100	33,000	No	No	Stable	Decreasing
	cis-1,2-DCE	39 J	70	NE	No	NA	Stable	Decreasing
	Vinyl chloride	420	0.5	2.9	**Yes**	Yes	Decreasing	Decreasing
	1,1-DCA	9.2	800	NE	No	NA	Stable	Stable
MW1-02	**TCE**	7.5	5	56	**Yes**	No	Stable	Decreasing
	1,1-DCE	1.9	0.5	1.9	**Yes**	Yes	Stable	Decreasing
	trans-1,2-DCE	14	100	33,000	No	No	Stable	Decreasing
	cis-1,2-DCE	490 J	70	NE	**Yes**	NA	Stable	Decreasing
	Vinyl chloride	110	0.5	2.9	**Yes**	Yes	Stable	Stable/decreasing
	1,1-DCA	0.37 J	800	NE	No	NA	Stable	Decreasing
South Plantation								
MW1-04	**TCE**	32,000 J	5	56	**Yes**	Yes	Highly variable	Stable
	1,1-DCE	25 J	0.5	1.9	**Yes**	Yes	Highly variable	Stable
	trans-1,2-DCE	170 J	100	33,000	**Yes**	No	Highly variable	Stable/decreasing
	cis-1,2-DCE	17,000 J	70	NE	**Yes**	NA	Highly variable	Stable
	Vinyl chloride	960 J	0.5	2.9	**Yes**	Yes	Highly variable	Decreasing
MW1-05	TCE	0.52	5	56	No	No	Stable	Decreasing
	trans-1,2-DCE	0.55	100	33,000	No	No	Stable	Decreasing
	cis-1,2-DCE	0.85	70	NE	No	NA	Stable	Decreasing
	Vinyl chloride	17	0.5	2.9	**Yes**	Yes	Highly variable	Decreasing
	1,1-DCA	2.6	800	NE	No	NA	Stable	Decreasing
MW1-16	TCE	3.2	5	56	No	No	Decreasing	Decreasing
	1,1-DCE	1.2 J	0.5	1.9	**Yes**	No	Stable	Decreasing

Table 6-1 (Continued)
Summary of Data Trends in Groundwater, Surface Water, and Seeps at OU 1

Location	Chemical	Maximum Concentration in Last 5 Years (µg/L)	Drinking Water RG[a] (µg/L)	Surface Water RG[b] (µg/L)	Exceeds Drinking Water RG?	Exceeds Surface Water RG?	Trend of Last 5 Years[c]	Overall Trend[d]
	trans-1,2-DCE	34	100	33,000	No	No	Decreasing	Decreasing
	cis-1,2-DCE	1,300	70	NE	**Yes**	NA	Stable	Decreasing
	Vinyl chloride	360	0.5	2.9	**Yes**	Yes	Highly variable	Decreasing
	1,1-DCA	1,500	800	NE	**Yes**	NA	Decreasing	Decreasing
P1-6	**TCE**	23.2	5	56	**Yes**	No	Decreasing	Decreasing
	trans-1,2-DCE	78.2	100	33,000	No	No	Decreasing	Decreasing
	cis-1,2-DCE	8,600	70	NE	**Yes**	NA	Decreasing	Decreasing
	Vinyl chloride	3,800	0.5	2.9	**Yes**	Yes	Highly variable	Decreasing
	1,1-DCA	211	800	NE	No	NA	Decreasing	Decreasing
P1-7	**TCE**	33,800	5	56	**Yes**	Yes	Increasing	Stable/decreasing
	1,1-DCE	ND	0.5	1.9	No	No	ND	Stable/decreasing
	trans-1,2-DCE	305	100	33,000	**Yes**	No	Increasing	Stable
	cis-1,2-DCE	55,700	70	NE	**Yes**	NA	Increasing	Stable
	Vinyl chloride	6,850	0.5	2.9	**Yes**	Yes	Increasing	Stable
P1-8	TCE	ND	5	56	No	No	ND	Decreasing
	trans-1,2-DCE	30,900	100	33,000	**Yes**	No	Stable	Decreasing
	cis-1,2-DCE	9,090	70	NE	**Yes**	NA	Decreasing	Decreasing
	Vinyl chloride	774	0.5	2.9	**Yes**	Yes	Stable	Decreasing
P1-9	**TCE**	10,200	5	56	**Yes**	Yes	Decreasing	Decreasing
	trans-1,2-DCE	262	100	33,000	**Yes**	No	Stable	Decreasing
	cis-1,2-DCE	30,900	70	NE	**Yes**	NA	Stable	Decreasing
	Vinyl chloride	2,590	0.5	2.9	**Yes**	Yes	Highly variable	Decreasing
P1-10	**TCE**	4,130	5	56	**Yes**	Yes	Stable	Decreasing
	trans-1,2-DCE	20	100	33,000	No	No	Stable	Decreasing
	cis-1,2-DCE	4,390	70	NE	**Yes**	NA	Highly variable	Decreasing
	Vinyl chloride	1,150	0.5	2.9	**Yes**	Yes	Increasing	Decreasing

Table 6-1 (Continued)
Summary of Data Trends in Groundwater, Surface Water, and Seeps at OU 1

Location	Chemical	Maximum Concentration in Last 5 Years (µg/L)	Drinking Water RG[a] (µg/L)	Surface Water RG[b] (µg/L)	Exceeds Drinking Water RG?	Exceeds Surface Water RG?	Trend of Last 5 Years[c]	Overall Trend[d]
Central Landfill								
MW1-17	**1,1-DCE**	1.9	0.5	1.9	**Yes**	Yes	Stable	Stable
	cis-1,2-DCE	430	70	NE	**Yes**	No	Increasing	Increasing
	Vinyl chloride	89	0.5	2.9	**Yes**	Yes	Increasing	Increasing
Surface water MA12	TCE	140	NA	56	NA	Yes	Stable	Stable
	1,1-DCE	1.5	NA	1.9	NA	No	Stable	Increasing
	trans-1,2-DCE	5.8	NA	33,000	NA	No	Stable	Stable
	cis-1,2-DCE	830	NA	NE	NA	NA	Stable	Stable
	Vinyl chloride	91	NA	2.9	NA	Yes	Stable	Decreasing
	1,1-DCA	2.7 J	NA	NE	NA	NA	Decreasing	Decreasing
Seep SP1-1[e]	TCE	0.14 J	NA	56	NA	No	Stable	Stable
	trans-1,2-DCE	0.14 J	NA	33,000	NA	No	Stable	Highly variable
	cis-1,2-DCE	0.40 J	NA	NE	NA	NA	Stable	Decreasing
	Vinyl chloride	0.31 J	NA	2.9	NA	No	Stable	Decreasing
	1,1-DCA	0.10 J	NA	NE	NA	NA	Stable	Highly variable
	PCBs	0.696	NA	0.04	NA	Yes	Increasing	Stable

[a]Drinking water RG values are from OU 2 ROD.
[b]Surface water RG values are from OU 2 ROD.
[c]Trends were interpreted from the last 5 years of data and trend graphs (see Appendices B and D).
[d]Trends were interpreted by trend graphs (see Appendix D).
[e]Seep sample was not sampled in 2012 or 2013. Therefore, the last 5 years of data consist of years 2009 through 2011 and 2014 only.

Notes:
Bolded value indicates concentration exceeds or is equal to the RG for drinking water.
Red font indicates the trend is increasing where there is an exceedance of an RG.
Yellow highlighted indicates concentration exceeds or is equal to the RG for surface water.
"Stable" means that the concentrations are similar from year to year.
"Highly variable" means that the concentrations fluctuate up and down from year to year.

Table 6-1 (Continued)
Summary of Data Trends in Groundwater, Surface Water, and Seeps at OU 1

DCA - dichloroethane
DCE - dichloroethene
J - The result is an estimated concentration that is less than the method reporting limit, but greater than or equal to the method detection limit.
µg/L - microgram per liter
NA - not applicable
ND - not detected
NE - not established
RG - remediation goal
TCE - trichloroethene

South Plantation Data Trends. Table B-1 contains the compiled, tabulated analytical results for the south plantation groundwater monitoring. MW1-04 continued to display very high concentrations as in the previous 5-year review. Unusually high detections were noted at MW1-05 in 2014 for TCE and at MW1-16 in 2011 for multiple VOCs. Current VOC concentrations at all south plantation wells exceed VOC RGs, except MW1-16, as depicted on Figure 6-1. As shown on Table 6-1, the trends for select wells over the last 5 years are stable or decreasing (except VOCs at piezometers P1-7 and P1-10 are increasing), although results for some chemicals are highly variable making it difficult to assess a trend. Overall trends are stable and decreasing as shown on graphs in Appendix D (Figures D-3a through D-10b). Additional information regarding concentrations for MW1-04 and piezometer P1-7 are discussed here. A more detailed discussion regarding trends at all the piezometer locations is presented in the intrinsic bioremediation section below.

TCE concentration trends at well MW1-04 and piezometer P1-7 have been consistently stable, regardless of the wide seasonal swings. These data indicate the presence of residual source material (sorbed TCE) in the vicinity of the southern boundary of the south plantation. The dissolved TCE concentrations in groundwater samples collected from these two monitoring wells remain two orders of magnitude less than the aqueous solubility limit for TCE, so the concentrations are not directly indicative of nonaqueous-phase TCE.

Isoconcentration contour maps for COCs in the shallow aquifer beneath the south plantation were prepared for TCE, 1,1-DCE, cis-1,2-DCE, vinyl chloride, and total chlorinated VOCs (CVOCs) for the years 1999/2000, 2004/2005, 2010, and 2014 and are included in Appendix C. These maps demonstrate a contraction of the TCE plume footprint from an area covering most of the south plantation to a smaller area along the southern edge of the plantation. The maximum TCE concentrations in some wells and piezometers along this southern plantation edge, however, have remained in the same order of magnitude over the time frame of 1999 through 2014 (in particular, P1-7 and MW1-04). Similar, but less pronounced spatial and temporal patterns are apparent for the breakdown compounds 1,1-DCE, cis-1,2-DCE, and vinyl chloride. For vinyl chloride in particular, the overall plume footprint (as represented by the 0.5-µg/L contour, has not contracted substantially since 1999. However, the core of the vinyl chloride plume (as represented by the 1,000-µg/L contour) has contracted substantially.

When the COC plume in the shallow aquifer beneath the south plantation is assessed as the sum of CVOCs, the overall plume footprint contracts somewhat from 1999 through 2014, and the core of the plume contracts substantially, with the highest concentrations now located in the vicinity of piezometer P1-7 (see Figures C-33 through C-36 in Appendix C).

Evaluation of the isoconcentration contours overall with consideration of the data from the passive diffusion bags monitored by the USGS implies a primary groundwater to surface water

COC transport pathway from the area of piezometer P1-7 to the reach of Marsh Creek between Stations S-4 and S-5B (see Appendix C).

Upgradient Wells Data Trends. As shown on Figure 6-1, chemicals have not been detected above RGs at wells MW1-03 and MW1-20. Table B-1 contains the tabulated analytical results for these wells.

Risk and Compliance Monitoring Data. Figure 6-2 indicates which risk and compliance monitoring locations at OU 1 exceeds RGs. Appendix B lists all historical and recent analytical results. As listed in Table 6-1, target COCs in the north plantation, south plantation, and central landfill area generally exhibited overall stable or decreasing trends, except at well MW1-17 which is discussed below. Isoconcentration contour maps are provided in Appendix C and overall trend graphs for upper aquifer wells in Appendix D. Results regarding piezometers and peepers are discussed under the intrinsic bioremediation monitoring section below.

Because most of the upper aquifer phytoremediation monitoring program wells are the same as the risk and compliance monitoring program wells, the exceedances and trends for north and south plantation wells already discussed will not be repeated here. The central landfill shallow aquifer well and intermediate and deep aquifer wells are included in risk and compliance monitoring and are discussed below.

Central Landfill Area Data Trends. Only well MW1-17 was sampled in the central landfill, and it exceeded VOC RGs (Figure 6-2). MW1-17, located downgradient of the central portion of the landfill, has historically exhibited low COC concentrations below the RGs, with the exception of vinyl chloride. However, during the last 5 years, concentrations of 1,1-DCE that were consistently below the drinking water RG have increased to above the RG, cis-1,2-DCE concentrations have increased from levels just above the drinking water RG to 5 times the RG, and vinyl chloride concentrations have increased from levels 30 times above the drinking water RG to over 100 times above the RG, with the highest detected concentrations occurring in June 2013 for all three compounds (see Appendix B Table B-1). As shown on Appendix D Figure D-11, overall trends in well MW1-17are stable for 1,1-DCE and increasing for 1,2-DCE and vinyl chloride. Concentration increases in breakdown products such as 1,2-DCE and vinyl chloride are expected as part of biodegradation of parent compounds such as PCE and TCE. However, the consistently increasing concentrations of breakdown products in well MW1-17 over the last 10 years implies that a plume of degradation products is beginning to reach well MW1-17 from a previously unidentified source located upgradient of this well.

Figures C-9 through C-13 (Appendix C) show the COC concentrations in groundwater over time and indicate increasing concentrations at well MW1-17. Well MW1-17 is located downgradient of the central landfill. Therefore, a separate source area east and somewhat south of MW1-17 could be postulated based on the groundwater flow direction that is generally from east to west-northwest (Figure 6-2). However, there is also uncertainty regarding the source, since limited groundwater or other data have been collected from within the central landfill area.

Intermediate and Deep Aquifer Well Data Trends. The following additional wells are monitored under the risk and compliance program:

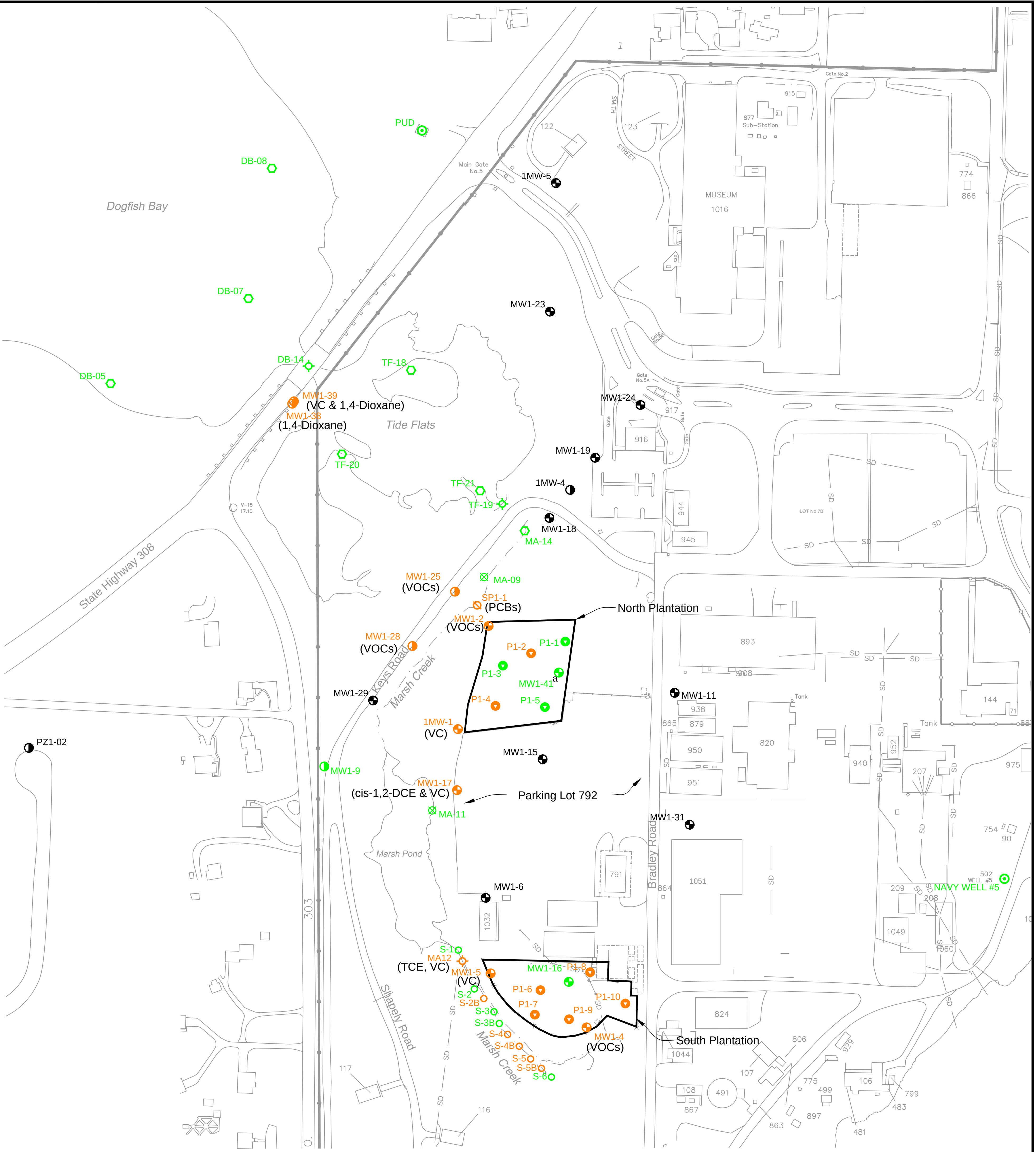
- Intermediate aquifer wells MW1-09, MW1-25, MW 1-28, MW1-38, and MW1-39
- Deep aquifer wells Navy Well #5 and PUD well

The wells screened in the intermediate aquifer were sampled according to the regulator-approved LTM work plan (U.S. Navy 2012h). RGs were exceeded in all of these wells except for MW1-09 and MW1-38 (see Table B-1). MW1-09, located downgradient of the central landfill area and south plantation, has exhibited no detection of VOCs since monitoring began in 1995. Trends over the last 5 years appear to be stable. Overall trends for those chemicals detected above RGs are stable to decreasing at wells MW1-25, MW1-28, and MW1-38, except cis-1,2-DCE. Concentrations of cis-1,2-DCE have slightly increased from 1,300 μg/L in 2000 to 1,600 μg/L in 2014. Trend graphs were not performed on the intermediate aquifer in the LTM reports because of the low number of detected contaminant concentrations over time and thus are not available for inclusion in this report.

The two wells screened in the deep aquifer (Navy Well #5 and PUD well) are sampled annually in accordance with the regulator-approved LTM work plan (U.S. Navy 2012h). Target VOCs were not detected in these two wells during any sampling event (see Table B-1). Overall trends were not performed for these wells because there were no detections and thus there are no trends.

CRA Monitoring Data. Wells MW1-09, MW1-38, and MW1-39, screened in the intermediate aquifer, were sampled according to the CRA plan (U.S. Navy 2012i). Deep aquifer wells (Navy Well #5 and PUD well) are monitored as part of the CRA plan, and target VOCs were not detected, as discussed previously. Figure 6-2 indicates which CRA monitoring locations at OU 1 exceed RGs. RGs were not exceeded except for vinyl chloride at MW1-39 (see Table B-1). Trends over the last 5 years appear to be stable. Overall trend graphs were not completed based on low or no detections of COCs.

1,4-Dioxane Monitoring Data. As shown on Figure 6-2, the MTCA Method B value for 1,4-dioxane was exceeded in groundwater at wells MW1-38 and MW1-39 in the most recent round of sampling data (see Table B-2 of Appendix B). Groundwater samples from the 16 monitoring wells were analyzed for 1,4-dioxane in July 2006 (see Table B-2 of Appendix B). At that time, 1,4-dioxane was detected in the north plantation, central landfill, and downgradient of the north plantation at concentrations ranging from 1 to 29 μg/L. It was not detected in the south plantation wells. Analysis for 1,4-dioxane was performed again in 2012 and 2014 at intermediate and deep aquifer wells based on Recommendation 4 of the third 5-year review (see Appendix B



Color Coding Notes:
- Green symbol indicates no current exceedance of RGs.
- Orange symbol indicates current exceedance of RGs.
- Black symbol indicates location not sampled.

Analytical Results Notes:
1. Groundwater was analyzed for VOCs in all shallow, intermediate, and deep aquifer wells.
2. Groundwater was also analyzed for 1,4-dioxane in wells MW1-9, MW1-38, MW1-39, Navy Well #5 and PUD Well. An RG was not established for 1,4-dioxane. 1,4-Dioxane is compared to the MTCA Method B value.
3. Seep water was analyzed for VOCs and PCBs.
4. Surface water was analyzed for VOCs.
5. Sediment was analyzed for metals.
6. Piezometers and peepers were analyzed for VOCs as part of the intrinsic bioremediation monitoring program. Multiple VOCs were detected at these locations.
7. Groundwater RG is based on drinking water. Surface water RG is based on protection of human health. Sediment RGs are based on protection of ecological health (Sediment Management Standards).

Abbreviations:
DCE - dichloroethene
PCBs - polychlorinated biphenyls
RG - remediation goal
TCE - trichloroethene
VC - vinyl chloride
VOCs - volatile organic compounds

Legend:
- Piezometer
- Monitoring Well (Shallow Depth)
- Monitoring Well (Intermediate Depth)
- Monitoring Well (Deep Depth)
- Surface Water Sampling Station
- Seep Sampling Station
- Sediment Sampling Station
- Sediment and Surface Water Sampling Station
- Passive-Diffusion Sampler Site
- a Last Sampled in 2011

U.S. NAVY	0 100 200 SCALE IN FEET	**Figure 6-2** **2014 Risk and Compliance Monitoring Locations at OU 1**	NBK Keyport FOURTH FIVE-YEAR REVIEW

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Table B-2), and concentrations ranged from not detected to 2.5 µg/L. The detection limit achieved during all sampling events was 1.0 µg/L. No RG is established for 1,4-dioxane. However, the current MTCA Method B cleanup level is 0.44 µg/L, as documented in the CRA plan. This value was exceeded in wells MW1-01, MW1-02, MW1-17, MW1-25, MW1-28, MW1-38, and MW1-39 (see Appendix B Table B-2). However, detected concentrations are below any trigger requiring action in the CRA plan. Based on the lower cleanup level established in the CRA plan, this 5-year review recommends that all OU 1 monitoring wells currently being sampled for this emerging contaminant be analyzed using a laboratory analytical method that can achieve a reporting limit of 0.4 µg/L.

Summary of OU 1 Groundwater Monitoring Recommendations. Based on reviewing the last 5 years of data, the following changes are recommended for the groundwater monitoring programs:

- Based on a published change in the toxicity value for 1,4-dioxane, the MTCA Method B cleanup level has decreased from 4 to 0.44 µg/L. Therefore, this 5-year review recommends that future monitoring for 1,4-dioxane use a laboratory analytical method that can achieve a reporting limit of 0.4 µg/L. The wells included in the CRA plan (MW1-09, MW1-38, and MW1-39) will continue to be analyzed for 1,4-dioxane once every 2 years. It is recommended that the frequency of sampling for Navy Well #5 and PUD well be changed to once every 2 years, instead of sampling on an annual basis.

- Collect a groundwater sample from well MW1-15, located upgradient and somewhat cross gradient from well MW1-17, and from well MW1-6, upgradient and somewhat cross gradient from surface water sampling station MA12, to assess current COC concentrations in the landfill area upgradient of well MW1-17 and the potential for surface water contaminants to be originating in the central portion of the landfill. Based on the results of these samples, determine if the addition of wells MW1-15 and/or MW1-6 to the long-term groundwater monitoring program is warranted.

The frequency of sampling should be maintained for the groundwater monitoring programs, as follows:

- Maintain the current monitoring frequency on an annual basis for downgradient central landfill well MW1-17, based on increasing concentrations.

- Maintain the current monitoring frequency on an annual basis for south plantation wells MW1-04, MW1-05, and MW1-16, based on exceeding RGs and very high concentrations at MW1-04. Maintain the current monitoring frequency on an annual basis for upgradient well MW1-20.

- Maintain the current monitoring frequency of once every two years in north plantation wells 1MW-1 and MW1-2, based on stable or decreasing concentrations in these wells. Maintain the current monitoring frequency of once every 2 years for upgradient well MW1-3.

- Maintain the current monitoring frequency of once every 5 years in wells downgradient north plantation wells MW1-25 and MW1-28 based on stable concentrations.

- Maintain the current monitoring frequency of once every two years in downgradient central landfill well MW1-9, and in downgradient north plantation wells MW1-38 and MW1-39 to meet the requirements of the CRA plan (U.S. Navy 2012i).

- Continue monitoring on an annual basis Navy Well #5 and PUD well based on the OU 1 ROD.

The recommended changes to OU 1 monitoring will be incorporated into the overall revisions to the OU 1 LTM plan and implemented with plan approval by regulators and stakeholders (Section 8).

Intrinsic Bioremediation Monitoring Data. Overall conclusions based on the bioremediation monitoring data collected over the last five years are the following:

- Data are similar to previous years. No widespread changes in groundwater conditions were identified in 2014 that should result in less favorable conditions for the reductive dechlorination process.

- Data indicate the presence of a persistent and ongoing source in the south plantation.

Intrinsic bioremediation monitoring was implemented by the Navy under an agreement with USGS to monitor natural attenuation (biodegradation) processes at the site. Intrinsic bioremediation monitoring is conducted annually and is timed to coincide with the LTM/phytoremediation monitoring period for OU 1. The most recent published report by USGS for intrinsic bioremediation monitoring addressed groundwater chemistry and analytical testing for 1999 through 2013 (Huffman 2014). The unpublished data from the 2014 sampling event are not expected to change the conclusions in the Huffman (2014) report (Dinicola 2014).

Evaluation of the 1999 through 2013 geochemistry studies and data has revealed that reductive dechlorination (i.e., natural biodegradation) of CVOCs has been ongoing. However, contaminant reduction has been more apparent in the north plantation than in the south plantation. Overall and similar to previous years, no widespread change in groundwater conditions was identified in 2014 that should result in less favorable conditions for the reductive dechlorination process.

Review of the results for CVOC piezometer data from the upper aquifer beneath the north plantation indicates that concentrations in 2007 through 2014 at most piezometers were similar to or slightly less than measured in previous years (see Appendix B Table B-3). USGS concluded that reductive dechlorination is a substantial cause of the downward trend in VOC contaminant concentrations beneath the north plantation. Figure 6-2 shows that RGs were exceeded at piezometers P1-2 and P1-4, but were not exceeded at P1-1, P1-3, and P1-5. No overall trends were performed for the north plantation piezometers.

For the upper aquifer beneath the south plantation, CVOC concentrations at the piezometers were most often extremely high and continued to exhibit considerable variances, both spatially and over time (see Appendix B Table B-3). These results are consistent with those found at monitoring well MW1-04 in the south plantation. Although groundwater conditions are favorable for the reductive dechlorination process beneath both the north and south plantations, elevated levels of VOC contamination continue to be detected in the south plantation, indicating the presence of a persistent and ongoing source. Figure 6-2 shows that RGs for multiple VOCs were exceeded at all piezometers in the south plantation. As shown in Table 6-1, the trends for south plantation piezometers over the last 5 years are stable or decreasing, except for VOCs at P1-7 and vinyl chloride at P1-10. However, results for some chemicals are highly variable, making it difficult to assess a trend. Although unusually high detections were noted at P1-8 and P1-9 in 2011 for multiple VOCs, overall trends are stable and decreasing for the south plantation piezometers (see Appendix D Figures D-6a to D-10b).

Also, listed in Appendix B Table B-3 are the passive diffusion sampler results (S-1 through S-6). As shown on Figure 6-2, locations S-2B, S-4, S-4B, S-5, and S-5B have some VOCs that exceed groundwater RGs in the most recent round of sampling data. Trend analysis was not conducted because of highly variable results.

With respect to the 2013 dechlorination evaluation performed by the USGS (Huffman 2014), concentrations of redox-sensitive constituents measured at all landfill or downgradient wells and piezometers were consistent with those measured in previous years, with all dissolved oxygen concentrations at 0.2 mg/L; little to no detectable nitrate; abundant dissolved manganese, iron, and methane; and commonly detected sulfide. In the upper aquifer of the north plantation in 2013, CVOC concentrations at all piezometers were similar to those measured in previous years, with total CVOC concentration at piezometer P1-4 (located in the north plantation's southwest quadrant [see Figure 4-3]) the lowest measured at that site. Concentrations of the reductive dechlorination byproducts ethane and ethene throughout the north plantation were slightly lower or the same as concentrations measured in 2012. In the upper aquifer of the south plantation, CVOC concentrations measured in piezometers during 2013 continued to be variable, as in previous years, and often very high (up to 82 mg/L total CVOCs in P1-7, located in the south plantation approximately 90 feet west-northwest of MW1-04 [see Figure 4-4]), and reductive dechlorination byproducts were detected in two of the three wells and in all but one piezometer. Beneath the marsh adjacent to the south plantation, chloroethene concentrations measured in 2013 continued to vary spatially and temporally and were also very high (up to 3.2 mg/L total CVOCs in S-4B, located in Marsh Creek southwest of the south plantation and in MW1-04). Total CVOC concentrations at what have historically been the most contaminated passive diffusion sampler sites (S-4, S-4B, S-5, and S-5B located in Marsh Creek, south and southwest of the south plantation and MW1-04), remained relatively high. For the intermediate aquifer in 2013, concentrations of reductive dechlorination byproducts ethane and ethene and CVOCs were consistent with those measured in previous years.

For the intermediate aquifer, total CVOC concentrations in 2008, 2010, and 2012 at wells MW1-25, MW1-28, and MW1-39 were consistent with concentrations from previous years. For the intermediate aquifer in 2013, the USGS concluded that concentrations of reductive dechlorination byproducts ethane and ethene and CVOCs were consistent with those measured in previous years, and reductive dechlorination was active in the intermediate aquifer (Huffman 2014).

Based on these findings, this 5-year review recommends reducing the frequency of intrinsic bioremediation monitoring to once every 5 years, as specified in the ROD. This recommended change in frequency will be incorporated into the overall revisions to the OU 1 LTM plan and implemented with plan approval by regulators and stakeholders (Section 8).

Based on the results of ongoing site investigations not evaluated under this 5-year review, additional surface water and passive diffusion bag sampling in the vicinity of the south plantation can be determined in the future through collaboration with site regulators and stakeholders.

Surface Water and Seep Monitoring Data

At Area 1, the surface water location MA12 and seep location SP1-1 are monitored under the phytoremediation program for VOCs only, as shown on Figure 6-1. The risk and compliance monitoring program includes MA12, SP1-1, and all other surface water locations, as depicted on Figure 6-2. Sampling was conducted in accordance with the regulator-approved LTM work plan

(U.S. Navy 2012h). Table B-4 in Appendix B presents the VOC results for Area 1 surface water and seep samples and Table B-5 the PCB results for SP1-1.

As shown on Figure 6-1, RGs were exceeded in surface water location MA12 immediately downgradient of the south plantation for TCE and vinyl chloride, and seep location SP1-1 did not exceed VOC RGs. As listed in Table 6-1, VOC trends over the last 5 years are stable at both of these locations. The overall VOC trend graphs for MA12 and SP1-1 are provided in Appendix D and are stable to decreasing.

As shown on Figure 6-2, RGs were exceeded at MA12 for TCE and vinyl chloride and at SP1-1 for PCBs. PCB trends at SP1-1 are showing overall increasing trends recently, although concentrations were stable between 2000 and 2010 (see Table 6-1 and Figure D-13b of Appendix D). For all other surface water locations shown on Figure 6-2, no RG exceedance was noted in the most recent round of sampling data or over the last 5 years, so no overall trends analysis was conducted.

Based on these sampling results, recommendations regarding VOC surface water monitoring are as follows:

- Continue the monitoring frequency of once every 5 years at locations DB14, SP1-1, and TF19, which is consistent with the requirements of the ROD.
- Continue annual monitoring frequency for locations MA09, MA11, and MA12, based on detections near or above RGs.

One change regarding seep monitoring for PCBs is recommended: Because PCB results at location SP1-1 showed an increase in 2014 and sediment PCB trends at MA14 and TF21 increased during the most recent round of sampling, it is recommended that sediment monitoring for PCBs be conducted at and around SP1-1 to establish current baseline conditions and future trends, if warranted. It is also recommended that the frequency of PCB analysis of seep water at SP1-1 be increased to once every 2 years to monitor increasing trends at this location.

Additional OU 1 investigations are in progress at this time, and the monitoring recommendations and investigation results are not available for inclusion in this 5-year review. Future recommendations for additional surface water and seep water sampling in the vicinity of the south plantation can be determined through collaboration with site regulators and stakeholders based on the results of these investigations.

The recommended change regarding frequency of PCB analysis for seep monitoring at OU 1 will be incorporated into the overall revisions to the OU 1 LTM plan and implemented with plan approval by regulators and stakeholders (Section 8).

Sediment Monitoring Data

As shown on Figure 6-2, current concentrations of COCs (i.e., metals) in sediments during the 2014 LTM sampling event were below the RGs (sediment quality standards [SQS]). As listed on Appendix B Table B-6, metals were below the SQS levels during this 5-year period.

Sediment sampling is conducted at the time of the 5-year review according to the LTM work plan (U.S. Navy 2012h). Data are now available from 1996 (the post-ROD sampling event), 2000, 2002 (limited number of stations), 2004, 2009, and 2014 (U.S. Navy 2015a). Samples are collected from nine stations located in three general areas: Dogfish Bay (three locations), the tide flats (three locations), and the Marsh Creek (three locations). Based on the third 5-year review recommendations and approval by regulators, SVOCs, pesticides, and PCBs were dropped from the sediment monitoring program, with only metals remaining on the analyte list for this 5-year review period. Consistent with historical monitoring reporting practices, SVOC and pesticide data are not tabulated in Appendix B of this report because the results are consistently very low or not detected. Concentrations of metals in sediments during the 2014 LTM sampling event were below the SQS screening levels (see Appendix B Table B-6).

In 2012, a one-time sampling event of five sediment, two soil, and two catch basin accumulated solids samples was conducted and analyzed for total chromium and hexavalent chromium. This investigation was recommended in the third 5-year review based on a high total chromium concentration at MA11 from June 2009. Historical and recent sediment LTM data for OU 1 are summarized in Appendix B Table B-6. The 2012 chromium sediment evaluation report (U.S. Navy 2012a) is summarized below in the OU 1 Post-ROD Investigations section and included in Appendix A. The data results are summarized below and tabulated in Tables 4-1 and 4-2, and sampling locations are shown on Figure 4-1 of the chromium sediment evaluation report in Appendix A.

For the 2012 one-time sampling event, total chromium results ranged from 22.1 to 212 mg/kg in sediment samples from locations MA11, MA15, MA16, MA17, and MA18. Results for MA11, the location that had exceeded the SQS screening level in 2009 based on a result of 269 mg/kg, were 138 and 144 mg/kg (field duplicate pair) in 2012 and 45.2 mg/kg in 2014. The report concluded that the high chromium result in sediment in 2009 was likely an anomaly. Hexavalent chromium sediment sample results ranged from an estimated 10.5 mg/kg to an estimated 32.5 mg/kg. No ARAR is established for hexavalent chromium in the SMS (sediment cleanup objective/screening cleanup level) for comparison with these data.

The 2012 soil (locations WBSD1 and WBSD2) and accumulated solids (locations EBFC1 and WBFC1) sample results for total chromium ranged from 28.2 to 42 mg/kg and were below the Puget Sound regional background value of 48 mg/kg and the MTCA Method A cleanup level of 2,000 mg/kg. One accumulated solids sample was analyzed for hexavalent chromium, resulting in an estimated value of 9.46 mg/kg. No ARAR is established for hexavalent chromium in accumulated solids for comparison to these data.

Metals were designated as chemicals of interest (COIs) in the ROD based on their potential accumulation in the marine environment over time. However, six rounds of sampling results over a period of approximately 20 years have demonstrated no spatial and temporal trends and no exceedance of SQS cleanup levels (except one chromium sample anomaly). Therefore, it is recommended that monitoring sediments for metals be discontinued.

Based on the increasing trend of PCB concentrations in surface water at seep location SP1-1, the overall and last 5 years of sampling trends (2004 to 2009) of total PCB concentrations were evaluated at those sediment sampling locations with historical detections above the PCB RG, including MA09, MA14, and TF21 (see Figure D-14 of Appendix D and Table B-6 of Appendix B). Overall, the PCB trends at the three sediment sampling locations are decreasing. However, over the last 5 years, PCB concentrations at MA09 decreased, while concentrations increased from 0.6 to 3.45 mg/kg at MA14 and from 1.16 to 6.2 mg/kg at TF21. Although the concentrations are below the RG, it is recommended that PCB analysis of sediment be conducted at and around monitoring locations MA09, MA14, and TF21 to establish current baseline conditions and future trends. In addition, collection of sediment samples at and around seep SP1-1 for PCB analysis is recommended to determine if there is a correlation between the concentrations of PCBs in seep water and sediment and evaluate if recontamination, as specified in the SMS regulation, is occurring.

The recommended changes to sediment monitoring at OU 1 will be incorporated into the overall revisions to the OU 1 LTM plan and implemented with plan approval by regulators and stakeholders (Section 8).

Shellfish Monitoring Data

Shellfish tissue sampling at Dogfish Bay (three locations) and the tide flats (three locations) has been discontinued at OU 1 as recommended in the third 5-year review (U.S. Navy 2010a). Historical tissue monitoring data from 1996 (the post-ROD sampling event), 2000, 2004, and 2009 (U.S. Navy 2009c) are summarized in Appendix B Table B-7. Sediment sampling locations that correspond to former tissue sampling locations are shown on Figure 4-2. Further information on shellfish monitoring can be obtained by reviewing Section 6.4 of the third 5-year review (U.S. Navy 2010a) included in Appendix A or on the EPA website http://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=1001102.

Based on the overall increasing trend of PCB concentrations in surface water at seep location SP1-1 and increase in PCB sediment concentrations at locations MA14 and TF21 from 2004 to 2009, it is recommended that PCB analysis of tissue samples be conducted at location TF21 at a frequency of twice every 5 years.

The recommended change to tissue monitoring at OU 1 will be incorporated into the overall revisions to the OU 1 LTM plan and implemented with plan approval by regulators and stakeholders (Section 8).

OU 1 Post-ROD Investigations During This Five-Year Review Period

Chromium Sediment Evaluation. The third 5-year review (U.S. Navy 2010a) identified the need to assess chromium concentrations in sediment around location MA11, including in catch basin solids, because the chromium concentration in the 2009 sediment sample from location MA11 was higher than typically observed and exceeded the screening level for the first time since 1996. Based on this recommendation, the Navy performed a one-time sampling event at new and existing locations at OU 1 in 2012. The overall objective of this sampling was to determine the extent and source of chromium present in sediments in the pond adjacent to the Area 1 landfill. A copy of this report is included in Appendix A.

This investigation found that total chromium concentrations in the sediment samples were all less than the SQS criterion. Based on these sampling results, it was concluded that the 2009 result was considered an anomaly, and no change to the LTM program was recommended. Hexavalent chromium was detected in all of the sediment and accumulated solids samples that were collected, suggesting that an industrial source of chromium exists. There are no established ARARs for hexavalent chromium sediment for comparison with these data.

Natural Attenuation Evaluation. Because phytoremediation at the OU 1 south plantation was concluded to not have been as effective as intended by the ROD, the third 5-year review (U.S. Navy 2010a) recommended that the Navy perform the evaluation of natural attenuation and intrinsic bioremediation called for in Section 11.1.6 (U.S. Navy, USEPA, and Ecology 1998). Section 11.1.6 states that "if phytoremediation is determined to be ineffective and is discontinued, natural attenuation and intrinsic bioremediation will be evaluated to determine whether they satisfy the key objectives for which the phytoremediation action was intended to address." Based on the recommendation in the third 5-year review and the ROD evaluation requirement, the Navy conducted a natural attenuation evaluation in 2012 that included both the north and south plantations. The objective of this evaluation was to assess natural attenuation, including intrinsic biodegradation, as a potential stand-alone remedy for OU 1 and provide a supporting document for possible modification of the selected remedy for OU 1 through an Explanation of Significant Differences or ROD amendment (U.S. Navy 2012c). A copy of the natural attenuation report is included in Appendix A.

This natural attenuation report recommended the following:

- Perform additional investigation in the south plantation to fill data gaps regarding the presence or absence and extent of a discrete hot spot.

- Use the data generated during the data gap investigation to evaluate the feasibility of additional remedial action at the south plantation to shorten the restoration time frame.

Optimization Review. Because current levels of VOC contamination in groundwater and surface water indicate that the phytoremediation remedy is not performing as intended in the south plantation, the Navy, EPA, Ecology, and the Suquamish Tribe agreed to work collaboratively to conduct an optimization review of OU 1 to evaluate potential options for improving remedy performance. This review was initiated during a site visit on December 3, 2012, with the EPA leading the optimization effort. The optimization review focused on the VOC contamination and included a review of site documents, a site visit, interviews with personnel familiar with remedial activities at OU 1, and an analysis of the information gathered. A copy of this report is included in Appendix A.

Based on the optimization review team's interpretation of existing characterization data, remedy operation data, site visit observations, and the CSM, the report described the following potential implications for a remedial strategy:

- If the actual average hydraulic conductivity of the upper aquifer is higher than suggested in existing site documents, groundwater transport times may be faster than previously thought, and changes in groundwater and surface water concentrations may respond more rapidly to remediation than previously thought.

- If density-driven dense nonaqueous-phase liquid flow is the mechanism for contaminant migration from the upper (shallow) to the intermediate aquifer, it is likely that the cis-1,2-DCE and vinyl chloride in that aquifer may persist for many years.

- If the primary mass flux of contamination to upper (shallow) aquifer groundwater (and hence to surface water) continues to be from a well-understood, targeted area of the overlying waste, then source area hot spot remediation may be relatively more straightforward than if the primary mass flux of contamination was smeared throughout the saturated zone and continues to reside in saturated silts and clays.

- Vinyl chloride concentrations at surface water monitoring location MA12, situated in Marsh Creek prior to entering the pond, are approximately 18 to 30 times the RG, and mass flux will need to be reduced 95 to 97 percent for the remedy to comply with the surface water RG for vinyl chloride.

The optimization review identified the primary data gap as the horizontal and vertical extent of the contaminant source area in the southern portion of the landfill. This contaminant source area contributes to ongoing contamination of the upper (shallow) aquifer and potentially ongoing contamination in the intermediate aquifer. Therefore, the extent of contamination in the southern portion of the landfill should be further characterized to determine a path forward for remedy optimization. At the time of the optimization review site visit, the Navy was preparing to conduct a characterization event in which tree core samples, in-plant sorbent samples, and soil gas samples would be collected throughout the southern portion of the landfill that should provide information on the areal extent of contamination. (Note that Phase I of this work was completed. However, the data report was not available for incorporation into this 5-year review report.) The optimization team suggested the Navy consider using an alternate option for the characterization effort, which would use the more traditional method of collecting groundwater samples from temporary well points, collecting passive soil gas samples, and evaluating these new data alongside existing groundwater monitoring data. The optimization review also recommended the following actions:

- The RI work and the associated data quality should be reviewed to determine if the findings are adequate to eliminate the vapor intrusion pathway for the buildings across Bradley Road from Torpedo Road south to Gadberry Street. For some buildings, particularly near Torpedo Road, a vapor intrusion evaluation potentially starting with near slab or subslab soil vapor sampling might be appropriate.

- The use of extracted contaminated water in the phytoremediation remedy irrigation system should be considered for testing. This optimization approach would reduce the net amount of water flowing through the aquifer and potentially increase the exposure of the tree roots to contaminated groundwater. If this approach is tested, the optimization review team suggested that a piezometer be installed near the extraction well, an aquifer test be conducted to provide a better understanding of the hydraulic conductivity of the upper aquifer, and a shallow piezometer be installed in the waste to determine the thickness of a perched water table, if any.

- Before evaluating various remedial improvement strategies for this site, the RGs established in the ROD for the site should be clarified, including the surface water and the groundwater RGs. The ROD established the point of compliance within surface water at the sampling locations within the marsh, tide flats, and Dogfish Bay rather than a single point. This optimization report identified the need to clarify a single Navy, regulator, and stakeholder agreed-upon point of compliance within surface water, such as location MA12. The intent is to ensure that the LTM plans clearly articulate agreed-upon points of compliance to address the perceived ambiguity in the ROD.

- If results from further site characterization indicate high levels of contamination in a relatively targeted area or areas, it may be reasonable to conclude that these targeted areas are source area hot spots that might be appropriately addressed by excavation with off-site disposal.

- If results from further site characterization indicate high levels of contamination over a relatively broad area or areas, it may be reasonable to conclude that a remedial approach other than excavation is appropriate. Given that a majority of the contaminant mass is likely in the waste layer, soil vapor extraction may be an appropriate remedial approach.

- If results from further site characterization indicate an extensive source area with significant contaminant mass in the silts and clays that underlie the waste layer or upper aquifer, source material will not be easily removed by excavation or soil vapor extraction, and it might be appropriate to contain the contamination rather than remove the source. Potential approaches for containment in the upper (shallow) aquifer in the order of the least to the most costly option include a permeable reactive barrier, recirculation system, and pump and treat system.

Future Investigations

Based on the results of the natural attenuation evaluation and the optimization review, the Navy in consultation with EPA, Ecology, and the Suquamish Tribe, has performed Phase I of a site recharacterization investigation using tree-core sampling and geophysical surveys to refine the understanding of COC distribution and look for potential buried sources (August 2014). Based on the results of Phase I, the Navy will proceed with a Phase II intrusive investigation, to further assess whether previously undetected source areas exist beneath the south plantation, the central portion of the landfill, and/or at other locations that might explain the data trends and why phytoremediation, especially in the south plantation, appears to be performing below expectations. If an ongoing source of TCE and/or dense nonaqueous-phase liquid is identified and removed, contaminant trends following removal will be expected to exhibit a downward trend overall of TCE and its daughter products. Plans are currently being developed by the Navy in collaboration with site regulators and stakeholders to guide these investigations.

6.4.3 OU 2 Area 2 Monitoring Data

Table B-8 in Appendix B contains the tabulated groundwater analytical results for VOCs and Table B-9 has results for 1,4-dioxane. Overall at Area 2, COC concentrations consistently trended lower over this 5-year review period and have been below the RG for TCE at all three groundwater monitoring wells since at least 2011, as listed in Table B-8 of Appendix B. Current COC exceedances of RGs are depicted on Figure 6-3. Vinyl chloride has been detected above the RG at 2MW-6 since sampling began at this well in 2006. Although there was no RG established for cis-1,2-DCE, concentrations are well below the current MTCA Method B risk-based screening level. The isoconcentration contour maps for TCE and vinyl chloride (Figures C-37 through C-44) also illustrate the contracting plume size and decreasing concentrations since the time of the ROD. As shown on Table 6-2, the trends over the last 5 years are stable and decreasing. Overall trends are stable and decreasing, as displayed on the graphs included in Appendix D (Figures D-15 and D-16).

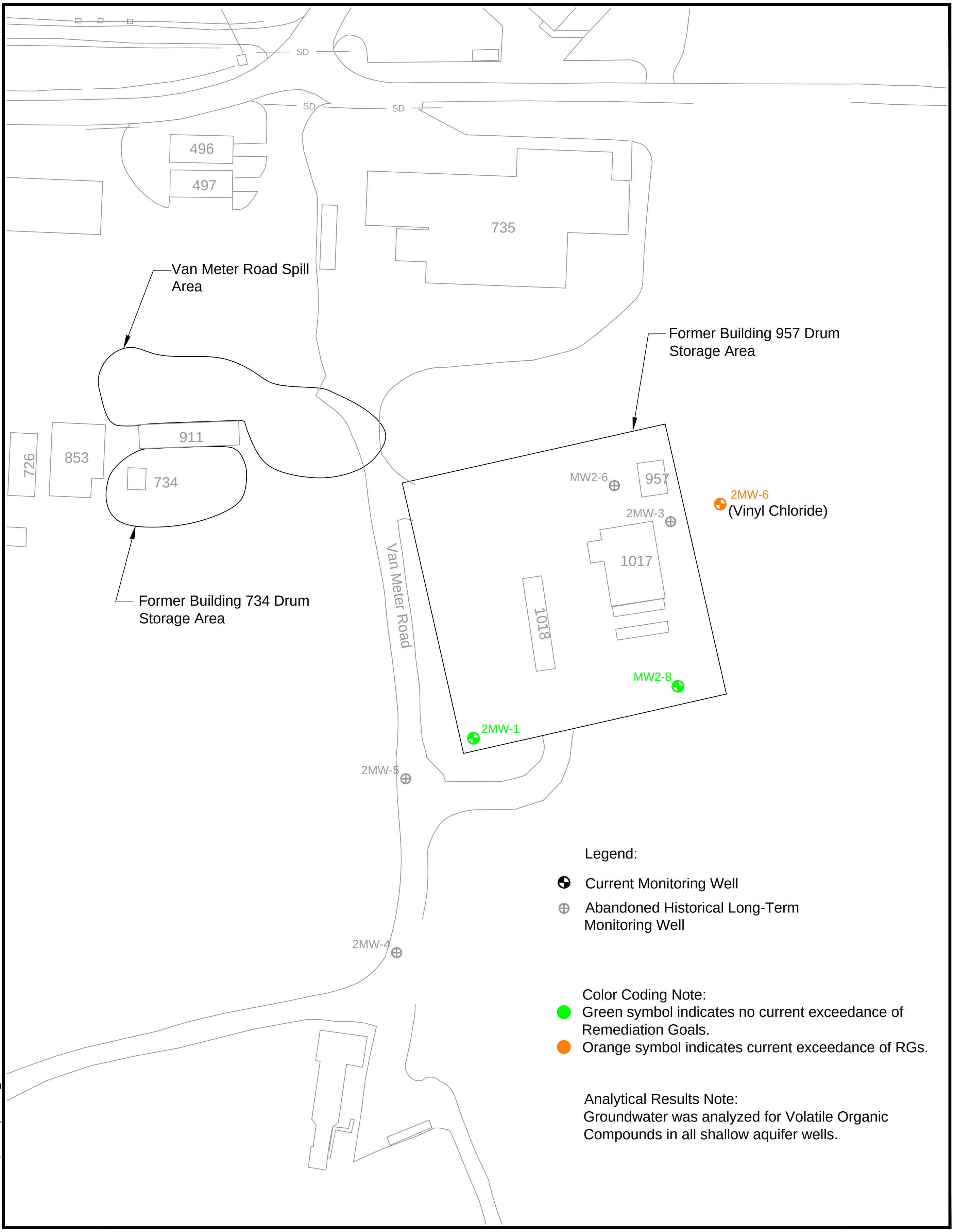
The monitoring recommendations for Area 2 are as follows:

- Discontinue monitoring for cis-1,2-DCE and TCE at wells 2MW-1, 2MW-6, and MW2-8 based on concentrations being below the MTCA Method B RGs over the last 5 years. Based on improved analytical techniques, continue monitoring for vinyl chloride once every 5 years at wells 2MW-1, 2MW-6, and MW2-8 until concentrations meet the ROD RG of 0.023 μg/L, rather than the practical quantitation limit (PQL) of 1 μg/L.

- Based on the change in toxicity, the MTCA Method B cleanup level for 1,4-dioxane has decreased from 4 to 0.44 μg/L. Therefore, this 5-year review recommends that two rounds of annual sampling for 1,4-dioxane be completed using a laboratory analytical method that can achieve a reporting limit of 0.4 μg/L. Sampling will be discontinued if two rounds of sampling demonstrates 1,4-dioxane has not been detected above 0.44 μg/L.

- ICs currently in place to prevent use of the shallow groundwater as drinking water should remain in effect until risk-based levels are met and monitoring is discontinued.

The recommended reduced monitoring frequency is consistent with the ROD, which states that monitoring frequencies can be reduced if concentrations decrease with time. The recommended changes to monitoring at Area 2 will be incorporated into the overall revisions to the Area 2 LTM plan and implemented with plan approval by regulators and stakeholders (Section 8).



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SCALE IN FEET

Figure 6-3
2014 Monitoring Locations
at OU 2 Area 2

NBK Keyport
FOURTH FIVE-YEAR
REVIEW

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Table 6-2
Summary of Data Trends in Groundwater at OU 2 Area 2

Location	Chemical	Maximum Concentration in Last 5 Years (µg/L)	Drinking Water RG (µg/L)	Exceeds Drinking Water RG?	Trend of Last 5 Years[c]	Overall Trend[d]
2MW-1	**TCE**	5.8 J	5[b]	**Yes**	Decreasing	Decreasing
	cis-1,2-DCE	0.089	16[a]	No	Stable	NP[e]
	Vinyl chloride	0.018 J	0.023	No	Stable	NP[e]
2MW-6	TCE	0.03 J[f]	5[b]	No	Stable	NP[e]
	cis-1,2-DCE	7.1	16[a]	No	Decreasing	NP[e]
	Vinyl chloride	0.99	0.023	**Yes**	Stable/decreasing	Decreasing
2MW-8	TCE	0.0045 J	5[b]	No	Stable	NP[e]
	cis-1,2-DCE	1.2	16[a]	No	Decreasing	NP[e]
	Vinyl chloride	0.07 J	0.023	**Yes**	Stable	NP[e]

[a]No RG for cis-1,2-DCE was established in the Record of Decision. For comparison purposes, the current MTCA Method B value is shown here.
[b]Value listed accounts for adjustment when the maximum contaminant level or water quality standard is sufficiently protective to serve as the MTCA cleanup level for that individual chemical. Individual chemical cleanup levels may require downward adjustment for multiple chemical contaminants or multiple exposure pathways (Ecology 1993). Value does not account for adjustments because of background levels or practical laboratory quantitation limits.
[c]Trends were interpreted from the last 5 years of data and trend graphs (see Appendices B and D).
[d]Trends were interpreted by trend graphs (see Appendix D).
[e]No trends analysis was performed.

Notes:
"Stable" means that the concentrations are similar from year to year.
DCE - dichloroethene
EPA - U.S. Environmental Protection Agency
J - The result is an estimated concentration that is less than the method reporting limit, but greater than or equal to the method detection limit.
µg/L - microgram per liter
MTCA - Model Toxics Control Act
NP – not performed
PQL - practical quantitation limit
RG - remediation goal

Groundwater samples were analyzed for 1,4-dioxane from the three monitoring wells as a one-time sampling event in spring 2007 to evaluate if this emerging contaminant was present at the site (see Appendix B Table B-9). 1,4-Dioxane was only detected in one well (2MW-6) at an estimated concentration of 0.3 µg/L. The reporting limit was 1 µg/L during the 2007 monitoring event. Although there is no RG established for 1,4-Dioxane, the current MTCA Method B cleanup level is 0.44 µg/L, which represents a decrease from 4 µg/L in 2007 (see Section 7.2.2).

6.4.4 OU 2 Area 8 Monitoring Data

Historical and recent monitoring data in all media for Area 8 are summarized in Appendix B Tables B-10 through B-15. Trend graphs for overall data trends and data trends over the last 10 years in monitoring wells (MW8-8, MW8-9, MW8-11, MW8-12, and MW8-16) and Seeps A and B are included in Appendix D (Figures D-17a to D-31b). Trends in the data observed over the last 5 years are summarized by medium in the sections that follow and in Table 6-3.

Groundwater Monitoring Data

At Area 8, groundwater results for seven target analytes (1,1-DCE, cis-1,2-DCE, tetrachloroethene [PCE], 1,1,1-trichloroethane [TCA], TCE, dissolved cadmium, and dissolved chromium) have been included in LTM reports (U.S. Navy 2015c), and sampling was conducted as indicated in accordance with the regulator-approved LTM work plan (U.S. Navy 2012h). 1,4-Dioxane was added to the list of analytes beginning in 2011 in accordance with Recommendation 9 of the third 5-year review (U.S. Navy 2010a). Groundwater monitoring data for Area 8 are summarized in Appendix B Tables B-10 through B-12.

Table B-10 of Appendix B contains the tabulated groundwater analytical results for VOCs and Table B-11 has results for 1,4-dioxane. Groundwater isoconcentrations for 1,1-DCE, PCE, TCE, cadmium, and chromium in upper aquifer wells are included in Appendix C and discussed at the end of this section. As shown on Figure 6-4, the TCE drinking water RG was exceeded at all monitoring wells, except MW8-14. The PCE drinking water and surface water RGs were exceeded at MW8-8 and MW8-12 (see Figure 6-4).

Table 6-3 highlights the analytes that exceeded RGs during this 5-year review period and summarizes the results of concentration trend analyses covering three different time periods, as follows: current trends that include the last 5 years of data, trends including the last 10 years of data, and overall trends including all data since the time of the ROD.

Volatile Organic Compounds. Over the last 5 years, VOC trends are increasing at MW8-8 for PCE at concentrations over both RGs, and TCE at MW8-9 is increasing at concentrations above the drinking water RG. The VOC trends over the last 10 years are stable and decreasing for all VOCs, except for TCE at MW8-9, which is increasing at concentrations above the drinking water RG (see 10-year trend graphs included in Appendix D Figures D-25a to D-29a). The overall VOC trends in groundwater show concentrations decreasing, except TCE at MW8-16 is increasing at concentrations above both RGs (see overall graphs included in Appendix D Figures D-17a to D-21a). Extrapolation of the recent trends implies that the time frame for meeting the RGs for TCE and PCE in groundwater is on the order of decades.

Table 6-3
Summary of Data Trends in Groundwater and Seeps at OU 2 Area 8

Location	Chemicals	Maximum Concentration in Last 5 Years (µg/L)	Drinking Water RG[a] (µg/L)	Surface Water RG[b] (µg/L)	Exceeds Drinking Water RG?	Exceeds Surface Water RG?	Trend of Last 5 Years[c]	Trend of Last 10 Years[d]	Overall Trend[d]
MW8-8	**PCE**	9.8	5	8.9	**Yes**	Yes	Stable/increasing	Decreasing	Stable/decreasing
	TCE	59	5	81	**Yes**	No	Stable/decreasing	Decreasing	Decreasing
	cis-1,2-DCE	8.4	70	NE	No	NA	Decreasing	Decreasing	Stable
	Cadmium	0.114	5	8	No	No	Decreasing	Decreasing	Stable/decreasing
	Total chromium	118	50	50	**Yes**	Yes	Stable	Stable/decreasing	Decreasing
MW8-9	PCE	0.49 J	5	8.9	No	No	Stable/increasing	Stable/increasing	Stable/increasing
	TCE	43 J	5	81	**Yes**	No	Increasing	Increasing	Decreasing
	cis-1,2-DCE	2.7	70	NE	No	NA	Increasing	Increasing	Decreasing
	Cadmium	0.343	5	8	No	No	Stable/decreasing	Decreasing	Decreasing
	Total chromium	7.46	50	50	No	No	Stable	Stable/decreasing	Decreasing
MW8-11	PCE	1.5	5	8.9	No	No	Stable	Stable/increasing	Increasing
	TCE	80 J	5	81	**Yes**	No	Stable/decreasing	Stable/decreasing	Stable
	cis-1,2-DCE	0.83	70	NE	No	NA	Stable/increasing	Stable/increasing	Increasing
	Cadmium	214	5	8	**Yes**	Yes	Decreasing	Decreasing	Stable/decreasing
	Total chromium	187	50	50	**Yes**	Yes	Stable	Stable/decreasing	Decreasing
	1,4-Dioxane	29	0.44[e]	NE	Yes	NA	Decreasing	NP	Decreasing
MW8-12	**PCE**	6.3	5	8.9	**Yes**	No	Decreasing	Decreasing	Stable/decreasing
	TCE	31	5	81	**Yes**	No	Decreasing	Decreasing	Stable/decreasing
	cis-1,2-DCE	3.9	70	NE	No	NA	Decreasing	Decreasing	Stable
	Cadmium	0.433	5	8	No	No	Decreasing	Decreasing	Decreasing
	Total chromium	137	50	50	**Yes**	Yes	Stable	Stable	Decreasing
MW8-14	**Cadmium**	10.4	5	8	**Yes**	Yes	Decreasing	Decreasing	Stable/decreasing
	Total Chromium	28.3	50	50	No	No	Stable	Stable	Stable
MW8-16	PCE	0.97	5	8.9	No	No	Stable/increasing	Stable/decreasing	Stable
	TCE	90	5	81	**Yes**	Yes	Decreasing	Decreasing	Stable/increasing
	1,1-DCE	0.13 J	7	3.2	No	No	Decreasing	Decreasing	Stable

Table 6-3 (Continued)
Summary of Data Trends in Groundwater and Seeps at OU 2 Area 8

Location	Chemicals	Maximum Concentration in Last 5 Years (µg/L)	Drinking Water RG[a] (µg/L)	Surface Water RG[b] (µg/L)	Exceeds Drinking Water RG?	Exceeds Surface Water RG?	Trend of Last 5 Years[c]	Trend of Last 10 Years[d]	Overall Trend[d]
MW8-16 Cont'd	cis-1,2-DCE	9.2	70	NE	No	NA	Decreasing	Decreasing	Stable/increasing
Seep A	PCE	0.73	NA	8.9	NA	No	Stable/increasing	Stable	Stable/decreasing
	TCE	13	NA	81	NA	No	Stable/increasing	Stable/increasing	Stable/decreasing
	1,1-DCE	11 J	NA	3.2	NA	Yes	Increasing	NP	NP
	cis-1,2-DCE	1.9	NA	NE	NA	NA	Stable/decreasing	Stable/decreasing	Decreasing
	Cadmium	15.4	NA	8	NA	Yes	Decreasing	Decreasing	Decreasing
	Total chromium	7.52	NA	50	NA	No	Stable	Decreasing	Decreasing
Seep B[f]	PCE	0.81 J	NA	8.9	NA	No	Decreasing	Stable/decreasing	Stable/increasing
	TCE	5.7	NA	81	NA	No	Increasing	Increasing	Decreasing
	cis-1,2-DCE	0.51	NA	NE	NA	NA	Decreasing	Stable/increasing	Decreasing
	Cadmium	1.05	NA	8	NA	No	Stable	Decreasing	Stable/decreasing
	Total Chromium	3.7	NA	50	NA	No	Stable	Decreasing	Stable/decreasing

[a]Drinking water RG value of 50 µg/L is for total chromium. Hexavalent chromium is 80 µg/L.
[b]Surface water RG of 50 µg/L is for hexavalent chromium. There is no goal for total chromium.
[c]Trends were interpreted from the last 5 years of data and trend graphs (see Appendices B and D).
[d]Trends were interpreted by trend graphs (see Appendix D).
[e]There is no RG for 1,4-dioxane. The MTCA Method B values is listed in the drinking water RG column.
[f]Seep B data from years 2007 to 2011 were evaluated as the last 5 years.

Notes:
Bolded value indicates concentration exceeds or is equal to the RG for drinking water.
Red font indicates the trend is increasing where there is an exceedance of an RG.
Yellow highlighted indicates concentration exceeds or is equal to the RG for surface water.
DCE - dichloroethene
J - The result is an estimated concentration that is less than the method reporting limit, but greater than or equal to the method detection limit.

Table 6-3 (Continued)
Summary of Data Trends in Groundwater and Seeps at OU 2 Area 8

µg/L - microgram per liter
NA – not applicable
NE – not established
NP – not performed (No trends graph nor analysis was performed.)
ND - not detected
RG - remediation goal
"Stable" means that the concentrations are similar from year to year
TCA - trichloroethane
TCE - trichloroethene

Inorganics. Overall, the concentrations of metals are generally declining (see Appendix B Table B-12 and Table 6-3). As shown on Figure 6-4, in the most recent round of sampling data dissolved cadmium exceeded the RG at wells MW8-11 and MW8-14, and dissolved chromium exceeded the RG at wells MW8-8, MW8-11, and MW8-12. In addition, groundwater samples from one or more wells have continued to exhibit concentrations exceeding the RGs for arsenic and copper over the last 5 years (Table B-12 of Appendix B). At well MW8-11, nickel, silver, and zinc concentrations exceeded their respective RGs over the last 5 years (Table B-12 of Appendix B). Although arsenic concentrations in most wells consistently exceed the RG, concentrations of arsenic have never exceeded the site-specific arsenic background level of 12 µg/L. Extrapolation of the recent trends implies the time frame for meeting the RGs for metals in groundwater is on the order of decades.

As summarized in Table 6-3 and shown on Appendix D Figure D-16b, chromium concentration trends over the last 5 years are stable at well MW8-8, with concentrations slightly above the RG of 50 µg/L in all years except 2011 (118 µg/L). The trends over the last 10 years and overall trends in groundwater are stable and decreasing for cadmium and chromium (see 10-year trend graphs included in Appendix D Figures D-25b to D-29b and overall cadmium and chromium trends in Figures D-17b to D-21b).

Groundwater Concentration Contour Maps for VOCs and Inorganics. Evaluation of isoconcentration contour maps depicting key COC concentrations over time (Figures C-45 through C-64) leads to the following conclusions:

- The CVOC plume footprint has contracted since the time of the ROD, and the maximum concentrations have generally decreased.
- The decline in TCE concentrations since the time of the ROD at well MW8-9 (a decrease of two orders of magnitude), compared to the less substantial TCE concentration decline at other wells to the north, gives the impression of the TCE plume core shifting to the north over time.
- The areal extent of cadmium in groundwater has contracted since the time of the ROD. This interpretation is based primarily on the reduced concentrations over this time period in wells MW8-12 and MW8-14. Well MW8-11 continues to represent the center of the cadmium plume, and concentrations in this well, though slightly reduced, remain within the same order of magnitude as reported at the time of the ROD.
- Chromium concentrations have declined by an order of magnitude in well MW8-12 since the time of the ROD, but have exhibited a somewhat less dramatic decline in well MW8-11. The result is an apparent shift of the

chromium plume core northward. Overall, the chromium plume has contracted since the time of the ROD, and the maximum detected concentration has declined by an order of magnitude.

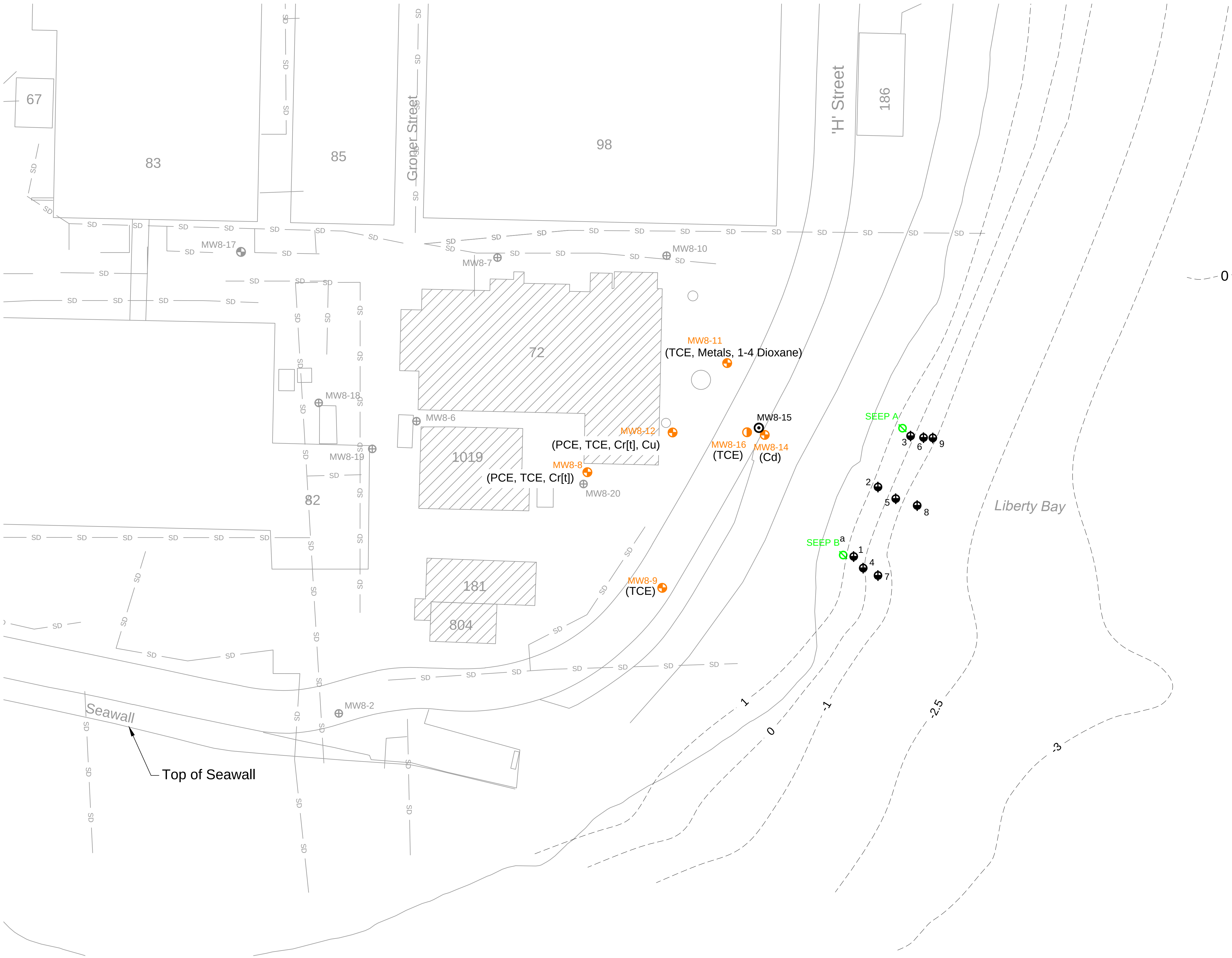
1-4 Dioxane. As shown on Figure 6-4, the MTCA Method B cleanup level for 1,4-dioxane was exceeded at well MW8-11 in the most recent round of sampling data. 1,4-Dioxane was first sampled in spring 2007. Based on Recommendation 9 in the third 5-year review, 1,4-dioxane was then added to the Area 8 groundwater monitoring analyte list beginning in the 2011 sampling event. In the last 4 years of sampling (2011 through 2014), 1,4-dioxane was detected in four of the six wells (MW8-8, MW8-11, MW8-12, and MW8-14) at concentrations ranging from an estimated 0.31 to 39 µg/L. Although there is no RG established for 1,4-dioxane, the current MTCA Method B cleanup level is 0.44 µg/L (see Section 7.3.1), which was exceeded in all four wells where this compound was detected. Figure D-24 shows overall 1,4-dioxane concentration trends for MW8-8, MW8-11, and MW8-12. Meaningful trends are apparent at only MW8-11, with the recent and overall trend for 1,4-dioxane decreasing at this well. Concentrations at MW8-8 had two detections just above the MTCA Method B value, and MW8-12 had detections above and below MTCA Method B value.

Summary of Groundwater Monitoring Recommendations. Based on a review of the last 5 years of data at Area 8, this 5-year review recommends that future monitoring for 1,4-dioxane use a laboratory analytical method that can achieve a reporting limit of 0.4 µg/L to meet the MTCA Method B cleanup level is 0.44 µg/L. No other change to Area 8 monitoring is recommended. This recommended change will be incorporated into the overall revisions to the Area 8 LTM plan and implemented with plan approval by regulators and stakeholders (Section 8).

Seep Monitoring Data

At Area 8, seep concentration trends for seven target analytes (TCE, 1,1,1-TCA, PCE, 1,1-DCE, cis-1,2-DCE, dissolved cadmium, and dissolved chromium) have been tracked since the signing of the ROD (U.S. Navy 2015c). Historical and recent seep monitoring data for Area 8 are summarized in Appendix B Tables B-10 and B-12. As a result of consistently low and stable VOC and dissolved metals concentrations, sampling at Seep B was discontinued starting with spring 2012, as recommended in the third 5-year review (U.S. Navy 2010a).

As shown on Figure 6-4, VOC and metal concentrations did not exceed RGs at Seeps A or B in the most recent sampling event. As listed on Table B-10, in the last 5 years of sampling, only 1,1-DCE exceeded its surface water RG in one sample in 2012 at Seep A. No other VOCs exceeded their respective RGs at Seeps A or B. Also, as listed on Table B-12, cadmium exceeded its surface water RG in one sample in 2012 at Seep A. No other metals exceeded their respective RGs in Seeps A or B.



Legend:

- Monitoring Well (Shallow Depth)
- Monitoring Well (Intermediate Depth)
- Monitoring Well (Deep Depth)
- Historical Monitoring Well
- Abandoned Historical Long-Term Monitoring Well
- Seep Sampling Location
- Sediment and Tissue Monitoring Location
- a Last Sampled in 2011
- Former Building
- 0 Approximate Tidal Height Contour (ft Above MLLW). Based on the 2008 Elevation of Sediment and Tissue Monitoring Locations and General Shape of Contours Provided in Previous Investigations.

Color Coding Notes:

- Green symbol indicates no current exceedance of RGs.
- Orange symbol indicates current exceedance of RGs.
- Black location was either not sampled or there is no established RG.

Analytical Results Notes:

1. Groundwater was analyzed for VOCs, 1,4-dioxane, and dissolved metals in all shallow aquifer wells and the intermediate depth well. An RG was not established for 1,4-dioxane. 1,4-Dioxane is compared to the MTCA Method B value.
2. Arsenic exceeded the drinking water and surface water RGs at groundwater monitoring locations and the surface water RG at seep monitoring locations. However, it is not included on figures because concentrations are below background. The arsenic RGs are based on protection of human health (MTCA Method B).
3. At MW8-15, only groundwater elevations were collected and groundwater was not sampled.
4. Seep water was analyzed for VOCs and dissolved metals.
5. Sediment and tissue were analyzed for total metals. RGs were not established for tissue and sediment, rather on assessment of risks.
6. Groundwater RG is based on drinking water. Surface water RG is based on protection of human health for VOCs and chromium (III) and ecological health for the remaining metals.

Abbreviations:

Cd - cadmium
Cr(t) - total chromium
Cu - copper
PCE - tetrachloroethene
RG - remediation goal
TCE - trichloroethene
VOCs - volatile organic compounds

U.S. NAVY

NBK Keyport
FOURTH FIVE-YEAR
REVIEW

0 25 50
SCALE IN FEET

Figure 6-4
2014 Monitoring Locations at OU 2 Area 8

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As shown on Table 6-3, the VOC trends over the last 5 years indicate increasing trends at Seep A for 1,1-DCE and TCE and at Seep B for TCE. However, TCE concentrations at both seeps are below the associated surface water RG. The VOC trends over the last 10 years are stable and decreasing for all VOCs, except TCE at Seeps A and B (see 10-year trend graphs included in Appendix D Figures D-30a and D-31a). The overall VOC trends in both seeps show concentrations decreasing (see overall graphs included in Appendix D Figures D-22a and D-23a). In the last 5 years, cadmium concentrations at Seep A have exceeded the surface water RG (Table 6-3). The last 5-year, 10-year, and overall trends for cadmium and chromium in both seeps are stable and decreasing (see overall trend graphs included as Figures D-22b and D-23b of Appendix D and 10-year trend graphs as Figures D-30b and D-31b).

In 2011, 1,4-dioxane was analyzed for in seep water samples from Area 8. 1,4-Dioxane was not detected in 2011 above the reporting limit of 1.0 µg/L in either Seep A or B water samples. Seep water is not considered to be a drinking water pathway risk, and, therefore, sampling for 1,4-dioxane in seep water is not required.

No change is recommended for seep monitoring at Area 8.

Sediment Monitoring Data

Data Collected During this Review Period. Historical and recent sediment results are shown on Appendix B Table B-13 for SVOCs and Table B-14 for metals. Sediment sampling is conducted at the time of each 5-year review, and data are now available from 1996 (the post-ROD sampling event), 2000, 2004, 2008, and 2012 (Table B-14). Intertidal and subtidal sediment samples were collected from 20 sampling stations in 2012. Prior to 2012, sediment samples were collected from only nine intertidal stations (Stations 1 through 9) along three transects on the beach bordering Liberty Bay and analyzed for SVOCs and metals (as shown on Figures 4-4 and 6-4). SVOCs (see Table B-13) are no longer being monitored as per the recommendations of the last 5-year review (U.S. Navy 2010a). Sediment sampling performed in 2012 was more comprehensive to assess the extent of metals impacts in sediment deeper into the intertidal and subtidal offshore areas and concentration trends of metals in sediment at the post-ROD sampling stations. Therefore, the fall 2012 sediment sampling included the 9 existing intertidal sediment locations, 3 new intertidal sediment locations along the established transects at lower elevations, and 12 new subtidal sediment sampling locations along new transects within Liberty Bay.

Because past sediment monitoring data showed cadmium concentrations slowly increasing in sediment and the presence of 1,4 dioxane in groundwater wells, concerns were raised about the effectiveness of the remedy for Area 8 (U.S. Navy 2010a). Ecology expressed their concern in the last 5-year review that excavation and off-site disposal of the vadose zone soil was not effective in preventing migration of contaminants to Liberty Bay. The Navy noted that the remedy was not intended to prevent migration unless an unacceptable risk was identified that warranted control actions. Furthermore, there were issues regarding the use of human health and ecological risk assessments in the last 5-year review because of new information (such as the EPA Region 10 recommendation for using the Suquamish Tribe ingestion study in the risk assessment). The Navy, Suquamish Tribe, EPA, and Ecology jointly decided not to use the HHRA prepared for the third 5-year review. With regards to the ecological risk assessment, EPA, Ecology, and the Suquamish Tribe did not agree with the evaluation findings, which did not identify significant health risks to the marine environment, based in part on bioassays (U.S. Navy 2009b). More specifically, the stakeholder group identified concerns related to whether sampling had occurred deep enough in the intertidal zone to address the worst-case scenario (finer grain size), given the dynamic nature of the beach environment, and whether there were sufficient bioassay samples to make conclusions about ecological impacts.

Based on the disagreements regarding the HHRA assessments and the latest trend and concentration information from the LTM program, additional data collection for metals and performance of an additional ecological risk evaluation and follow-on HHRA were agreed to by the stakeholder group as per the recommendation of the third 5-year review (U.S. Navy 2010a). The Navy, EPA, Ecology, and Suquamish Tribe agreed to address the recommendation in the 5-year review through a stepwise sampling approach (U.S. Navy 2013b and 2015). Therefore, the sediment data presented as Appendix B Table B-14 does not fully address the recommendation in the third 5-year review. Instead, the data were used to determine the next steps in the process.

Cadmium and tin were the only metals that exceeded the SQS during the 2012 sampling event. Cadmium exceeded the cleanup screening level of 6.7 mg/kg at Stations 3, 5, 6, and 9 (see Figure 4-4 and Appendix B Table B-14). The 2012 cadmium concentrations at these stations were an estimated 7.0, 7.9, 7.0, and 12 mg/kg, respectively. The 2012 cadmium concentrations were all below the 2008 cadmium concentrations, which were the highest concentrations detected in sediment since testing began in 1996. Cadmium concentrations appear to be decreasing since 2008 at seven of the nine original intertidal stations. The mean site cadmium concentrations have also decreased below the 2008 mean cadmium concentrations, decreasing from 8.1 mg/kg in 2008 to 4.3 mg/kg in 2012. Tin exceeded the cleanup screening criterion of 15 mg/kg at Station 1 and subtidal Stations 26 and 27. The tin concentrations at these stations were an estimated 19, 27, and 18 mg/kg, respectively. Tin concentrations have increased in eight of nine original intertidal stations. The mean tin concentration at intertidal stations has increased from a nondetected value of 4.3 mg/kg in 2008 to 8.2 mg/kg in 2012.

As in the last 5-year review, mercury concentrations continue to decrease, as shown on Table B-14 of Appendix B. The mean of the mercury concentration at intertidal stations is below the cleanup screening level and has decreased from 0.28 mg/kg in 1996 to 0.049 mg/kg in 2012. The mean intertidal concentrations for chromium, copper, lead, nickel, silver, and zinc appear to be stable to decreasing when comparing 1996 data to 2012 data.

Future Sediment Monitoring. Although nine sampling stations were established in the initial post-ROD LTM plan, stakeholders and regulators more recently opined that the beach may not have been fully characterized during the RI and requested a larger area to be sampled. In response to these concerns and those described above, additional sediment data were collected in 2012 to evaluate the extent of metals impacts in sediment deeper into the intertidal and subtidal areas offshore of Area 8 (U.S. Navy 2013b). As indicated above, cadmium exceeded the cleanup screening level of 6.7 mg/kg at Stations 3, 6, and 9, the northernmost sampling locations (see Figure 4-4). Based on these results, it was determined that the northern extent of sediment contamination had not been fully characterized. So, these data were reviewed with stakeholders during workgroup sessions held in 2015 to develop a sampling and analysis plan (SAP) to allow for characterization of the extent of contamination and collect the data necessary to support future risk assessments. Through this review, it was concluded that the subtidal areas offshore of Area 8 have been minimally impacted. In addition, during a 2014 site walk conducted by the stakeholder team as part of the scoping of the 2015 SAP, five additional seeps were observed located north of Seep A (Seeps C through G). Since the northerly extent of elevated COC concentrations in the intertidal zone north of Seep A has not been assessed, the study area extends north to Seep G to ensure that potential impacts to the north of Seep A are fully characterized. The 2015 SAP also identifies the exposure area for potential human and ecological exposures that will be evaluated during future risk assessments, which is limited to the intertidal areas of Area 8 from the south at Seep B to the north at Seep G (U.S. Navy 2015).

Also in support of the future ecological risk assessment, surface water samples will be collected immediately above each of the identified seep and outfall locations (surface water is better measure of exposure to aquatic receptors in the intertidal zone). To characterize site surface water concentrations relative to background, surface water samples will be collected from the recreational shellfish harvesting beach area at Penrose Point State Park. This area was selected by the project team as the reference area based on the remoteness of the site, lack of nearby point sources, and good agreement with site sediment characteristics and biological habitat. The details of the future surface water sampling design are described in the 2015 SAP (U.S. Navy 2015).

The biological assessment recently conducted (U.S. Navy 2014a) confirmed an abundance of Pacific littleneck and butter clams along the entire stretch of beach adjacent to Area 8. This finding indicates that human health and ecological exposures are possible everywhere within the currently selected exposure area, as defined by the observed seeps and historical COC concentration data (see Post-ROD Investigations section below). A copy of this report is included in Appendix A.

Shellfish Tissue Monitoring Data

Data Collected During This Review Period. No new shellfish data has been collected for evaluation during this 5-year review because of disagreement between the Navy and stakeholder and regulators regarding tissue sampling locations and analyte list. Tissue sampling was excluded from the 2012 sampling event. Shellfish sampling was conducted at the time of each 5-year review in the past, and data are available from 1996 (the post-ROD sampling event), 2000, 2004, and 2008 (Appendix B Table B-15). Past shellfish samples were collected along the same beach transects and at the same sampling locations used for sediment sampling (U.S. Navy 2009e). Although tissue sampling was anticipated to occur at the same time as sediment sampling in 2012, it was delayed until additional information regarding extent of contamination and defining risk assessment needs could occur in consultation with stakeholders (Ecology, EPA, and the Suquamish Tribe). Further information on previous tissue findings can be obtained by reviewing Section 6.4 of the third 5-year review (U.S. Navy 2010a) included in Appendix A or on the EPA website http://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=1001102.

Future Shellfish Tissue Monitoring. Potential human and ecological exposures to marine tissue will be evaluated in future planned risk assessments. Site-related contaminants are reaching the marine environment through discharge of impacted groundwater into Liberty Bay at shoreline seeps, as expected in the OU 2 ROD. Thus, the marine organisms most likely to be impacted by site-related contamination are those present in the shallow sediments in the intertidal zone nearest the impacted seeps. LTM sampling confirms that elevated detections of ROD COCs have been noted in sediments and clam tissue near the historical seep locations in the nearshore areas of Area 8, immediately downgradient of the plating shop. In addition, the biological assessment conducted in summer 2014 confirmed the abundance of Pacific littleneck and butter clams in the nearshore areas of Area 8 (see Post-ROD Investigations section below). Although there is potential for marine organisms other than clams (e.g., mussels and crab) to be affected by site-related contamination, clams are assumed to be the most impacted because they live and feed in the shallow intertidal sediments, where the most significant site-related impacts are believed to be occurring. Therefore, Pacific littleneck clams were selected by the project team to be the representative species to evaluate site-related concentrations in marine tissues (U.S. Navy 2015).

Pacific littleneck clam samples will be collected along each transect associated with the identified seeps. To characterize site clam tissue concentrations relative to background, Pacific littleneck clam samples will also be collected from the recreational shellfish harvesting beach area at Penrose Point State Park (U.S. Navy 2015).

The tissue data results from this sampling event will be used to evaluate calculated human health and ecological site risks, as specified in the ROD, using data from Penrose Point State Park as background to compare calculated risks.

Post-ROD Investigations During This Five-Year Review Period

2014 Biological Study of Shellfish. Prior to the development of the sediment and tissue sampling plan for the 2015 investigation, a biological study was conducted during August 2014 to assess species occurrence, relative abundance, and the appropriate biologically active zone for shellfish within the intertidal portion of the beach. This information was used to help select the locations for future tissue and sediment samples. The specific objectives of the biological survey were to document infaunal shellfish species and general abundance within the intertidal portion of the beach and to identify the buried depth for infaunal shellfish species observed. The most abundant clam species found in the survey were native littleneck and butter clams. A copy of this report is included in Appendix A.

2013 Health Consultation/Shellfish Evaluation. The Agency for Toxic Substances and Disease Registry (ATSDR) prepared a health consultation (ATSDR 2013) in response to a request from representatives of the Suquamish Tribe and Ecology. These parties requested that ATSDR evaluate clam tissue data collected from Area 8 between 1996 and 2008 using the accepted Suquamish Tribe shellfish ingestion rates. A copy of this report is included in Appendix A.

The 2013 health consultation report served as a follow-up of a public health assessment (PHA) conducted by ATSDR in 2001, which evaluated the potential for human exposure to contaminants in shellfish harvested from Area 8 using 1996 and 2000 data and much lower subsistence ingestion rates than currently accepted. Since the PHA was released, the Navy has conducted two additional rounds of sampling in 2004 and 2008.

The nearshore areas of NBK Keyport are part of the Suquamish Tribe's "usual and accustomed" fishing grounds. This beach has been and continues to be closed to shellfish harvesting because of pollution in Liberty Bay (Chang 2015 and Maier 2015) and because the inner tidal areas adjacent to NBK Keyport are maintained by the Navy as high security areas, which are patrolled by security and marked with no trespassing signs (fishing is also not permitted). The tribe would like to harvest from this beach in the future.

The ATSDR (2013) report concluded the following:

- There is no current exposure to the contaminants detected and no current health hazard, because shellfish from the nearshore area of OU 2 Area 8 are not currently being collected for consumption. The shellfish are not being consumed.

- Pacific littleneck clam samples collected from seep areas near Area 8 exceeded health-based screening levels for several heavy metals. Eating clams from this area at Suquamish tribal subsistence quantities for longer than a year could harm people's health.

- A general public health conclusion on future shellfish consumption could not be made based on data limitations, including a small sample area, single species of clam sampled, analysis limited to inorganics and SVOCs, and a single season of sampling.

The ATSDR (2013) report recommended the following:

- Sample a variety of shellfish (the major shellfish species that would be consumed) at varying times of the year from a broader area representing the open areas.
- Analyze samples for cadmium, hexavalent chromium, lead, methylmercury, SVOCs, pesticides, PCBs, tributyltin, and biological contamination.
- Area 8 should not be reopened until LTM of shellfish demonstrates a decline in cadmium, chromium, lead, and mercury levels at a point that no longer presents a health concern.
- Analysis should include speciation of chromium and methylmercury to better quantify hazards.
- The Navy should collaborate with the Suquamish Tribe and Ecology to determine a range of consumption rates for any future HHRAs.

6.4.5 Institutional Controls Inspection Data

The findings of the June 2014 ICs inspection are summarized below. These findings are consistent with those from 2009 through 2014.

For OU 1 Area 1, the former landfill, the inspection found the following:

- The area is being used as a parking lot and motorcycle training course. There are also two phytoremediation plantations at the site.
- Security procedures for base entry have maintained restricted access to Keyport.
- No new water well has been installed in the last year in Area A (between the marsh and tide flats), Area B (between the tide flats and pass and ID building), or Area D (the former landfill), or on Navy property within 1,000 feet of the former

landfill. Wells previously have been installed in these areas for monitoring and remedial action purposes.

- No activity has occurred in Area C, the tide flats, that could interfere with or compromise monitoring or remedial actions.
- No employee is permanently assigned to work in buildings in Area D, the former landfill.
- The only land use activities for Area D, the former landfill, are those involving occasional occupancy by workers.
- Keyport follows an excavation/dig permit procedure to control construction and digging activities at Area D, the former landfill. The permit requirements have been effective in maintaining the requirements of the ICs plan.
- No activity has occurred in Area E, the marsh pond or marsh system, that has disturbed the wetlands, resulted in an exposure hazard, interfered with or compromised the monitoring, or interfered with or compromised remedial actions for the landfill.

For OU 2 Area 2, Van Meter Road Spill/Drum Storage Area, the inspection found the following:

- The area is being used for reutilization of government equipment, which is classified as light industrial use.
- Security procedures for base entry have maintained restricted access to Keyport.
- Construction and digging activities have been controlled by the base excavation/dig permit procedures, which have been effective in maintaining the requirements of the ICs plan.
- No water wells have been installed at OU 2 Area 2, except those installed previously for monitoring or remedial actions.
- No residential development has occurred at OU 2 Area 2.

For OU 2 Area 8, Plating Shop Waste/Oil Spill Area, the inspection found the following:

- The area is being used for light industrial use and as a parking lot.

- Security procedures for base entry have maintained restricted site access.
- Construction and digging activities have been controlled by the base excavation/dig permit procedures, which have been effective in maintaining the requirements of the ICs plan.
- No water wells have been installed at OU 2 Area 8, except those installed previously for monitoring or remedial actions.
- No residential development has occurred at OU 2 Area 8.

For Site 23, former building 21 Area, the inspection found the following:

- The area is being used for light industrial use and as a parking lot.
- Security procedures for base entry have maintained restricted site access.
- Construction and digging activities have been controlled by the base excavation/dig permit procedures, which have been effective in maintaining the requirements of the ICs plan.
- No water wells have been installed at Site 23, except those installed previously for monitoring or remedial actions.
- The asphalt-concrete surface pavement remains in place and intact.

6.5 RESULTS OF SITE INSPECTION

The site inspection checklist is included as Appendix E. This section contains a summary of the site inspection findings. The site visit was performed on September 4, 2014, and conducted by the following personnel:

- Carlotta Cellucci, NAVFAC NW
- John Blacklaw, Washington State Department of Ecology
- Michael Meyer, URS Corporation

The site visit included verifying that remedial actions remained operational (for those items that could be visually inspected) and inspecting all portions of the site covered by ICs. Site conditions observed at OU 1, OU 2 Areas 2 and 8, and Site 23 indicate that ICs requirements for these sites are being met. Independent observations during the site inspection were recorded by

Ecology (Blacklaw 2014) and documented as part of the Ecology interview response provided in Appendix F.

The paved portion of the OU 1 former landfill was visually inspected, as were the stormwater control facilities. Tree plantations and monitoring wells were inspected. ICs inspections are being performed and documented yearly. The following observations were noted during this site inspection:

- Landfill cover: Settlement, a 12-inch hole, and numerous cracks in asphalt observed in the south end of landfill area; eight cracks observed in area paved in 2003; cracks along swale adjacent to Bradley Road; tree roots causing bulging and cracking of asphalt in south end of landfill; water ponding south of irrigation shed along Bradley Road and in southern portion of landfill; concrete aprons around monitoring wells need to be resealed with asphalt; and clogged drain beneath overhead cover on east side of landfill

- Surface water structures at landfill: Alder trees and other brush growing up through penetrations in the asphalt near old foundations in southern portion of landfill

- Phytoremediation: Some apparent tree health stress observed in both plantations compared to previous inspections, including leaf curl and burn and low leaf density

The tide gate at OU 1 was functioning and in good condition. Documentation is available of regular tide gate inspections and maintenance in the annual monitoring reports and is summarized in Section 6.4.

No significant recommendation was made for OU 2 or Site 23. The following recommendations were made regarding OU 1:

- All drainage from the landfill asphalt cover should be directed away from the plantations.

- All drainage types (e.g., oil/water separators, underground pipes, and ditches) and locations at the landfill should be evaluated for potential improvements to limit the infiltration pathway.

- Maintain the drain in Building 791.

- Remove unused stored material from Building 1032 and a large temporary building just north of the south plantation.
- Limit driving on landfill cover with heavy trucks.
- Repair wooden walkway on the west side of the landfill near small pond and wetland area.
- Install drain along Bradley Road that would intercept both surface water and groundwater flow and direct it to the south as a potential remedy improvement option.

6.6 RESULTS OF INTERVIEWS

Interviews were conducted with persons familiar with the CERCLA actions at NBK Keyport. Interviewees were selected from the Navy (including NAVFAC NW, NBK Keyport, and Navy contractors), Ecology, EPA, Kitsap Public Health District, the Suquamish Tribe, and the community. Interview instructions and questions were sent to potential interviewees via regular mail and follow-up email. Not all those invited to comment chose to do so. Interview responses are documented in Appendix F. Highlights of the interview responses are summarized in the following sections.

6.6.1 Navy Personnel

Navy personnel associated directly with NBK Keyport and from NAVFAC NW were interviewed.

NBK Keyport

Interview questions were sent to two NBK Keyport personnel. One of the respondents stated he is not familiar with the RODs or the remedies implemented at NBK Keyport. He indicated his role was limited to overseeing a contractor performing maintenance of the phytoremediation plantation and acting as the Navy Technical Representative during the construction of the landfill cover. The second respondent indicated that he was familiar with the RODs and remedy implementation, but because he has not been involved with the remedial activities since 1999, is not familiar with monitoring and maintenance activities. However, based on what he has heard regarding the site, he thought both OU 1 and OU 2 Area 8 are working as expected, and ICs inspections and environmental monitoring are being conducted as required. The respondent also indicated that he was not aware of any violation of the ICs requirements at either of the OUs.

NAVFAC NW Personnel

In her role as the NAVFAC NW Remedial Project Manager for Keyport, the respondent indicated that she is familiar with the RODs for OUs 1 and 2 and the current monitoring and maintenance activities. She has reviewed all documents produced since August 9, 2013 when she became the remedial project manager for the site. The NAVFAC NW respondent indicated that regular inspections of the ICs are being performed and are effective, and the environmental monitoring is being performed as required. Furthermore, she is not aware of any violation of the ICs requirements or any community concerns.

OU 1. The NAVFAC NW respondent believes that the plantations are impeding migration of contaminants and reducing contaminant concentrations in concert with intrinsic bioremediation, as demonstrated by the USGS report, and that there is no current risk to human health and the environment. Progress is being made on reassessing the phytoremediation remedy in the southern portion of the landfill where the remedy is not performing as anticipated, and results of the first phase of investigations are being used to scope the second phase of the investigation. The removal of PCB-contaminated sediment was completed and successful, the tide gate is operating as expected, and no contingent action has been necessary, because contamination has not been detected in off-base wells. She stated that there is no significant O&M issue. However, it is not clear whether the oil/water separator and drainage swale installed during the remedial action are being maintained. Furthermore, the landfill cap requires upgrades and maintenance.

OU 2. No comment was made regarding Area 2. The NAVFAC NW respondent believes that the monitoring and ICs at OU 2 Area 8 have been successful. Groundwater monitoring results have shown steadily decreasing trends and degradation of parent compounds to daughter products. Excavation of contaminated soils at Area 8 has reduced the potential for contamination of the adjoining bay. Although former investigations and risk assessments have shown there are no unacceptable risks at OU 2 Area 8, additional investigation and risk assessment are being performed based on disagreements by stakeholders regarding the risk assessment methods previously used. The results of these additional investigation and risk assessment activities will be used to determine whether additional actions (groundwater controls) are necessary.

Navy Contractors

Interview questions were sent to two Navy contractors that perform LTM/O&M and phytoremediation activities at OU 1 and LTM/O&M at OU 2. Only one contractor provided comments. The respondent's role is the task order manager/quality control manager, and he has been involved with this site since 2007. He indicated the monitoring is sufficient to evaluate trends and whether ROD goals are being met, and ICs and site controls are adequate to maintain ROD goals for land use. He stated that fertilizer use was stopped in 2011 and irrigation halted during the summer of 2013 in an effort to encourage deeper tree-root growth, potentially optimizing phytoremediation. Based on results of LTM, CRA plan monitoring, ICs inspections, and O&M over the past 5 years, he noted that the remedies in place continue to be protective of human health on and off site. With respect to optimizing sampling, he recommended analysis of only the COCs identified for each of Areas 1, 2, and 8 because contaminants other than COCs have consistently either not been detected or have been detected in trace concentrations.

6.6.2 Agency Personnel

Interview questions were sent to two Ecology staff members, including the Ecology project manager and a sediment specialist. The Ecology project manager indicated that he is very familiar with the RODs for OUs 1 and 2 at NBK Keyport and has been involved with this site since January 2012. Although progress has been slow and difficult historically because of the differing concerns of the stakeholders, he indicated recent progress has been good. Because recent monitoring data show that several sediment locations exceed regulatory criteria, he indicated work is continuing at OU 2 Area 8 to determine the extent of contamination, assess risks, and establish background concentrations. Based on this information, the remedy for OU 2 Area 8 may need to be upgraded in Ecology’s opinion.

The Ecology project manager stated that the tide gate is functioning well at OU 1 and the ICs have been effective at NBK Keyport. During the site inspection, Ecology identified several deficiencies in the landfill cover that should be addressed (previously discussed in Section 6.5). The Ecology project manager indicated that phytoremediation and intrinsic bioremediation are not adequately reducing the groundwater concentrations of TCE and daughter products in the south plantation area or limiting release to the marshy area, stream, or pond on the south and west sides of the landfill. In addition, preliminary sampling results from tree coring and geotechnical evaluations at OU 1 indicate that the TCE plume in the south plantation is more extensive than previously thought. Because of this, the remedy is not likely to meet a reasonable remediation time frame. The restoration time frame at the south phytoremediation plantation, although anticipated to be decades long in the ROD, is likely to exceed the 30- to 50-year time frame currently expected by Ecology. Therefore, further study of OU 1 is required, in Ecology’s opinion, to fill data gaps, understand the nature and extent of contamination, and determine whether a remedy upgrade is warranted. Furthermore, the Ecology project manager expressed concerns regarding the work being performed by the USGS at OU 1. In Ecology’s opinion, this work is being conducted without Ecology or any other stakeholder review and oversight, as required by the Federal Facilities Agreement (FFA). The Navy acknowledges this comment. However, The FFA was written to cover RI/FS and remedial design/remedial action documents and 5-year review reports. Therefore, monitoring plans and reports are not stipulated in, nor covered by the FFA and do not require regulatory review.

The Ecology project manager indicated that monitoring results for the Keyport lagoon, which was being evaluated as a possible mitigation site, exceeded regulatory criteria. Furthermore, this new information justifies further investigation to assess the nature and extent of contamination and determine if cleanup actions are required. The Ecology project manager felt that the results of the lagoon sampling should be included in the 5-year review. However, the Navy has determined that the lagoon area is not part of the CERCLA action and would require a separate regulatory process.

The Ecology sediment specialist indicated that she began providing technical support to the Ecology project manager in October 2013 regarding sediment issues at OU 2 Area 8. Therefore, she is familiar with the portions of the OU 2 ROD applicable to Area 8, including the RI, remedial actions, RGs, and LTM data. She is not involved with OU 1. This Ecology respondent indicated that while ICs have been effective in limiting human exposure, further evaluation is needed to determine impacts to the sediments and biological receptors from the continued discharge of contaminants from Area 8 groundwater, given that COCs appear to be accumulating in sediment, and concentrations of cadmium at several sediment stations exceed the sediment management standards (SMS) cleanup screening level. Furthermore, ATSDR concluded that clam samples from seep areas near Area 8 exceeded human health-based screening levels for several heavy metals and could present a health hazard to subsistence and recreational shellfish consumers (ATSDR 2013). Ecology did not agree with the inputs and findings from previous Navy human health and ecological risk evaluations. However, the respondent indicated they appreciated the collaborative process being used to develop the latest quality assurance project plan, which will be used to further assess risk to human health and environmental receptors. This plan also includes an expanded sampling area to assess the extent of exceedances in the northern end of the sampling area.

Both Ecology respondents indicated that they were not aware of any complaint, violation, or incident related to NBK Keyport or any community concerns. Community involvement has been very limited, except for the continuing involvement of the Suquamish Tribe.

The EPA respondent feels he is well informed regarding the remediation activities and the progress at NBK Keyport, although he has only been EPA's project manager since December 2013 and is not as familiar with the site as he would like to be. EPA indicated that most components of both the OU 1 and OU 2 remedies have been effective. The effectiveness of phytoremediation at OU 1 is inconclusive in his opinion, given the data currently available. The Navy's planned activities at OU 1 should address whether there is potentially an unknown source at the site, or phytoremediation is not effective. EPA indicated that concerns regarding the remedy at OU 2 Area 8 are being addressed by the Navy through additional sediment and shellfish sampling and risk assessment. The EPA respondent was not aware of any complaint, violation, or other incident related to NBK Keyport or any community concerns.

The Kitsap Public Health District (Health District) respondent indicated that he was most familiar with OU 1, because the Health District has regulatory responsibilities for landfills. He has reviewed the documents related to OU 1, inspected the landfill at OU 1, and met with the Navy regarding the landfill. The Health District respondent also indicated that he has read the RODs and the 5-year reviews and is somewhat familiar with the remedies and monitoring and maintenance activities. However, the Health District has not received any material related to the site since the last interview performed in 2009 as part of the third 5-year review, and requests that data from the last round of sampling in August 2014, as wells as USGS intrinsic bioremediation studies, be provided to the Health District for review. In addition, the Health District has not been included in discussions on additional investigations or remedies and requests to be included in any future discussions regarding the OU 1 landfill.

Based on the information the Health District received during the third 5-year review, they indicated that the phytoremediation at OU 1 is not working as intended, although they did indicate that progress is being made slowly. Data from one of the seeps indicates that contaminants continue to enter surface water, most likely from the landfill. Although the removal of PCB-contaminated sediments may have been effective, the continued releases of PCBs may negate the benefits of the sediment removal. The Health District indicated that the tide gate has protected the landfill from erosion, and that the landfill cover, contingent actions for the off-base domestic wells, and ICs have been effective. Furthermore, the respondent indicated that the LTM is critical to the assessment of the remedies.

Based on information provided for the interview and the third 5-year review, the Health District indicated that the OU 2 Area 2 remedy is working as intended, but the OU 2 Area 8 needs further review. However, they are satisfied with the progress made on the OU 2 remedy.

The Health District is not aware of any community concern or complaint, violation, or other incident related to NBK Bangor. The Health District has concerns and would like to see the following steps implemented at the site:

- Further reduce or eliminate releases of COCs to surface and groundwater at the site.
- Ensure that shellfish closure areas are adequate to protect public health.
- Investigate the elevation of groundwater in the landfill, if not already performed, to ensure that waste in the landfill is not submerged in groundwater or tidally influenced groundwater.

6.6.3 Tribe Personnel

The Suquamish Tribe Project Manager responded that they are active participants in the OU 1 and OU 2 Area 8 project teams and are familiar with the RODs, remedies, and monitoring and maintenance activities at the site. They were also involved in the third 5-year review and routinely review and comment on reports, work plans, and sampling plans. The Project Manager felt they were well informed about the remediation activities and progress at NBK Keyport and indicated that the current Navy project manager is committed to ensuring that project team members have input into planning processes and site management decision making. The Project Manager indicated that the Suquamish Tribe will continue to be actively involved with ongoing activities related to NBK Keyport, including reviewing new data and developing updated site management strategies. The Project Manager noted that the presence of contamination impacts protected resources and limits the tribe's ability to safely gather and consume fish and shellfish from the area.

They expressed ongoing concern that the remedies implemented at OU 1 and OU 2 Area 8 have not effectively addressed contamination and do not meet RGs and regulatory criteria. The Project Manager indicated that phytoremediation using hybrid poplar trees has not functioned as intended by the OU 1 ROD in the southern portion of the landfill, and VOC concentrations in groundwater and in the closest surface water sample consistently exceed RGs and regulatory criteria. Although exposure routes are being controlled and monitored at OU 1, the Suquamish Tribe does not believe that phytoremediation, even in conjunction with intrinsic bioremediation, is protective of human health and the environment in the long term.

The Project Manager also indicated that LTM of groundwater, sediments, and shellfish at OU 2 Area 8 demonstrates that site-related contaminants are continuing to impact sediments and clams offshore of Area 8. They indicated that the risk assessments performed for OU 2 Area 8 during the previous 5-year review did not adequately address the Suquamish Tribe's concerns regarding potential impacts to human health and the environment. However, the Suquamish Tribe supports the Navy's current efforts to further characterize the nature and extent of contamination at both of these sites, reevaluate potential risks to human health and the environment at OU 2 Area 8, and assess the need for additional actions at NBK Keyport.

6.6.4 Community

Interview questions were sent to 19 community members, including 2 former RAB members, 3 port commissioners, and 14 other community members. Four of the letters sent to community members were returned as undeliverable. Only one former RAB member responded to the interview request. The community respondent indicated that this is the first communication she has received, presumably since the last 5-year review. She expressed that she was glad that investigations are still taking place, and indicated that they appear to be thorough. The community respondent also indicated that they obtain local information from the *Kitsap Sun* newspaper.

7.0 TECHNICAL ASSESSMENT

This section presents the details of the functionality of the remedies, the continued validity of ROD assumptions, any new information that has arisen that could affect the protectiveness of the remedy, and a technical assessment summary for the remedies for OU 1 Area 1, OU 2 Areas 2 and 8, and Site 23.

This section answers three questions:

- Question A: Is the remedy functioning as intended by the decision documents?
- Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid?
- Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Based on the answers to the questions discussed in this section, a technical assessment of the remedies is summarized in Table 7-1. This table provides a quick reference to the answers to questions A, B, and C by OU and site. A discussion of the answers to the three questions and the technical assessment summary are presented in order under each OU and site in the sections below.

Table 7-1
Technical Assessment Summary

Location	Question A: Is the remedy functioning as intended by the decision documents?	Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid?	Question C: Has any other information come to light that could call into question the protectiveness of the remedy?
OU 1 Area 1	Yes	Yes	Yes
OU 2 Area 2	Yes	Yes	No
OU 2 Area 8	Yes	Yes	Yes
Site 23	Yes	Yes	No

Notes:
Yellow highlight identifies an issue.
OU - operable unit
RAO - remedial action objective

In answering question B, any change to ARARs used to establish RGs in the ROD and any change to risk assessment assumptions (exposure and toxicity) are reviewed to evaluate the protectiveness of the remedy. In the preamble to the NCP, EPA stated that ARARs are generally "frozen" at the time of ROD signature, unless new or modified requirements call into question the protectiveness of the selected remedy. Five-year review guidance (USEPA 2001 and 2012) indicates that the question of interest in developing the 5-year review is not whether a standard identified as an ARAR in the ROD has changed in the intervening period, but whether this change to a regulation calls into question the protectiveness of the remedy. If the change in the standard would be more stringent, the next stage is to evaluate and compare the old standard and the new standard and their associated risk. This comparison is done to assess whether the currently calculated risk associated with the standard identified in the ROD is still within EPA's acceptable excess cancer risk range of 10^{-4} to 10^{-6}. If the old standard is not considered protective, a new cleanup standard may need to be adopted after the 5-year review through CERCLA's processes for modifying a remedy.

RGs were established for soil, sediment, groundwater, and surface water. During the first, second, and third 5-year reviews for NBK Keyport, ARARs were reviewed to assess whether any substantive changes were made to ARARs that would call into question the protectiveness of the remedy and the RGs established in the ROD. For this 5-year review, all the ARARs identified in the ROD were again reviewed for changes that could affect the assessment of whether the remedy is protective. Based on this review, it was concluded that five of the regulations listed as ARARs have changed, as follows:

- Washington State MTCA regulations updated in 2013, with criteria updated in the CLARC database as of May 2014
- Federal and state drinking water regulations (maximum contaminant levels [MCLs])
- Federal marine ambient water quality criteria (AWQC)
- Washington State marine AWQC
- Washington State SMS updated in September 2013

The Navy acknowledges the changes to EPA's human health surface water criteria and Ecology's CLARC database revisions in 2015. However, these changes occurred after the data review period for this 5-year review, which was from July 2009 to June 2014. Given that institutional controls are in place to prevent exposure to site risks, these changes do not currently impact the protectiveness of the remedy, so will be assessed during the next 5-year review.

In addition to establishing risk-based cleanup levels, MTCA also allows for use of background or the laboratory PQL as a cleanup level when the MTCA cleanup level is lower than these values. The 5-year review includes an assessment of current PQLs used for LTM and a comparison of the current ARARs with the RGs based on the PQLs or background.

7.1 OU 1 AREA 1

7.1.1 Functionality of Remedy for OU 1 Area 1

Is the remedy functioning as intended by the decision documents? Yes. However, phytoremediation performance in the south plantation has been slower than anticipated. Therefore, the restoration time frame at the south plantation, although anticipated to be decades long in the ROD, is likely to exceed the 30- to 50-year time frame currently expected as a matter of policy by Ecology. The COC concentrations found today in the landfill, marsh, and downstream sampling locations are similar to or lower than those at the time of the ROD, when those conditions were found to be sufficiently protective of human health and the environment. The current conditions do not impact the short-term protectiveness of the remedy as established in the ROD. All other components of the remedy, landfill cover upgrade, natural attenuation, sediment removal, tide gate upgrade, ICs, and LTM are also functioning as intended.

The RAOs established in the OU 1 ROD are the following:

- RAOs for soil, waste, and vapor within the landfill:
    - Prevent exposures to humans due to dermal contact with or ingestion of landfill soil or waste material that contains contaminants that may result in unacceptable risk. For this objective, unacceptable risk is defined by exposure of humans to concentrations of landfill contaminants above state cleanup levels for soil (MTCA Method B).
    - Prevent exposures to humans due to inhalation of vapor from the landfill that contains contaminants that may result in unacceptable risk. For this objective, unacceptable risk is defined by exposure of humans to concentrations of landfill contaminants above state cleanup levels for air (MTCA Method B).
- RAOs for groundwater:
    - Prevent exposures to humans due to drinking water ingestion of groundwater that contains landfill contaminants at concentrations above state and federal drinking water standards and state cleanup levels for groundwater (MTCA Method B).

- Prevent unacceptable risks to humans and aquatic organisms due to migration of landfill contaminants via groundwater into the adjacent aquatic environments, as defined in the RAOs discussed below for surface water.

- RAOs for surface water:

  - Prevent exposures to humans due to ingestion of seafood that contains contaminants at concentrations that pose unacceptable risk as a result of chemicals migrating from the landfill via groundwater into the adjacent marine water. For this objective, unacceptable risk is defined by exposure of seafood resources to concentrations of landfill contaminants in surface water above state water quality standards, federal water quality criteria, and state cleanup levels for surface water (MTCA Method B). This refers to those surface water criteria and standards developed for the protection of human health (i.e., seafood ingestion).

  - Prevent exposures to aquatic organisms due to contaminants present in surface water at concentrations that pose unacceptable risk as a result of chemicals migrating from the landfill via groundwater into the adjacent surface water. For this objective, unacceptable risk is defined by concentrations in surface water above state water quality standards or federal water quality criteria developed for the protection of marine organisms.

- RAOs for sediments:

  - Prevent exposures to humans due to ingestion of seafood that contains contaminants at concentrations that pose unacceptable risk as a result of chemicals migrating from the landfill via groundwater into the sediments of the adjacent aquatic systems and thence into seafood tissues. For this objective, unacceptable risk is defined by concentrations in littleneck clam tissues, as defined in the seafood ingestion RAO discussed below for shellfish.

  - Prevent exposures to aquatic organisms due to contaminants present in sediments at concentrations that pose unacceptable risk as a result of chemicals migrating from the landfill via groundwater into the adjacent aquatic systems. For this objective, unacceptable risk is defined by concentrations in sediments above state SQS (for chemistry) and by bioassays.

- RAOs for Shellfish:

  - Prevent exposures to humans due to ingestion of seafood that contains contaminants at concentrations that pose unacceptable risk as a result of chemicals migrating from the landfill via groundwater into the adjacent aquatic systems. For this objective, unacceptable risk is defined by concentrations in littleneck clam tissues above a cumulative incremental cancer risk of 1 x 10^{-5} or above a noncancer hazard index (HI) of 1, using exposure assumptions for subsistence harvesters as identified in Appendix B of the ROD. These target risk levels are within EPA's acceptable risk range, which refers to an incremental cancer risk range of 10^{-6} to 10^{-4} and a noncancer HI of 1 as acceptable targets for Superfund sites. The risk levels are also in accord with the risk assessment framework used in MTCA to establish state cleanup levels for exposures to multiple hazardous substances (WAC 173-340-708). MTCA does not establish cleanup levels that are specific for shellfish samples.

- Prevent exposures of aquatic organisms to contaminants migrating from the landfill that pose unacceptable risk. For this objective, unacceptable risk is defined by concentrations of landfill contaminants in littleneck clams above the ecological risk-based screening values (i.e., the maximum acceptable tissue concentrations) in Appendix J of the summary data assessment report (U.S. Navy 1997a).

Overall, the remedy for OU 1 has been implemented as intended by the ROD. However, as found during the third 5-year review, the phytoremediation component of the remedy is not as effective as expected by site stakeholders and regulators. Per the language of the ROD (U.S. Navy, USEPA, and Ecology 1998, Section 11.1.1), the objective of the phytoremediation action is to reduce "the main sources of the TCE-family contamination in the landfill in order to improve conditions over the long term and to reduce the potential for these chemicals to cause unacceptable risks in the future." Thus, the intent of this remedy "is to speed up the removal of TCE-family compounds at the source areas compared to that being accomplished by natural attenuation processes" (U.S. Navy, USEPA, and Ecology 1998, Section 11.1.1). The expectation in the ROD is that phytoremediation and natural attenuation are expected to work in concert to remove and degrade TCE-family compounds to harmless by-products.

The ROD established that risks to human health and the environment at the site were acceptable at the time of the ROD and focused the remedy on preventing future increases in risk:

> Test results have shown downgradient concentrations that (1) do not indicate current unacceptable risk to human health via the seafood ingestion pathway at locations where seafood resources now exist, (2) do not flow toward off-base drinking water resources, and (3) do not pose sufficient ecological risk to require active remediation of downgradient resources at this time. The site

characterization studies indicate that this favorable situation will most likely continue in the future.

The COC concentrations found today in the landfill, marsh, and downstream sampling locations are similar to or lower than those at the time of the ROD, when those conditions were found to be sufficiently protective of human health and the environment as long as exposures were controlled. Although Ecology and the Suquamish Tribe note in their interview responses the ongoing exceedances of RGs and migration of contaminants, these conditions match those expected by the ROD, so do not call into question the protectiveness of the remedy as established in the ROD.

All components of the OU 1 remedy have been implemented. Implementation of phytoremediation, PCB-contaminated sediment removal, and the tide gate upgrade were complete prior to the first 5-year review. ICs were also implemented prior to the first 5-year review, and LTM, maintenance, and inspection programs are in place. The landfill cover was upgraded during the second 5-year review period, and the Navy prepared and implemented a contingent remedial action plan in March 2003.

Functionality of Phytoremediation

The phytoremediation component of the remedy has not been as effective in the south plantation as expected by site stakeholders and regulators during the ROD preparation. The effectiveness of phytoremediation was assessed against the performance criteria established in the ROD and the original phytoremediation work plan.

Tree Health. The trees are healthy given the poor growing conditions at the site, which were acknowledged at the time of remedy implementation. Although the leaf cover appeared sparse during the site inspection for this 5-year review compared to the previous 5-year review, the trees are not obviously diseased and the plantation mortality remains below industry norms. The tree canopy is closed at each plantation, indicating that the water uptake capabilities of the two plantations have been maximized (all of the available solar insolation is being utilized by the plantations).

Groundwater Flow. LTM of the groundwater elevation beneath both the north and south plantations has not revealed any discernible effect from the trees on groundwater elevation, flow direction, or gradient, as anticipated by the ROD. Detailed analyses of tidal effects on groundwater beneath the plantations and on transpiration imply that the trees have difficulty in the summer drawing as much water from the low-productivity shallow aquifer as they could use (U.S. Navy 2006b) and that this performance criterion may not be sensitive enough to demonstrate effects by the trees (U.S. Navy 2003b).

Although the LTM has not been sensitive enough to demonstrate groundwater uptake by the trees and evaluate the performance criteria established by the ROD, transpiration and groundwater elevation studies have shown other ancillary benefits to phytoremediation at the site. The closed tree canopy intercepts and allows the evaporation of a significant percentage of the precipitation falling on the plantations before this precipitation can infiltrate the landfill. The trees also intercept and use soil moisture from the vadose zone before this soil moisture can migrate to the shallow aquifer. This interception of water inputs to the landfill should reduce the leaching of contaminants from the landfill during the growing season.

Contaminant Concentrations. Contaminant concentrations in groundwater beneath OU 1 have decreased overall since the time of the ROD. The lateral extent of the COC plumes beneath both the north and south plantations have contracted, and the maximum concentration of COCs in groundwater has decreased beneath the north plantation. The estimated areal extent of groundwater beneath the south plantation exhibiting TCE concentrations greater than 5 μg/L has decreased from approximately 36,000 square feet in 1999/2000 (Figure C-17) to approximately 16,000 square feet in 2014 (Figure C-20). On this basis, the plume beneath the south plantation has contracted approximately 56 percent over the last 15 years. The maximum COC concentrations in groundwater beneath the southern edge of the south plantation, however, have remained similar to those measured at the time of the ROD.

As found during the third 5-year review, annual monitoring and evaluation of the site by the USGS has concluded that biodegradation has been a primary cause for the decreased contaminant concentrations beneath OU 1. In addition to biodegradation, it is probable that phytoremediation is having some positive effect on contaminant reduction and, at the least, that phytoremediation does not appear to be impeding the natural biodegradation processes operating beneath OU 1. Phytoremediation appears to be reducing the infiltration of precipitation into the landfill surface, which should result in reduced leaching of contaminants from unsaturated soil into groundwater.

Functionality of Natural Attenuation

As stated in the OU 1 ROD, it was anticipated that "source reduction by the poplar trees will work in concert with natural attenuation processes and decrease the overall time frame for cleansing of the site" (U.S. Navy, USEPA, and Ecology 1998). Thus, phytoremediation was not expected to perform as a stand-alone remedy. Since the third 5-year review, the Navy has performed an evaluation of natural attenuation at the site in accordance with Section 11.1.6 of the ROD, which states that "if phytoremediation is determined to be ineffective and is discontinued, natural attenuation and intrinsic bioremediation will be evaluated to determine whether they satisfy the key objectives for which the phytoremediation action was intended to address."

The evaluation of natural attenuation at the site (U.S. Navy 2012c) found that natural biodegradation was effective at reducing the COC mass transported via the groundwater to surface water pathway. However, COCs in surface water still consistently exceed ARARs, and the restoration time frame for meeting the RGs is likely to exceed a 30- to 50-year time frame currently expected as a matter of policy by Ecology. In spite of the long predicted restoration time frame and ongoing ARARs exceedance, the evaluation procedure established in the ROD for the groundwater monitoring data focuses on an assessment of whether "adverse trends that indicate risks to receptors downgradient of the landfill will become unacceptable in the future." The shallow intermediate aquifer data are not indicative of increasing risk, and therefore the remedy is functioning as the ROD intended.

Functionality of Sediment Removal

The removal of PCB-contaminated sediment successfully reduced the amount of PCBs present in marsh sediments. PCB concentrations found in 2002, 2004, and 2009 sediment samples were below the screening values, and PCB analysis of sediment samples has been discontinued in accordance with the recommendations of the third 5-year review. PCBs are also detected in water samples from landfill seep SP1-1, and the ongoing monitoring program is functioning to assess the potential for long-term recontamination of the marsh.

Functionality of Tide Gate

The tide gate is functioning to regulate the marsh water level, and no erosion of the landfill is apparent. Maintenance of the tide gate is being performed and documented.

Functionality of Landfill Cover Upgrade

The upgraded landfill cover is functioning to reduce infiltration into the landfill by improving the integrity of the existing impervious surface and better controlling stormwater runoff. The site inspection during this 5-year review concluded that maintenance of the landfill cover is needed to ensure future functionality of this remedy component.

Functionality of Institutional Controls

ICs are being inspected annually and the findings documented. These controls are functioning to control human exposures to contaminated soil and groundwater at OU 1. ICs also currently restrict buildings from being located over the landfill in order to prevent vapor intrusion exposures to humans (west of Bradley Road). Based on review of the soil vapor and groundwater data used to establish this IC, additional vapor intrusion investigation is recommended in Section 8 to assess whether this component of the remedy should be extended to the east, across Bradley Road.

Functionality of Long-Term Monitoring

LTM is being conducted regularly for all required media and is functioning to evaluate the ongoing effectiveness of the remedy. The results are regularly evaluated to assess the remedy, the need to implement contingent remedial actions, and the need for modifications to the monitoring program. Based on the data review in Section 6.4, reductions in the monitoring program are warranted in some areas of OU 1, while an increase in monitoring is warranted for the groundwater to surface water pathway from the south plantation and for groundwater in the central portion of the landfill. Specific recommendations regarding this additional monitoring will be made as part of the ongoing recharacterization of the south plantation area.

7.1.2 Continued Validity of ROD Assumptions

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid? Yes, the ARARs, exposure assumptions, toxicity data, and RAOs are still valid and protective of human health and the environment in the short term. Changes to the ARARs used to establish cleanup levels in the ROD are evaluated below and summarized in Table 7-2. The changes to the toxicity and exposure risk assumptions are discussed in the following section.

Review of ARARs and Toxicity Criteria

OU 1 RGs were established for groundwater, surface water, sediment, and clam tissue. The basis for the RGs was the protection of human health if groundwater was used for drinking, if surface water contained a food source, or if clams were harvested by a subsistence population (U.S. Navy, USEPA, and Ecology 1998). For sediment, no specific numeric RG was established. Instead, the ROD indicated that bioassays would be conducted if sediment concentrations exceeded SQS. No numeric RG was established for the landfill soil. Instead, the ROD indicated that ICs would be maintained to prevent contact with landfill soil and vapor.

For groundwater, surface water, and clam tissue, the COCs with numeric RGs are nine chlorinated solvents and PCBs. In addition, the ROD identified a number of COIs in sediment and clam tissue for inclusion in the LTM program for sediment and shellfish. However, no RG was established for the COIs. Specific COIs in sediment were acenaphthene and phenol, based on the supplemental ecological risk assessment. COIs in clam tissue were arsenic, beryllium, chromium, lead, mercury, nickel, and zinc, based on the supplemental human health and ecological risk assessments using the 1995/1996 data. A chemical was selected as a COI if the maximum concentration exceeded one-third of the lowest risk-based screening level.

A comparison of ROD RGs with current ARARs (as of June 2014) for groundwater and surface water is provided in Table 7-2, and those with lower values that may impact the protectiveness of the remedy are discussed by media in the sections below. In addition, sediment and tissue RGs established in the ROD are discussed.

Table 7-3 summarizes the chemicals with changes in toxicity criteria and the basis of the toxicity criteria change, and provides the calculated health risks of the ROD RGs for the chemicals that would result in lower RGs using current ARARs (1,1-dichloroethane [DCA], 1,2-DCA, cis-1,2-DCE, TCE, PCE for surface water only, and vinyl chloride). This comparison is done to assess whether the ROD RGs still meet the ROD's target risk of 1 x 10^{-5} and are within EPA's acceptable excess cancer risk range of 10^{-4} to 10^{-6}, or below an HI of 1 for noncancer effects. The calculated risk levels listed in Table 7-3 that exceed target health goals are discussed by media in the following sections.

Groundwater. Table 7-2 compares current ARAR values (as of June 2014) with the RGs presented in the OU 1 ROD (U.S. Navy, USEPA, and Ecology 1998, Table 11-4). The RGs were based on the groundwater as drinking water pathway. Lower drinking water ARARs are noted for 1,1-DCA, 1,2-DCA, cis-1,2-DCE, TCE, and vinyl chloride.

As listed in Table 7-2, the RG for 1,1-DCA was based on the MTCA Method B drinking water value, and the current value is two orders of magnitude lower. The lower value is based on changes in toxicity criteria, and the chemical is currently evaluated as a carcinogen. As shown in Table 7-3, the calculated risk at the RG concentration is at 1 x 10^{-4}, at the top of EPA's risk range of 10^{-4} to 10^{-6}. Because ICs are in place, the RG remains protective.

The RGs for 1,2-DCA, cis-1,2-DCE, and TCE were based on their respective MCLs. As shown in Table 7-3, the current maximum contaminant levels (MCLs) remain unchanged from the ROD RGs. Although the MCLs have not changed, the current MTCA Method B values are lower. According to procedures specified in Ecology's methodology to assess the protectiveness of MCLs (WAC 173-340-720[7][b]), the RGs for 1,2-DCA and TCE are 1 x 10^{-5} and 1 x 10^{-6}, respectively (see Table 7-3). Therefore the RGs for 1,2-DCA and TCE remain protective. The assessed hazard of the MCL for cis-1,2-DCE of 4 would not meet WAC 173-340-720(3)(a) requirements as "sufficiently protective," based on exceeding target hazard quotient (HQ) of 1. However, ICs are in place, and the remedy remains protective for these three COCs.

As listed in Table 7-3, 1,2-DCA, cis-1,2-DCE, TCE, and vinyl chloride have lower current ARARs, based on changes in toxicity since the time of the ROD. Also noted in Table 7-3, 1,1-DCE is no longer considered a carcinogen, and the current MCL is an order of magnitude higher and MTCA Method B value three orders of magnitude higher. Therefore, prior to removal of ICs, the current ARARs for 1,1-DCE should be considered.

Table 7-2
Groundwater and Surface Water ARARs for OU 1

Chemical	Drinking Water						Surface Water Protection (Marine)				
	ROD RG[a] (µg/L)	Basis of ROD RG	Current MTCA Method B (µg/L)	Current Federal and State MCL (µg/L)	Current PQL as Applicable (µg/L)	Change in RG if Established today?	ROD RG Based on MTCA Method B Surface Water[a] (µg/L)	Current MTCA Method B Surface Water Value (µg/L)	Current National AWQC (µg/L)	Current PQL as Applicable (µg/L)	Change in RG if Established Today?
1,1-DCA	**800**	**MTCA B, drinking water**	**7.7**	**None**	**NA**	**Yes, lower (MTCA)**	None	None	None	NA	NA
1,2-DCA	**5**	**MCL**	**0.48**	**5**	**NA**	**No (MCL); yes, lower (MTCA)**	59	59	37[d]	NA	No (MTCA)
1,1-DCE	0.5	PQL	400	7	0.02	Yes, higher (MCL)	1.9	23,000	7,100[d]	NA	Yes, higher
cis-1,2-DCE[b]	**70**	**MCL**	**16**	**70**	**NA**	**No (MCL); yes, lower (MTCA)**	None	None	None	NA	NA
trans-1,2-DCE	100	MCL	160	100	NA	No	33,000	33,000	10,000	NA	No (MTCA)
PCE[c]	5	MCL	5	5	NA	No	**4.2**	**3.3**	**3.3[d]**	**NA**	**Yes, lower**
1,1,1-TCA	200	MCL	16,000	200	NA	No	41,700	930,000	None	NA	Yes, higher
TCE[c]	**5**	**MCL**	**4**	**5**	**NA**	**No (MCL); yes, lower (MTCA)**	**56**	**30**	**30[d]**	**NA**	**Yes, lower**
Vinyl chloride	**0.5**	**PQL**	**0.029**	**2**	**0.02**	**yes, lower (MTCA/PQL)**	2.9	3.7	2.4[d]	NA	Yes, higher
PCBs	0.04	PQL	0.044	0.5	0.02-0.04	No (MTCA/PQL)	PQL: 0.04	0.00011	0.000064[d]	0.02-0.04	No (PQL)
1,4-Dioxane[e]	None	NA	0.44	None	NA	NA	None	None	None	NA	NA

[a]Source: ROD Table 11-4 for groundwater and Table 11-5 for surface water (U.S. Navy, USEPA, and Ecology 1998)
[b]In accordance with Washington Administrative Code 173-340-720(3)(a) and 173-340-720(7)(b), the MCL for cis-1,2-DCE is not sufficiently protective when compared to the current MTCA B drinking water values. Therefore, the MCL would no longer be acceptable if cleanup levels were to be established today, i.e., the cancer risk level of the MCL would exceed 1 x 10^{-5} or hazard index of 1.

Table 7-2 (Continued)
Groundwater and Surface Water ARARs for OU 1

[c]MTCA Method B values used are presented in Ecology's (2012) TCE/PCE guidance. For PCE, the MCL value of 5 µg/L is used as the MTCA Method B value, instead of the calculated value based on the guidance document. Although the MTCA Method B value for TCE is lower than the MCL, the MCL is used based on the guidance document and is still protective, meeting target risks of 10^{-5}. The national AWQC for TCE and PCE are recommended for the MTCA Method B value in the guidance. Details are included in Section 7.1.2.
[d]Current U.S. Environmental Protection Agency national recommended AWQC for protection of human health marine waters organism only (fish from the water body)
[e]The chemical was identified as a potential chemical of concern in the second 5-year review; therefore, no ROD RG was established.

Notes:
Current ARARs are CLARC database values and federal surface water criteria as of June 2014, based on the 5-year data review period of July 2009 to June 2014.
Bold and yellow highlight indicate COC with lower current ARARs
ARARs - applicable or relevant and appropriate requirements
AWQC - ambient water quality criteria
DCA - dichloroethane
DCE - dichloroethene
MCL - maximum contaminant level
µg/L - microgram per liter
MTCA - Model Toxics Control Act
PCBs - polychlorinated biphenyls
PCE - tetrachloroethene
PQL - practical quantitation limit
ROD - Record of Decision
TCA - trichloroethane
TCE - trichloroethene

Table 7-3
OU 1 Remediation Goals With Changes in Toxicity Values

Chemical	Drinking Water RG (µg/L)	Surface Water RG (µg/L)	Current Value for Drinking Water (µg/L)	Current MTCA Method B Value for Surface Water (µg/L)	Drinking Water Health Risk of the RG Based on New Toxicity	Surface Water Health Risk of the RG Based on New Toxicity	Remedy Is Still Protective?	Reason for Toxicity Revision
1,1-DCA	**800**	**None**	**MTCA B = 7.7 (cancer)** **MCL = none**	**None**	**Current MTCA B value is lower. Cancer risk at RG (800 µg/L) = 1 x 10^{-4} [a].**	**Not applicable**	**Yes**	**The basis of the ROD value of 800 µg/L is not known. The current MTCA B value is based on an oral SF of 0.0057 $(mg/kg\text{-}day)^{-1}$.**
1,2-DCA	**5 (MCL)**	**59**	**MTCA B = 0.48 (cancer)** **MCL = 5**	**59**	**Current MTCA B value is lower than MCL. Cancer risk at MCL = 1 x 10^{-5}**	**No change. Risks meet target goals.**	**Yes**	**Considered carcinogenic by EPA. Current MTCA B value is based on oral SF of 0.091 $(mg/kg\text{-}day)^{-1}$.**
1,1-DCE	0.5 (PQL)	1.9	MTCA B = 400 MCL = 7 PQL = 0.02	23,000	Current MCL value is higher than PQL. Risks meet target goals.	Current MTCA B value is higher. Risks meet target goals.	Yes	No longer considered a carcinogen by EPA. Current MTCA B value is based on the oral RfD of 0.05 mg/kg-day.
cis-1,2-DCE	**70 (MCL)**	**None**	**MTCA B = 16** **MCL = 70**	**None**	**Current MTCA B value is lower than MCL. Hazard at MCL (70) = 4[b].**	**Not applicable**	**Yes**	**Current MTCA B value is based on the oral RfD of 0.002 mg/kg-day.**
PCE	**5 (MCL)**	**4.2**	**MTCA B = 5** **MCL = 5**	**3.3**	**Current MTCA B is equal to MCL. Risks meet target goals.**	**Current MTCA B value is lower. Cancer risk = 1 x 10^{-6}.**	**Yes**	**The calculated MTCA B value is based on the oral SF, which changed from 0.54 to 0.0021 $(mg/kg\text{-}day)^{-1}$. However, the federal and state MCL is used as the current MTCA Method B value (Ecology 2012).** **For surface water, the oral SF of 0.11 $(mg/kg\text{-}day)^{-1}$, the basis**

Table 7-3 (Continued)
OU 1 Remediation Goals With Changes in Toxicity Values

Chemical	Drinking Water RG (µg/L)	Surface Water RG (µg/L)	Current Value for Drinking Water (µg/L)	Current MTCA Method B Value for Surface Water (µg/L)	Drinking Water Health Risk of the RG Based on New Toxicity	Surface Water Health Risk of the RG Based on New Toxicity	Remedy Is Still Protective?	Reason for Toxicity Revision
								of the RG, has been withdrawn by EPA. The current MTCA Method B value is based on the current federal AWQC (Ecology 2012).
1,1,1-TCA	200 (MCL)	41,700	MTCA B = 16,000 MCL = 200	930,000	Current MTCA B value is higher than MCL. Risks meet target goals.	Current MTCA B value is higher. Risks meet target goals.	Yes	Current MTCA B value is based on the oral RfD, which changed from 0.9 to 2 mg/kg-day.
TCE	**5 (MCL)**	**56**	**MTCA B = 4 MCL = 5**	**30**	**Current MTCA B value is lower than MCL. Cancer risk at MCL = 1 x 10^{-6} [c].**	**Current MTCA B value is lower. Cancer risk at RG = 2 x 10^{-6}.**	**Yes**	**Current MTCA B value is based on the oral RfD of 0.0005 mg/kg-day. If the oral SF of 0.046 $(mg/kg\text{-}day)^{-1}$ and early life exposure early age dependent adjustment factors were used, the MTCA Method B value is 0.54 µg/L. However, 4 µg/L is the Ecology recommended value (Ecology 2012), which is protective of a hazard index of 1 and target risk of 1 x 10^{-6}. Surface water RG is based on the current federal AWQC rather than the revised oral SF of 0046 $(mg/kg\text{-}day)^{-1}$ (Ecology 2012).**

Table 7-3 (Continued)
OU 1 Remediation Goals With Changes in Toxicity Values

Chemical	Drinking Water RG (µg/L)	Surface Water RG (µg/L)	Current Value for Drinking Water (µg/L)	Current MTCA Method B Value for Surface Water (µg/L)	Drinking Water Health Risk of the RG Based on New Toxicity	Surface Water Health Risk of the RG Based on New Toxicity	Remedy Is Still Protective?	Reason for Toxicity Revision
Vinyl chloride	**0.5 (PQL)**	**2.9**	**MTCA B = 0.029 (cancer) MCL = 2 PQL = 0.02**	**3.7**	**Current MTCA B value is lower than PQL. Cancer risk at PQL of 0.5 = 2 x 10^{-5} [d]. If achieves PQL of 0.02, then meets target risk goals.**	**Current MTCA B value is higher. Risks meet target goals.**	**Yes**	**Current MTCA B value is based on the oral SF, which changed from 1.9 to 1.5 (mg/kg-day)[1].**

[a] 1,1-DCA risk of RG exceeds 1 x 10^{-5} target goal.

[b] In accordance with Washington Administrative Code 173-340-720(3)(a) and 173-340-720(7)(b), the MCL for cis-1,2-DCE is not sufficiently protective when compared to the current MTCA B drinking water value. Therefore, the MCL would no longer be acceptable if cleanup levels were to be established today, i.e., the MCL would exceed a hazard index of 1.

[c] MTCA Method B values used are presented in Ecology's (2012) TCE/PCE Guidance. For PCE, the MCL value of 5 µg/L is used as the MTCA Method B value, instead of the calculated value based on the guidance document. Although the MTCA Method B value for TCE is lower than the MCL, the MCL is used based on the guidance document and is still protective, meeting target risks of 10^{-5}. The national AWQC for TCE and PCE are recommended for the MTCA Method B value in the guidance. Details are included in Section 7.1.2.

[d] The basis of the ROD vinyl chloride drinking water RG is the PQL. Since the time of the ROD, the analytical laboratories can achieve a PQL of 0.02 to 0.03 for vinyl chloride, which is at the MTCA B value. Therefore, the current PQL meets target health risk goals. Current ARARs are CLARC database values and federal surface water criteria as of June 2014 based on the 5-year data review period of July 2009 to June 2014.

Notes:
Bold indicates COC with lower current ARARs; however, the remedy remains protective.
AWQC - ambient water quality criteria
DCA - dichloroethane
DCE - dichloroethene
Ecology - Washington State Department of Ecology
EPA - U.S. Environmental Protection Agency
MCL - maximum contaminant level
µg/L - microgram per liter

Table 7-3 (Continued)
OU 1 Remediation Goals With Changes in Toxicity Values

mg/kg-day - milligram per kilogram per day
MTCA - Model Toxics Control Act
PCE - tetrachloroethene
PQL - practical quantitation limit
RfD - reference dose
RG - remediation goal
SF - slope factor
TCA - trichloroethane
TCE - trichloroethene

The RG for the remaining chemical, vinyl chloride, was based on the PQL of 0.5 µg/L achievable in 1998. Most laboratories can now achieve PQLs of 0.02 µg/L for vinyl chloride (requires selected ion monitoring [SIM] analysis). The assessed risk of the PQL is 2×10^{-5}, which exceeds the ROD target risk goals but is within EPA's target range (see Table 7-3). As shown in Appendix B Table B-1, the PQL used over the last 5 years for vinyl chloride is equal to the ROD RG, and, thus, the lower currently achievable PQL is not being used. Although the majority of the groundwater data still significantly exceed the ROD RG value of 0.5 µg/L (see Table B-1), lower PQLs should be adopted as concentrations decline to near the current PQL.

The second 5-year review recommended the addition of 1,4-dioxane to the groundwater analyte list because of its potential to be present in chlorinated solvent plumes. Therefore, post-2005 monitoring has included 1,4-dioxane. Because it is a newly identified chemical, no RG was established in the ROD. However, the 2012 CRA plan (U.S. Navy 2012i) reported the MTCA Method B value of 0.44 µg/L as a screening level and provided a trigger action matrix for detections of 1,4-dioxane. The current MTCA Method B value as shown in Table 7-2 remains the same.

In summary, the assessed risks and hazards for 1,1-DCA, cis-1,2-DCE, and vinyl chloride in groundwater exceed target health goals. However, because ICs are preventing drinking water use, the remedy remains protective and is not affected by the changes in toxicity. In addition, the screening level of 1,4-dioxane has not changed.

Surface Water. Table 7-2 also compares current ARAR values for surface water (as of June 2014) with those in the OU 1 ROD (U.S. Navy, USEPA, and Ecology 1998, Table 11-5). Only TCE and PCE have lower or more stringent current surface water ARARs. Based on the current MTCA Method B values, TCE's RG would decrease from 56 to 30 µg/L and PCE's from 4.2 to 3.3 µg/L if established today. Both of the current MTCA Method B values are federal Clean Water Act AWQC values (consumption of organism only), based on Ecology guidance (Ecology 2012). The TCE and PCE RGs of 56 and 4.2 µg/L represent health risks of 2×10^{-6} and 1×10^{-6}, respectively, both below the target risk goal for individual and total site's cumulative risks. Therefore, although current ARARs are lower than those specified in the ROD, the remedy remains protective for these chemicals, for the exposure parameters assumed in the federal AWQC. For PCBs, the surface water RG is based on the PQL, not a MTCA or AWQC value, which are both orders of magnitude lower. The maximum detected value remains above the RG. Therefore, using a method to achieve a lower PQL is premature at this stage. However, once concentrations reduce below the PQL, a revised method should be evaluated for future sampling to meet a human health risk-based value.

EPA is in process of promulgating new water quality criteria for Washington State that will incorporate updated exposure parameters. Because these criteria are not yet finalized, their impact to remedy protectiveness will be evaluated as an ARAR change during the next 5-year review.

Sediment. The OU 1 ROD established RGs for the nine VOCs identified as COCs and for PCBs (U.S. Navy, USEPA, and Ecology 1998, Table 11-6). The RGs were based on the Washington State 1995 SMS, which include SQS criteria for the protection of benthic community and performance of bioassays if the chemical result failed the SQS criterion. The OU 1 ROD also identified pesticides, SVOCs, and metals as sediment COIs to be included in LTM to monitor ecological risks posed by potential migration of landfill contaminants. Although RGs were not established in the OU 1 ROD, COI data have been historically compared to current SMS criteria. For this 5-year review period, only metals were analyzed in sediment. No exceedance of criteria was noted, as discussed further in Section 6.4. Based on no exceedance of criteria and given that landfill concentrations generally are equivalent to or lower than at the time of the ROD, the remedy remains protective for benthic community in sediment.

A revised SMS was promulgated in September 2013 and the cleanup decision framework was updated to address bioaccumulative chemicals that pose risks to human health and higher trophic level species. Under the revised SMS, the SQS criterion protective of the benthic community for PCBs remains 12 mg/kg. For the protection of human health, the revised SMS requires assessment of human health risk based on a tribal exposure scenario (fish and shellfish consumption rate). If risk levels are above acceptable ranges, risk-based sediment criteria are back calculated from tissue concentrations and compared to sediment background concentrations and PQL to determine RGs. (It should be noted that there is currently no recognized background data set for direct tissue and sediment sample comparison.)

For the tide flats, where human exposures are expected to occur through consumption of shellfish, clam tissue data were collected to directly measure the risks associated with consumption of marine organisms that could be potentially impacted by PCBs in sediment. The clam tissue data were evaluated in light of the new information regarding Suquamish Tribe consumption rates to determine whether the change in ARARs (i.e., the new SMS) would indicate that the sediment RGs are no longer protective. The most recent PCB results for clam samples collected from the tide flats in 2009 were not detected at a PQL of 10 µg/kg. Given that Suquamish Tribe ingestion rates for shellfish are among the highest rates documented for Puget Sound tribes, if PCBs were present at or even below the level of the current PQL, it can be assumed that the associated cancer risk would be above the updated SMS's sediment cleanup objectives (per WAC 173-204-561) of 1×10^{-6} for individual carcinogens and 1×10^{-5} for total site's cumulative risk.

However, because Suquamish tribal members are not currently harvesting and consuming shellfish from the tide flats, the short-term protectiveness of the remedy is not called into question. Further discussion among the Navy, Ecology, EPA, and Suquamish Tribe regarding the development of risk-based screening levels and appropriate analytical methods and PQL will be deferred to the Area 1 Phase II SAP development.

In the marsh, because shellfish are not present, calculation of a sediment cleanup level protective of human health via ingestion of clams is not needed. The purpose of resampling sediment in the marsh is to evaluate whether PCB concentrations have increased and ecological risk assessment is warranted to assess risks to higher trophic levels. As discussed above, under the revised SMS, the SQS criterion for total PCBs remains at 12 mg/kg and is considered to be protective for benthic community. The additional data needs required per SMS for upper trophic pathway evaluation, PCB PQLs, and PCB analytical methods will be considered in consultation with Ecology, EPA, and Suquamish Tribe during the Phase II SAP development.

Clam Tissue. Clam tissue samples have been analyzed for SVOCs, VOCs, PCBs, pesticides, and metals. Clam tissue RGs were established in the ROD only for the nine VOCs identified as COCs and for PCBs. RGs were not established for SVOCs, pesticides, and metals.

For VOCs, tissue analysis was performed during one post-ROD sampling event in 2000, as specified in the ROD. Because no target VOC was detected, the Navy and Ecology concluded that the RGs had been met for VOCs in shellfish tissue (U.S. Navy 2002). Based on this finding, VOCs were dropped from the analyte list in subsequent monitoring events after 2000.

Similarly, because PCBs were not detected in clam tissue above the RG of 0.015 mg/kg in the 2004 and 2009 monitoring events and the COIs were detected infrequently and at low concentrations, tissue analysis was discontinued after 2009 based on regulator-approved recommendations from the third 5-year review.

Although tissue data have not been collected during this review period, the remedy remains protective in the short term because currently no shellfish are harvested from the tide flats. Additionally, because landfill concentrations generally are equivalent to or lower than those measured at the time of the ROD, it is assumed that risks are not higher than at the time of the ROD. RGs established in the ROD have been met for VOCs and PCBs, and only low concentrations of SVOCs, pesticides, and metals have been historically detected in shellfish tissue.

It should be noted that the PCB RG for clam tissue was established as a risk-based level protective of subsistence harvesters. The exposure assumptions (shellfish consumption rate) used to calculate this RG are reviewed below, as well as current tribal exposure assumptions based on a new study. As stated in the preceding section, further discussion between the Navy, Ecology, EPA, and Suquamish Tribe regarding the development of risk-based screening levels and appropriate analytical methods and reporting limits will be deferred to the Area 1 Phase II SAP development.

Review of Risk Assessment Assumptions – Exposure Parameters

The original risk assessment did not find health risks in excess of target health goals from consumption of shellfish in Dogfish Bay adjacent to NBK Keyport. In the OU 1 ROD, it was noted that concentrations of COCs, particularly PCBs in shellfish tissue, could be increasing. The ROD provided that COIs would be further addressed "if clam tissue results exceed the remediation goals or if adverse spatial or temporal trends indicate that the remediation goals will be exceeded in the future." The LTM program, however, has not found increasing trends for any contaminant in shellfish tissue based on sampling and analysis results from 1996 through 2009.

The COCs (nine VOCs and PCBs) and associated RGs established for shellfish and the COIs (SVOCs, pesticides, and metals without established RGs, but compared to SQS criteria) are not considered to be a current concern in Dogfish Bay because (1) VOCs were never detected in tissue samples, and monitoring for these compounds has been discontinued, (2) PCBs were only detected once above the RG in tissue samples from the tide flats (in 2000) and have never been detected off Navy property, and (3) spatial and trend analysis of the COIs in tissue samples do not show that the landfill at OU 1 is the source of COIs to Dogfish Bay (U.S. Navy 2010a and U.S. Navy, USEPA, and Ecology 1998). Also, because Dogfish Bay shellfish harvesting is currently closed because of pollution unrelated to NBK Keyport (two large marinas in the immediate area) and marine biotoxins (Chang 2015 and Maier 2015), there is currently no complete exposure pathway. Note that surface water samples from Dogfish Bay have not been collected and analyzed by the Health District since the early 1990s.

The RG for PCBs in tissue was calculated during ROD preparation as a site-specific, risk-based level protective of subsistence-level ingestion of clams. Since the ROD was signed, additional subsistence ingestion rates have become available to evaluate the shellfish consumption pathway. If a risk assessment were to be conducted today at OU 1, it is likely that different fish/shellfish ingestion rates would be used. In addition, the EPA (2014b) revised its default exposure factors for several parameters, which may increase or decrease estimated risks. For example, the adult body weight changed from 70 to 80 kg, which would decrease estimated risks. If the fraction ingested parameter is changed to 1.0 from 0.25, estimated risks would increase.

7.1.3 New Information

Has any other information come to light that could call into question the protectiveness of the remedy? Yes, new information regarding the remedy at OU 1 could impact the protectiveness of the remedy, including potential vapor intrusion at buildings east of Bradley Road, based on changes in toxicity and current vapor intrusion guidance and a data gap evaluation regarding the human health and ecological risk assessments.

Vapor Intrusion Evaluation

An evaluation of the vapor intrusion pathway was first performed in 1988 prior to the RI and in 1990/1991 as part of the RI at the former landfill area, west of Bradley road. No vapor intrusion evaluation has been conducted at the buildings east of Bradley Road. Based on the recommendations in the 2013 optimization report (USEPA 2013), the EPA has indicated it may be necessary to reassess the vapor intrusion pathway at the OU 1 Area 1 former landfill based on changes to industry standards and to assess the vapor intrusion pathway at buildings east of Bradley Road. This section presents the previously collected data and provides recommendations as to whether an additional vapor intrusion investigation is warranted at Area 1. The determination as to whether a vapor intrusion evaluation is warranted was based on the following screening according to current vapor intrusion guidance (USEPA 2015 and Ecology 2009):

- If VOC concentrations in groundwater exceed the calculated groundwater screening level protective of indoor air and the well is within 100 feet of an occupied building

- If VOC concentrations in soil gas exceed 10 times Ecology's industrial indoor air cleanup level or EPA's industrial indoor air regional screening level and the location is within 100 feet of an occupied building

- If VOC concentrations in indoor air exceed Ecology's industrial indoor air cleanup level or EPA's industrial indoor air regional screening level

Although several VOCs were analyzed in groundwater, air, and soil gas, the focus of this data review is on TCE, given that it is the primary COC at the site and is highly toxic. Supporting references and figures are included in Appendix A.

A landfill gas investigation performed in 1988 (U.S. Navy 1988) included the installation of six gas monitoring wells (GW-1 through GW-6 [shown on Figure 3 of U.S. Navy 1998]) north and east of the abandoned landfill and collection of three indoor air samples from three contractor buildings situated on the north end of the landfill. Background indoor air conditions were established in Building 180, approximately 0.5 mile north of the landfill. Gas and air samples were analyzed for 10 selected VOCs, which included TCE. Gas and air results were compared to threshold limit values (TLVs) established by the American Conference of Governmental Industrial Hygienists at the time of sampling. The TCE TLV value was 50 ppm (approximately 273,000 $\mu g/m^3$) and is much higher than the current indoor air risk-based screening value of 2 $\mu g/m^3$. TCE soil gas results were detected in three of six locations, ranging from 0.023 ppm (126 $\mu g/m^3$) to 0.092 ppm (503 $\mu g/m^3$). These results were below the TLV, but exceed Ecology's current TCE soil gas screening value of 20 $\mu g/m^3$ (MTCA Method C air value of 2 $\mu g/m^3$ and default attenuation factor of 0.1). The detection limit of 0.01 ppm (55 $\mu g/m^3$) is also above the current TCE screening value. Indoor air samples from the contractor buildings showed VOCs at background levels and below TLVs. TCE indoor air concentrations ranged from 0.0061 ppm (33 $\mu g/m^3$) to 0.017 ppm (93 $\mu g/m^3$) exceeding Ecology's current TCE MTCA Method C air screening value of 2 $\mu g/m^3$. The report recommended future soil gas monitoring for combustible gas, but no further recommendation was made regarding additional indoor air or soil gas monitoring for VOCs.

As summarized in Table 7-4, the data collected in 1990/1991 as part of the 1993 RI included soil gas, outdoor air, and indoor air samples. The indoor air samples were collected from four buildings located over the landfill and evaluated in the 1993 HHRA. The current/future adult worker exposure to volatiles in indoor air exceeded target health goals of 1 x 10^{-5} and 1 (reasonable maximum exposure cancer risk of 3 x 10^{-4} [risk driver chloromethane] and HI of 2 [risk driver Freon 12]). In addition, particulate and emission flux samples were evaluated to assess current/future adult worker exposure to metal particulates and volatiles in outdoor air, and results were below target health goals. The soil vapor probe survey samples and soil vapor monitoring well samples were not evaluated in the HHRA (see Table 7-4).

The 1991 indoor air and soil vapor TCE results are depicted on figures in Appendix K of the RI (report included in Appendix A). All the indoor air sample results at locations I-1, I-2, I-4, and I-6, except one result at I-4, exceed Ecology's current TCE MTCA Method C industrial air screening level of 2 $\mu g/m^3$ with a maximum concentration of 156 $\mu g/m^3$ at location I-1. Three of the six soil vapor well location results exceed Ecology's current TCE industrial soil gas screening level of 20 $\mu g/m^3$, with a maximum concentration of 360 $\mu g/m^3$ at GM1-2. GM1-2 is located east of Bradley Road within 100 feet of Building 883. Sampling locations GM1-3 and GM1-4 are also east of Bradley Road, and TCE was not detected at these locations.

Based on the results of the 1993 HHRA, buildings on the landfill were vacated, and the office trailer buildings were removed from the northern part of the landfill. To prevent worker exposure to vapors from the landfill, ICs were included in the 1998 ROD restricting occupancy of buildings located on the landfill, limiting land use activities to parking, storage, or occasional occupancy by workers, maintenance of landfill cover, and prohibiting construction that could result in worker exposure to vapor from the landfill. Thus, there are currently no occupied buildings above the landfill, and land use controls prevent worker exposures to vapor above the landfill. However, on the east side of Bradley Road, worker occupied buildings currently exist.

The soil vapor data are over 20 years old, and TCE concentrations in groundwater beneath the landfill have decreased since that time. TCE concentrations in soil vapor also have most likely decreased. However, because of the elevated TCE soil gas concentration measured in 1991 at location GM1-2 east of Bradley Road, located within 100 feet of Building 883, the recent

Table 7-4
OU 1 Area 1 Landfill Summary of Soil Gas and Air Sampling

Source	Date of Sampling	Number of Samples	Sample Collection Methods/Purpose	Chemicals Analyzed	Risk Results
1993 remedial investigation and 1993 baseline HHRA	1990 soil vapor probe survey	75 locations (depths 1 to 6 feet below ground surface)	Field gas chromatograph; vacuum pump attached to probe (delineate the lateral extent and concentration of VOCs and methane to refine locations of borings and wells)	10 VOCs and methane	Inappropriate to include; not evaluated in baseline HHRA
	1990 and 1991 Soil vapor monitoring wells	10 locations (4 newly installed, 6 existing) sampled each year	Summa canisters and sampling pump (to monitor current VOC concentrations in soil)	TO-14 (51 VOCs)	Not evaluated in baseline HHRA
	1991 air sampling	16 locations emissions flux	• Emission flux samples in unpaved portions (directly measure gaseous emissions from soil) • Dispersion modeling used in HHRA to estimate outdoor exposure concentrations	VOCs and methane	Current/future adult worker exposure to volatiles in outdoor air; RME cancer risk of 3 x 10^{-6} (risk driver vinyl chloride) and HI of 0.0008 (risk driver Freon 12)
		14 particulate samples from 4 stations	Particulate samples "high volume" filters (measure particulates and metal air emissions)	Particulates and metals	Evaluated in baseline HHRA; no metals interpreted as resulting from site contamination
		15 indoor air samples from 4 stations (Buildings V-5 and V-9, trailer near Building 884, and modular building H-1)	8-hour integrated sample using Summa canisters (direct reading of indoor air concentrations) over 3 days	TO-14 (51 VOCs)	Current/future adult worker exposure to volatiles in indoor air; RME cancer risk of 3 x 10^{-4} (risk driver chloromethane) and HI of 2 (risk driver Freon 12)

Notes:
HHRA - human health risk assessment
HI - hazard index
RME - reasonable maximum exposure
VOC - volatile organic compound

groundwater TCE results were evaluated to provide information on the potential for current vapor intrusion exposures. Table 7-5 provides a summary of the recent upper aquifer groundwater results (October 2009 to June 2014) collected across the landfill and east of Bradley Road (U.S. Navy 2015a). Appendix B provides the historical and 2014 VOC groundwater concentrations and sampling locations for the north and south plantations. Four of seven results at well MW1-02 (maximum of 7.8 µg/L) and all eight results at well MW1-04 (maximum of 32,000 µg/L) exceed the TCE groundwater screening value of 5 µg/L considered protective using Ecology's industrial air value (see Table 7-5). If EPA's groundwater screening value of 7 µg/L is used, only one sample result exceeds at well MW1-02 of 7.8 µg/L, and all results still exceed at MW1-04. TCE has not been detected in groundwater at wells MW1-03 and MW1-20, located east of Bradley Road, over the last 5 years (see Figure 6-1). Although groundwater concentrations exceed screening values at two of the eight monitoring wells located within the landfill, it does not appear that VOCs in groundwater are migrating toward occupied buildings east of Bradley Road, based on MW1-03 and MW1-20. However, the eastern extent of the TCE plume is not well defined, as shown on Figure C-20 in Appendix C. Mitigating factors include that the groundwater flow direction is towards the west, away from the buildings located east of Bradley Road, and well MW1-2 is over 300 feet west and well MW1-4 over 100 feet west of the currently occupied buildings east of Bradley Road, as shown on Figure 6-1.

There have been changes in industry standards since the initial vapor intrusion evaluations were performed in the 1980s and 1990s at the former landfill, including comparison of indoor air concentrations against risk-based values instead of TLVs. As mentioned previously, current vapor intrusion guidance is available from EPA and Ecology and, based on review of the historical indoor air and soil gas and groundwater data, the concentrations would exceed today's screening levels. However, because land use controls are in place that prevent occupied building above the former landfill, there are no human receptors. Therefore, the vapor intrusion pathway west of Bradley Road is incomplete and a vapor intrusion pathway evaluation is not necessary. The historical results west of Bradley Road do not impact the protectiveness of the remedy, since ICs preventing building occupancy are functioning as intended.

A vapor intrusion evaluation has not been previously conducted east of Bradley Road. Although COCs are not detected in groundwater at the two wells east of Bradley Road, historically high soil gas concentrations were found at location GM1-2 near Building 883. An evaluation of the vapor intrusion pathway is recommended based on limited current VOC data for groundwater and soil gas east of Bradley Road, VOC detections in groundwater at the adjacent landfill, and the lack of confidence in the eastern extent of the TCE plume. The protectiveness of the remedy with regard to buildings in this area could be impacted.

Table 7-5
OU 1 Area 1 Landfill Summary of Recent Groundwater Results

Well ID	Sampling Date Range	TCE Concentration (µg/L)		Exceed GW Screening Level of 5 µg/L[a]?	How Many Exceed?	Latest Date Exceeded
		Minimum	Maximum			
1MW-1	10/2009 to 6/2014	0.5 U	0.17 J	No	0/7	--
MW1-2	**10/2009 to 6/2014**	**2.3**	**7.5**	**Yes[b]**	**4/7**	**6/2012**
MW1-03	10/2009 to 6/2012	0.5 U	0.5 U	No	0/7	--
MW1-04	**10/2009 to 6/2014**	**390**	**32,000 J**	**Yes**	**8/8**	**6/2014**
MW1-05	10/2009 to 6/2014	0.16 J	0.52	No	0/8	--
MW1-16	10/2009 to 6/2014	0.11 J	3.2	No	0/8	--
MW1-17	6/2010 to 6/2014	0.5 U	0.46 J	No	0/5	--
MW1-20	10/2009 to 6/2014	0.5 U	0.5 U	No	0/8	--

[a]The groundwater screening value protective of indoor air for TCE of 5 µg/L was calculated using the following formula:

groundwater screening level = (Method C air cleanup concentration)/(Henry's law x attenuation factor of one thousand x conversion factor)

where:

Air concentration (µg/m^3) = 2 (Ecology's MTCA Method C value [air])
Henry's law (unitless) = 0.422 (Ecology's Master Spreadsheet value)
Attenuation factor (unitless) = 0.001 (USEPA 2002)
Conversion factor (L/m^3) = 1,000

[b]Based on EPA's industrial air TCE concentration of 3 µg/m^3, the groundwater screening level is 7 µg/L. Therefore, only one location at MW1-02 would exceed EPA's TCE screening level.

Notes:
Bold value exceeds Ecology's groundwater screening level protective of indoor air.
EPA - U.S. Environmental Protection Agency
GW - groundwater
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
µg/L - microgram per liter
µg/m^3 - microgram per cubic meter
MDL - method detection limit
MRL - method reporting limit
TCE - trichloroethene
U - The compound was analyzed for, but was not detected at or above the MRL/MDL.

Data Gaps Relating to Human Health and Ecological Risk Assessment

An evaluation of data gaps that could impact the protectiveness of the remedy at Area 1 was conducted in support of this 5-year review at the direction of the Navy Remedial Project Manager. This data gaps analysis is not a standard element of a 5-year review, but was performed in this instance for the functionality questions described in Section 7.1.1 to inform decision making regarding future planned investigations. Details of this evaluation, which included researching exposure pathways evaluated during the baseline risk assessment in the context of current LTM monitoring results, are described below. The following data gaps were identified for Area 1, and recommendations are made in Section 8 to address them:

- The exposure assessment and data collection related to the shellfish ingestion pathway may warrant further investigation in coordination with stakeholders and regulators.
- A vapor intrusion evaluation has not been conducted at occupied buildings east of Bradley Road according to current vapor intrusion guidance.

The baseline HHRA (U.S. Navy 1993b) and the data collected in 1995/1996 to support the supplemental risk evaluation included in the ROD (U.S. Navy, USEPA, and Ecology 1998) evaluated the following human health exposure pathways at OU 1 (as shown on Figure 3-4):

- Inhalation of chemicals in indoor/outdoor air and suspended particulates above the landfill by current/future workers
- Incidental ingestion of chemicals in landfill soil by current/future workers
- Incidental ingestion of contaminated surface water and sediment by current/future recreational visitors and current/future nearby residents while swimming, boating, fishing, or playing along the beach at Dogfish Bay
- Incidental ingestion of contaminated surface water and sediment by future recreational visitors and future nearby residents while wading and shellfishing in the tide flats and wading in the marsh
- Ingestion of contaminated seafood by current/future recreational visitors, nearby residents, and subsistence users in Dogfish Bay and tide flats
- Ingestion and inhalation of chemicals in groundwater from shallow and intermediate aquifers by future on-site residents

- Ingestion and inhalation of chemicals in groundwater from the intermediate aquifer by future off-site residents

The baseline HHRA resulted in human health cancer and noncancer risk target goals being exceeded for the on-site worker indoor air pathway and hypothetical on-site residential use of the groundwater pathway. No other pathway resulted in unacceptable health risks.

Ecological pathways at OU 1 (U.S. Navy 1993c) included evaluation of ingestion of soil and plants by terrestrial mammals, ingestion of sediment, plants and surface water by herbivorous birds, ingestion and contact of aquatic benthic invertebrates with sediment and surface water, ingestion of benthic invertebrates by demersal fish, and ingestion of aquatic food species by carnivorous birds. Little to no risk was found to terrestrial receptors. Some localized risk to marine receptors was found for SVOCs (bis[2-ethylhexyl]phthalate) and chlorinated pesticides in sediment and metals and SVOCs in surface water.

Based on human health and ecological risks, the following remedial actions were implemented:

- Phytoremediation by planting two plantations of hybrid poplar trees to reduce VOC concentrations in groundwater

- Removal of buildings located above the landfill

- Placement of an asphalt cover over the landfill

- Installation of tide gate upgrades to prevent flooding/inundation

- Removal of PCB-containing sediment from the marsh sediment, based on a recommendation from ATSDR

RGs were established and LTM of groundwater, surface water, sediment, seep, and tissue was implemented. ICs were implemented to prevent use of groundwater. A CRA plan was completed in which the Navy will implement additional remedial actions if significant contaminant concentrations are found to be migrating from OU 1 to water supply wells in the area. COCs include several VOCs and PCBs, and COIs included several metals and SVOCs.

Based on removal of occupied buildings on the landfill, the landfill asphalt cover, and land use controls, the pathways evaluated in the HHRA are currently incomplete. Evaluation of the vapor intrusion pathway for buildings east of Bradley Road was identified as a data gap as discussed in the previous section.

The subsistence user reasonable maximum exposure cancer risk for ingestion of seafood in Dogfish Bay was equal to 1×10^{-5} because of the presence of arsenic (arsenic, cobalt, copper, lead, manganese, and mercury were evaluated). Uncertainties regarding the calculated risk for the seafood ingestion pathway were identified for PCBs and lead. However, supplemental data were collected in 1995/1996, and risks were reevaluated in the ROD. PCBs were detected in one of three samples in the tide flats and one of three samples from Dogfish Bay. The recreational risks were estimated at 8×10^{-6} and 3×10^{-6} for the tide flats and Dogfish Bay, respectively, below target health goals. The 1997 PHA by ATSDR evaluated all the lead and PCB data and concluded that the shellfish in Dogfish Bay did not contain chemicals at levels of health concern to humans, including recreational, subsistence, and commercial.

The 2001 PHA by ATSDR evaluated clam tissue data collected from Dogfish Bay and the tide flats between 1996 and 2000 using the Suquamish Tribe ingestion rates of 142 and 292 g/day for a 79-kg adult and 24 g/day for a 30-kg child and concluded that chemicals present in native littleneck clams along the shoreline of NBK Keyport do not present a public health hazard to subsistence seafood consumers. Data inconsistencies in the metals data were noted for June 2000 being reported in dry weight instead of wet weight. Based on inconsistencies, ATSDR recommended three additional tissue sampling rounds to evaluate temporal trends. PCBs in shellfish tissue were sampled in 1996, 2000, 2004, and 2009.

Surface water, sediment, tissue data, and groundwater from LTM were reviewed to understand if current concentrations have changed from when the ROD was signed and could impact the shellfish ingestion pathway. In the last 5 years, as shown in Appendix B Table B-4, water results for five surface water locations and one seep location have not exceeded VOC RGs (based on ingestion of fish) established in the ROD, except TCE and vinyl chloride in location MA12. Trend analysis of MA12 (see Appendix D, Figures D-12a and D-12b) results from 1995 through 2014 show that data are stable. As shown in Appendix B Table B-5, all PCB surface water results at location SP1-1 have exceeded the RG, and data results between 2000 and 2010 have been consistently detected at concentrations ranging from 0.3 to 0.4 µg/L, with a reported increase in 2014 to 0.696 µg/L. Ecology believes that it is critical to achieve the surface water RG to avoid recontamination of sediments per WAC 173-204-500(4)(b). Sediment PCB and metal results have been evaluated against ecological criteria, but have not been evaluated against human health criteria. As shown in Appendix B Table B-6, the PCB SQS screening level was exceeded at locations MA09 (1996 and 2000), MA14 (2000), and TF21 (1996 and 2000). The metal SQS screening levels were only exceeded for chromium at location MA11 (2009); however, follow-up investigation did not confirm these levels and this result was considered an anomaly (U.S. Navy 2012a). As shown in Appendix B Table B-7, PCBs in shellfish concentrations have been either not detected or below the RG of 15 µg/kg, based on the seafood ingestion pathway at all six locations, except one result at TF-21 in 2000. SVOCs have not been detected in tissue samples. Although the remedy in the south plantation is operating more slowly than anticipated, groundwater concentrations across the landfill and plantations have remained stable or decreased since the risk evaluations were completed. In general, COC concentrations in surface water, sediment, and tissue have remained stable or decreased since the risk evaluations were completed. Therefore, it is not anticipated that current site concentrations in various media would change the conclusions made regarding the seafood ingestion pathway in the baseline risk assessment.

The current/future off-site groundwater use scenario was evaluated in the ROD and found to be incomplete, based on observations that indicate that landfill chemicals do not currently flow beneath land areas where wells tapping the intermediate aquifer exist. These observations are supported by 20 years of data collected as part of the CRA monitoring program, which includes monitoring three intermediate wells (MW1-09, MW1-38, and MW1-39) and two deep aquifer wells (Navy Well #5 and the PUD well) downgradient of the landfill. No COC was ever detected above RGs at MW1-38, Navy Well #5, and the PUD well. Only trace detections were reported at MW1-09 in 1 out of 11 samples in various years for cis-1,2-DCE (July 2006), PCE (June 2012), and TCE (June 2000). At MW1-39, cis-1,2-DCE and vinyl chloride have been detected, and vinyl chloride concentrations have been consistently above the RG. These wells will continue to be monitored under the CRA program.

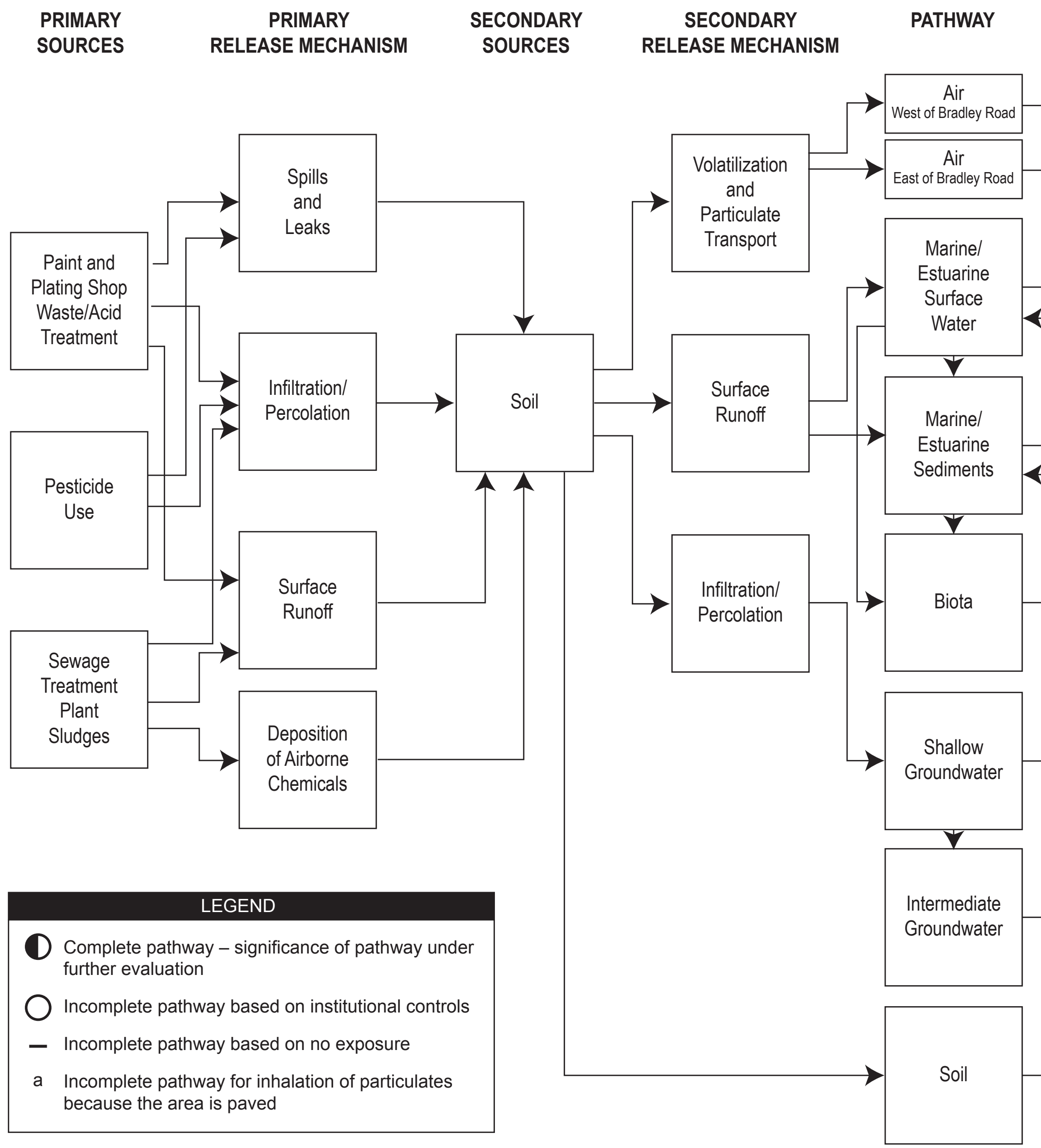
Based on the past exposure assumptions relative to the data collected and the remedy that is in place, the following pathways are considered incomplete or complete but insignificant:

- Inhalation of vapor and particulates and the incidental ingestion of soil by on-site workers west of Bradley Road
- Incidental ingestion of chemicals in landfill soil by current/future workers
- Ingestion, inhalation, and dermal contact of chemicals in groundwater from shallow and intermediate aquifers by future on-site residents
- Ingestion, inhalation, and dermal contact of chemicals in groundwater from the intermediate and deep aquifers by future off-site residents

Additional analytical data are proposed to be collected at OU 1. An exposure assessment and data gaps evaluation regarding the historical shellfish data and LTM program will proceed in consultation with stakeholders and regulators in the future. The vapor intrusion data gap raised by the stakeholder and regulators calls into question the protectiveness of the remedy. Figure 7-1 summarizes the remedy-in-place working CSM for OU 1 Area 1 for use as a starting point for further CSM development and discussion in collaboration with stakeholders and regulators.

7.1.4 Technical Assessment Summary

The remedy at OU 1 was implemented and has been operating for 15 years. The components of the remedy are functioning as intended by the ROD. However, concerns have been identified regarding the long restoration time frame and continued surface water ARARs exceedances at the



	RECEPTORS				
	CURRENT/FUTURE		FUTURE		
EXPOSURE ROUTE	EXCAVATION WORKERS	OFFICE WORKERS	VISITORS	RESIDENTS	SUBSISTENCE USERS
Inhalation	○	○	–	–	–
Inhalation	○	◐[a]	–	–	–
Ingestion	–	–	○	○	○
Dermal Contact	–	–	○	○	○
Ingestion	–	–	○	○	○
Dermal Contact	–	–	○	○	○
Ingestion	–	–	○	○	○
Ingestion	–	–	–	○	–
Inhalation	–	–	–	○	–
Dermal Contact	–	–	–	○	–
Ingestion	–	–	–	○	–
Inhalation	–	–	–	○	–
Dermal Contact	–	–	–	○	–
Ingestion	○	–	–	–	–
Dermal Contact	○	–	–	–	–

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Figure 7-1
Remedy-in-Place Working OU 1 Area 1 Conceptual Site Model

south phytoremediation plantation. Isoconcentration contour maps and COC concentration trend analyses show contracting COC plumes in groundwater and downward concentration trends at most monitoring locations, except along the southern edge of the south plantation. These results indicate slow, but continuing progress towards meeting RAOs. Natural attenuation processes are functioning to reduce COC concentrations, while exposures are prevented by ICs. COC concentration trends are tracked and evaluated through regular monitoring. Phytoremediation has not been as effective in the south plantation as originally anticipated when it was evaluated during remedy selection, and additional investigations are underway to explore remedy optimization. However, the remedy at OU 1 remains functional.

7.2 OU 2 AREA 2

7.2.1 Functionality of Remedy for OU 2 Area 2

Is the remedy functioning as intended by the decision documents? Yes.

The RAOs established in the OU 2 ROD for Area 2 are the following:

- Prevent human health exposures to TCE and vinyl chloride in soil and groundwater by pathways such as ingestion of groundwater, inhalation of volatiles while showering, or ingestion of soil or vegetables grown in the soil.
- Restore the groundwater to drinking water quality for VOCs such as TCE and vinyl chloride.

The remedy for Area 2 is functioning as intended by the OU 2 ROD. The ICs component of the selected remedy has been implemented and maintained and acts to prevent human exposures to COCs in soil and groundwater. The groundwater monitoring component of the remedy has also been implemented. Groundwater wells are sampled regularly and the results evaluated to assess the need for continued ICs. The results are also evaluated to assess the adequacy of monitoring, and the monitoring program is adjusted as necessary, with input from stakeholders and regulators. The remedy at OU 2 Area 2 remains functional, and a monitoring frequency reduction is recommended as a conclusion of this review.

7.2.2 Continued Validity of ROD Assumptions

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid? Yes, the ARARs, exposure assumptions, toxicity data, and RAOs are still valid and protective of human health and the environment. Changes to the ARARs used to establish cleanup levels in the ROD are evaluated below and summarized in Table 7-6. The changes to the toxicity risk assumptions are discussed in the following section. There were no changes to the exposure risk assessment assumptions.

Table 7-6
Groundwater ARARs for OU 2

Chemical	Drinking Water						Surface Water Protection (Marine)				
	ROD Drinking Water Cleanup Level (µg/L)	Basis of Cleanup Level	Current MTCA Method B (µg/L)	Current Federal MCL (µg/L)	Current State MCL (µg/L)	Change in Cleanup Level if Established Today?	ROD Surface Water Cleanup Level (µg/L)	Basis of Cleanup Level	Current MTCA Method B (µg/L)	Current National AWQC (µg/L)	Change in Cleanup Level if Established Today?
Area 2											
TCE[a]	**5**	**MCL**	**4**	**5**	**5**	**No (MCL); Yes, lower (MTCA)**	NA	NA	NA	NA	NA
Vinyl chloride	**1**	**PQL**	**0.029**	**2**	**2**	**Yes, lower (MTCA)**	NA	NA	NA	NA	NA
Area 8											
Metals											
Cadmium	5	Federal MCL	8	5	5	No	8	Marine chronic AWQC	41	8.8[b]	Yes, higher
Trivalent chromium	16,000	MTCA B	24,000	None	None	Yes, higher	160,000	MTCA B	243,000	None	Yes, higher
Hexavalent chromium	**80**	**MTCA B**	**48**	**None**	**None**	**Yes, lower**	50	Marine chronic AWQC	486	50[b]	No
Chromium (total)	50	State MCL	None	100	100	Yes, higher	None	None	None	None	NA
Volatile Organic Compounds											
1,1-DCE	7	MCL	400	7	7	No	3.2	National AWQC (HH)	23,000	7,100[c] (HH)	Yes, higher
cis-1,2-DCE[d]	**70**	**MCL**	**16**	**70**	**70**	**No (MCL); Yes, lower (MTCA)**	None	None	None	None	NA
PCE[a]	5	MCL	5	5	5	No	**8.9**	**National AWQC (HH)**	**3.3**	**3.3 [c] (HH)**	**Yes, lower**
1,1,1-TCA	200	MCL	16,000	200	200	No	42,000	MTCA B	930,000	None	Yes, higher
TCE[a]	**5**	**MCL**	**4**	**5**	**5**	**No (MCL); Yes, lower (MTCA)**	**81**	**National AWQC (HH)**	**30**	**30[c] (HH)**	**Yes, lower**

[a]MTCA Method B values used are presented in Ecology's (2012) TCE/PCE guidance. For PCE, the MCL value of 5 µg/L is used as the MTCA Method B value, instead of the calculated value based on the guidance document. Although the MTCA Method B value for TCE is lower than the MCL, the MCL is used based on the guidance document and is

Table 7-6 (Continued)
Groundwater ARARs for OU 2

still protective for TCE at a risk of 10^{-6}. The national AWQC for TCE and PCE are recommended for the MTCA Method B value in the guidance. Details are included in Sections 7.2 and 7.3.

[b]National recommended water quality criteria aquatic life criterion continuous concentration chronic

[c]Current U.S. Environmental Protection Agency national recommended AWQC for protection of human health marine waters organism only (fish from the water body)

[d]In accordance with Washington Administrative Code 173-340-720(3)(a) and 173-340-720(7)(b), the MCL for cis-1,2-DCE is not sufficiently protective when compared to the current MTCA B drinking water value. Therefore, the MCL would no longer be acceptable if a cleanup level were to be established today, i.e., the hazard level of the MCL would exceed 1.

Notes:
Current ARARs are CLARC database values and federal surface water criteria as of June 2014, based on the 5-year data review period of July 2009 to June 2014.
Bold and yellow highlight indicate chemical of concern with lower current ARARs
ARARs - applicable or relevant and appropriate requirements
AWQC - ambient water quality criteria
DCE - dichloroethene
HH - the AWQC based on human ingestion of fish in the water body
MCL - maximum contaminant level
µg/L - microgram per liter
MTCA - Model Toxics Control Act
PCE - tetrachloroethene
ROD - Record of Decision
TCA - trichloroethane
TCE - trichloroethene
NA - not applicable

Review of ARARs and Toxicity Criteria

A comparison of ROD RGs with current ARARs for groundwater is provided in Table 7-6, and those with lower values that may impact the protectiveness of the remedy are discussed further below.

Table 7-7 summarizes the chemicals with changes in toxicity criteria and the basis of the toxicity criteria change and provides the calculated health risks of the ROD RGs for the chemicals that would result in lower RGs using current ARARs (as of June 2014) for TCE and vinyl chloride. This comparison is done to assess whether the ROD RGs still meet the ROD's target risk of 1 x 10^{-5} and are within EPA's acceptable excess cancer risk range of 10^{-4} to 10^{-6}, or below an HI of 1 for noncancer effects. A discussion of the calculated risk levels listed in Table 7-7 that exceed target health goals are discussed below.

Area 2 COCs are TCE and vinyl chloride in groundwater only, and RGs are based on humans drinking the water. As shown in Table 7-6, the ROD RG for TCE was established as the MCL (5 µg/L), and there has been no change. However, the current MTCA Method B value of 4 µg/L is lower than the MCL. As listed in Table 7-7, TCE's toxicity criteria have changed since the time of the ROD, and in this case, the reference dose (noncancer) value is used rather than the slope factor (cancer) value based on Ecology guidance (Ecology 2012). Using Ecology's methodology to assess protectiveness of MCLs (WAC 173-340-720[7][b]), the risk of the TCE RG remains protective because it represents a cancer risk level equal to 1 x 10^{-6} below the target risk goals.

For vinyl chloride, the ROD RG was the MTCA Method B value of 0.023 µg/L. However, in the past, analytical methods could not achieve this value and the PQL of 1 µg/L was used. The current MTCA Method B value has increased slightly to 0.029 µg/L. Using Ecology's methodology to assess the protectiveness, the risk of the vinyl chloride PQL of 1 is 3 x 10^{-5}, which is just above the ROD target risk goals and within EPA's target risk range of 10^{-4} and 10^{-6}. As noted above for groundwater at OU 1, laboratories can currently achieve a PQL of 0.02 µg/L using EPA Method 8260C SIM analysis and can currently achieve the ROD RG value. As shown in Table B-8 of Appendix B, the PQL used since 2012 for vinyl chloride is the lower PQL of 0.02 µg/L.

Although target health goals were exceeded for vinyl chloride, ICs are in place restricting the use of groundwater for drinking. Therefore, the remedy remains protective.

Table 7-7
OU 2 Remediation Goals With Changes in Toxicity Values

Chemical	Drinking Water RG (µg/L)	Surface Water RG (µg/L)	Current Value for Drinking Water (µg/L)	Current Surface Water Value (µg/L)	Drinking Water Health Risk of the RG Based on New Toxicity	Surface Water Health Risk of the RG Based on New Toxicity	Remedy Is Still Protective?	Reason for Toxicity Revision
Area 2								
TCE	**5 (MCL)**	**None**	**MTCA B = 4 MCL = 5**	**NA**	**Current MTCA B value is lower than MCL. Cancer risk at MCL = 1 x 10^{-6} [a].**	**NA**	**Yes**	**Current MTCA B value is based on the oral RfD of 0.0005 mg/kg-day. If the oral SF of 0.046 $(mg/kg\text{-}day)^{-1}$ and ELE ADAFs were used, the MTCA Method B value is 0.54 µg/L. However, 4 µg/L is the Ecology (2012) recommended value, which is protective of an HI of 1 and target risk of 1 x 10^{-6}.**
Vinyl chloride	**1 (PQL)**	**None**	**MTCA B = 0.029 MCL = 2**	**NA**	**Current MTCA B value is lower than PQL. Cancer risk at PQL = 3 x 10^{-5} [b]. If achieve PQL of 0.02, then meets target risk goals.**	**NA**	**Yes**	**Current MTCA B value is based on the oral SF, which changed from 1.9 to 1.5 $(mg/kg\text{-}day)^{-1}$.**
Area 8								
Trivalent chromium	16,000	160,000	MTCA B = 24,000	MTCA B = 243,000	Current MTCA B value is higher. Risks meet target goals.	Current MTCA B value is higher. Risks meet target goals.	Yes	Current MTCA B value is based on the oral RfD, which changed to 1.5 mg/kg-day.

Table 7-7 (Continued)
OU 2 Remediation Goals With Changes in Toxicity Values

Chemical	Drinking Water RG (µg/L)	Surface Water RG (µg/L)	Current Value for Drinking Water (µg/L)	Current Surface Water Value (µg/L)	Drinking Water Health Risk of the RG Based on New Toxicity	Surface Water Health Risk of the RG Based on New Toxicity	Remedy Is Still Protective?	Reason for Toxicity Revision
Hexavalent chromium	**80**	**50**	**MTCA B = 48**	**MTCA B = 486** **Marine AWQC chronic aquatic life = 50**	**Current MTCA B value is lower. Hazard at RG (80) = 2.**	**NA. RG is based on protection of marine life.**	**Yes**	**Current MTCA B value is based on the oral RfD of 0.003 mg/kg-day.**
1,1-DCE	7 (MCL)	3.2	MTCA B = 400 MCL = 7	MTCA B = 23,000 Marine AWQC HH = 7,100	Current MTCA B value is higher than MCL. Risks meet target goals.	Current AWQC HH value is higher. Risks meet target goals.	Yes	No longer considered a carcinogen by EPA. Current MTCA B value is based on the oral RfD of 0.05 mg/kg-day.
cis-1,2-DCE	**70 (MCL)**	**None**	**MTCA B = 16** **MCL = 70**	**NA**	**Current MTCA B value is lower than MCL. Hazard at MCL (70) = 4[c].**	**NA**	**Yes**	**Current MTCA B value is based on the oral RfD of 0.002 mg/kg-day.**
PCE	**5 (MCL)**	**8.9**	**MTCA B = 5** **MCL = 5**	**MTCA B = 3.3** **Marine AWQC HH = 3.3**	**Risks meet target goals.**	**Current AWQC HH value is lower. Cancer risk level of RG = 3 x 10^{-6}.**	**Yes**	**The calculated MTCA B value is based on the oral SF, which changed from 0.54 to 0.0021 $(mg/kg\text{-}day)^{-1}$. However, the federal and state MCL is used as the current MTCA Method B value (Ecology 2012).**
1,1,1-TCA	200 (MCL)	42,000	MTCA B = 16,000 MCL = 200	MTCA B = 930,000	Current MTCA B value is higher than MCL. Risks meet target goals.	Current MTCA B value is higher. Risks meet target goals.	Yes	Current MTCA B value is based on the oral RfD, which changed from 0.9 to 2 mg/kg-day.
TCE	**5 (MCL)**	**81**	**MTCA B = 4** **MCL = 5**	**MTCA B = 30** **Marine AWQC HH = 30**	**Current MTCA B value is lower than MCL. Cancer risk at MCL = 1 x 10^{-6} [a].**	**Current AWQC HH is lower. Risk level of RG = 3 x 10^{-6}.**	**Yes**	**Current MTCA B value is based on the oral RfD of 0.0005 mg/kg-day. If the oral SF of 0.046 $(mg/kg\text{-}day)^{-1}$ and**

Table 7-7 (Continued)
OU 2 Remediation Goals With Changes in Toxicity Values

Chemical	Drinking Water RG (µg/L)	Surface Water RG (µg/L)	Current Value for Drinking Water (µg/L)	Current Surface Water Value (µg/L)	Drinking Water Health Risk of the RG Based on New Toxicity	Surface Water Health Risk of the RG Based on New Toxicity	Remedy Is Still Protective?	Reason for Toxicity Revision
								ELE ADAFs were used, the MTCA Method B value is 0.54 µg/L. However, 4 µg/L is the Ecology (2012) recommended value, which is protective of an HI of 1 and target risk of 1 x 10^{-5}.

[a]MTCA Method B values used are presented in Ecology's (2012) TCE/PCE guidance. For PCE, the MCL value of 5 µg/L is used as the MTCA Method B value, instead of the calculated value based on the guidance document. Although the MTCA Method B value for TCE is lower than the MCL, the MCL is used based on the guidance document and is still protective for TCE at a risk of 10^{-6}. The national AWQC for TCE and PCE are recommended for the MTCA Method B value in the guidance. Details are included in Sections 7.2 and 7.3.
[b]The basis of the ROD vinyl chloride drinking water RG is the PQL. Since the time of the ROD, the analytical laboratories can achieve a PQL of 0.02 to 0.03 for vinyl chloride, which is at the MTCA B value. Therefore, the current PQL meets target health risk goals.
[c]In accordance with Washington Administrative Code 173-340-720(3)(a) and 173-340-720(7)(b), the MCL for cis-1,2-DCE is not sufficiently protective when compared to the current MTCA B drinking water value. Therefore, the MCL would no longer be acceptable if a cleanup level were to be established today, i.e., the hazard of the MCL would exceed 1.

Notes:
Current ARARs are CLARC database values and federal surface water criteria as of June 2014, based on the 5-year data review period of July 2009 to June 2014.
Bold indicates chemical of concern with lower current ARARs; however, the remedy remains protective.
AWQC - ambient water quality criteria
DCE - dichloroethene
EPA - U.S. Environmental Protection Agency
HH - human health
MCL - maximum contaminant level
µg/L - microgram per liter
mg/kg-day - milligram per kilogram per day
MTCA - Model Toxics Control Act
PCE - tetrachloroethene
PQL - practical quantitation limit
RfD - reference dose
RG - remediation goal
SF - slope factor
TCA - trichloroethane
TCE - trichloroethene

7.2.3 New Information

Has any other information come to light that could call into question the protectiveness of the remedy? No, there is no new information regarding the remedy at Area 2 that could impact the protectiveness of the remedy.

Vapor Intrusion Evaluation

Soil gas and emission flux samples were collected at Area 2 as reported in the 1993 RI (see Appendix A). Risk assessment results indicated that inhalation of chemicals in particulates and volatiles in outdoor air by current/future workers and inhalation of chemicals in particulates by future residents were below target health goals. A vapor intrusion evaluation of indoor air was not previously conducted at Area 2. The on-site buildings are open sided and there is one small office building, all of which are occasionally occupied. The only recent subsurface data available to evaluate the current vapor intrusion pathway are groundwater VOC results from LTM (U.S. Navy 2015a). Appendix B Table B-8 summarizes the groundwater results, and none of the last 5 years of VOC results from wells 2MW-1, 2MW-6, and MW2-8 exceed groundwater screening values protective of Ecology's industrial air value (as calculated in Section 7.1.3). The screening of the last 5 years of data (four results) is summarized as follows:

- cis-1,2-DCE detected results ranged from 0.059 to 3.9 µg/L and are below the industrial groundwater screening level of 359 µg/L protective of indoor air for trans-1,2-DCE (note that there is no indoor air screening level for cis-1,2-DCE).

- TCE detected results ranged from an estimated 0.0045 µg/L to 3.8 µg/L and are below the industrial groundwater screening level of 5 µg/L protective of indoor air.

- Vinyl chloride detected results ranged from an estimated 0.01 to 0.34 µg/L and are below the industrial groundwater screening level of 2.5 µg/L protective of indoor air.

The vapor intrusion pathway for current/future workers is complete but insignificant, based on low VOC concentrations in groundwater in the vicinity of occasionally occupied buildings. The remedy remains protective regarding buildings in this area.

Data Gaps Relating to Human Health and Ecological Risk Assessment

An evaluation of data gaps that could impact the protectiveness of the remedy at Area 2 was conducted in support of this 5-year review at the direction of the Navy Remedial Project Manager. This data gaps analysis is not a standard element of a 5-year review, but was performed in this instance to support conclusions regarding functionality and long-term protectiveness. Details of this evaluation, which included researching exposure pathways evaluated during the baseline risk assessment in the context of current LTM results, are described below. No data gap was identified for Area 2.

The baseline HHRA (U.S. Navy 1993b) evaluated the following pathways at Area 2 (as shown on Figure 3-7):

- Incidental ingestion of chemicals from soil by current/future workers and future residents
- Inhalation of chemicals in particulates and volatiles in outdoor air by current/future workers
- Inhalation of chemicals in particulates in outdoor air by future residents
- Incidental ingestion of chemicals in stream sediment by future residents
- Ingestion and inhalation of chemicals in groundwater by future residents
- Ingestion of chemicals in homegrown produce by future residents
- Incidental ingestion of chemicals in marine surface water and sediment in the shallow lagoon by future residents and future visitors

In the baseline HHRA, human health cancer and noncancer risk target goals were exceeded for the future residential land use scenario, including vinyl chloride in groundwater and arsenic, beryllium, and vinyl chloride in soil. Based on a biological survey documented in the 1993 report on the shallow lagoon, no edible-size fish, crabs, or other organisms was found. Therefore, the seafood ingestion pathway is incomplete.

Ecological pathways at Area 2 included evaluation of the terrestrial and the aquatic environments. The risk assessment concluded that direct exposures to soil and the ingestion of prey species lower on the food chain do not pose significant risks to terrestrial or aquatic organisms living in the stream at Area 2.

Based on human and ecological risk results, LTM of groundwater and ICs restricting residential use and ingestion of groundwater were implemented as the remedy. RGs were established for COCs, including VOCs in groundwater. Today all the residential pathways are incomplete (ingestion of groundwater and incidental ingestion of soil and produce, inhalation of vapors in indoor air, ingestion of stream sediment, etc.) because ICs are in place that prevent residential use of the site. ICs also prevent use of the site by visitors. Therefore, these pathways are also incomplete. As shown in Appendix B Table B-8, TCE and vinyl chloride concentrations have decreased below their respective RGs. Although an RG was not established in the ROD, the concentrations of cis-1,2-DCE are below the current MTCA Method B value.

No risk was found from exposure to chemicals in outdoor air for current/future workers or future residents. However, the vapor intrusion to indoor air pathway was not evaluated. Based on review of current VOC concentrations in groundwater, the indoor air pathway for workers is complete but insignificant (see Vapor Intrusion section discussed previously). ICs are in place to prevent residential use. Therefore, the indoor air pathway for residents is incomplete.

Additional exposure assessment and data gaps evaluation does not appear to be necessary for OU 2 Area 2, based on decreasing groundwater trends and current land use controls. Therefore, the remedy at Area 2 remains functional and protective. Figure 7-2 summarizes the remedy-in-place working CSM for Area 2 for use as a starting point for further CSM development and discussion, as needed, in collaboration with stakeholders and regulators.

7.2.4 Technical Assessment Summary

The remedy at OU 2 was implemented and has been operating for 20 years. The remedy is functioning as intended by the ROD. COC concentrations in groundwater have declined below the RGs, and ICs have been effective at preventing exposures while COC concentrations decreased naturally. Regular groundwater monitoring documented progress towards, and eventual attainment of, RAOs. ICs should remain in place to prevent exposures to remaining COCs in soil, and groundwater monitoring should be performed prior to each 5-year review to document continued concentrations below RGs. Continued groundwater monitoring is warranted, in particular because the RG for vinyl chloride is based on the laboratory PQL, rather than a risk-based goal. Current concentrations are below the RG, but not consistently below current risk-based ARARs.

7.3 OU 2 AREA 8

7.3.1 Functionality of Remedy for OU 2 Area 8

Is the remedy functioning as intended by the decision documents? Yes.

The RAOs established in the OU 2 ROD for Area 8 are the following:

- Prevent human ingestion of groundwater containing metals and VOCs at concentrations above drinking water standards or acceptable human health risk levels.

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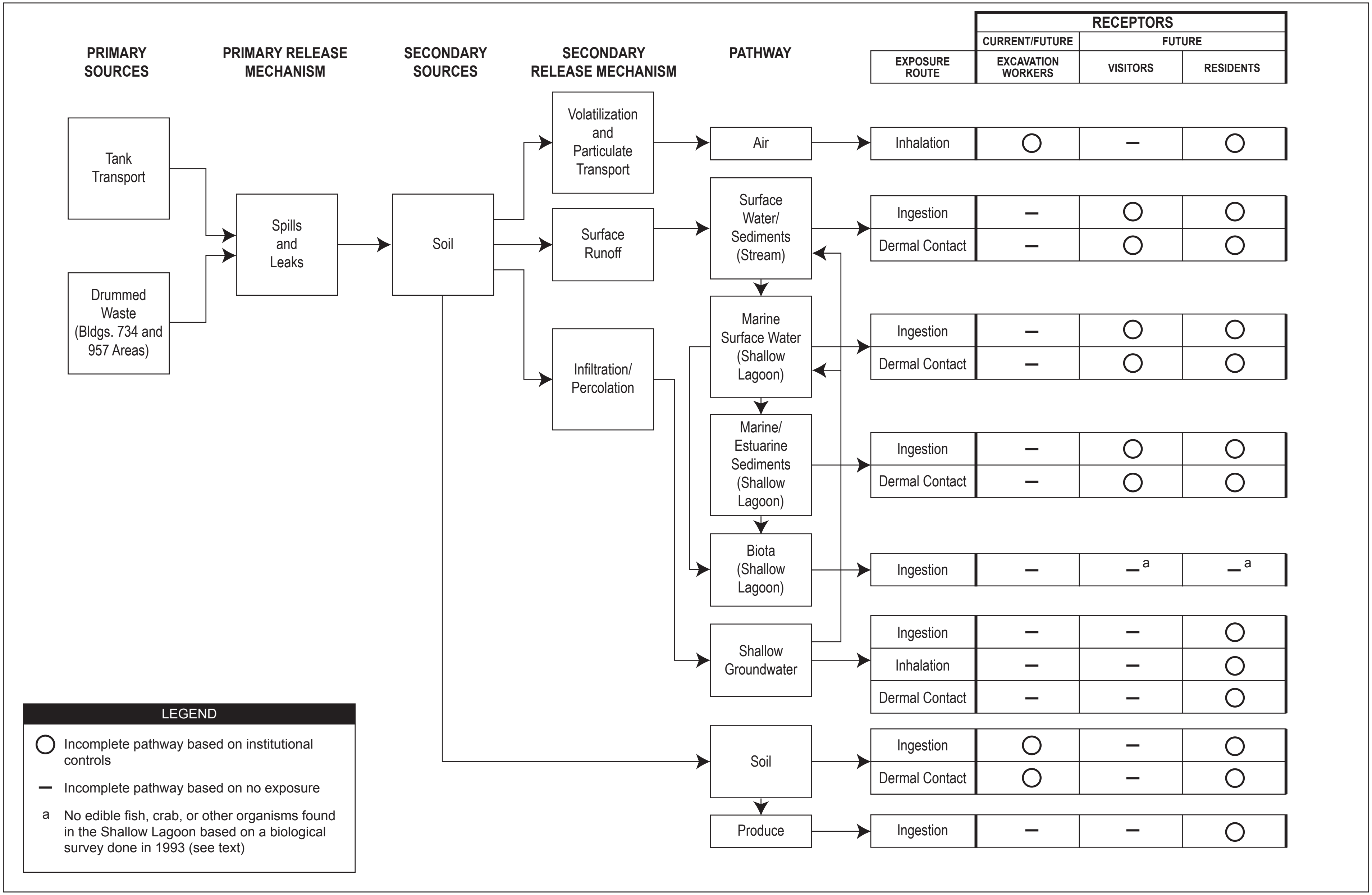


U.S. NAVY	**Figure 7-2** **Remedy-in-Place Working OU 2 Area 2 Conceptual Site Model**	NBK Keyport FOURTH FIVE-YEAR REVIEW

- Protect sediments and surface water quality offshore of Area 8 in Liberty Bay from contaminants in groundwater that could cause future adverse impacts or human health risks.

- Prevent humans from coming into direct contact with, or ingesting, soil containing COCs at concentrations that would present an unacceptable risk to human health.

- Protect groundwater and surface water quality from soil containing COCs.

The remedy for OU 2 Area 8 has been implemented as intended by the ROD. However, monitoring data show that metals concentrations above background values continue to be present in intertidal sediment. The assessment of risk to human health and the environment from these elevated metals concentrations is in progress, but not yet complete. The OU 2 ROD required a post-ROD risk assessment of potential future exposures in the marine environment for this area. The Navy is currently working with the regulators and stakeholders to perform additional investigation of the intertidal zone at Area 8 and complete human health and ecological risk assessments. The need for contingent groundwater control actions will be evaluated based on the completed HHRA, as well as additional evaluation of ecological risks.

The ICs component of the selected remedy has been implemented and maintained and acts to prevent human exposures to COCs in soil and groundwater. The removal and off-site disposal of vadose-zone soil from COC hot spots was complete prior to the first 5-year review. Groundwater, sediment, and tissue monitoring has been ongoing since 1995, with the results evaluated regularly to assess the effectiveness of the remedy and the adequacy of the monitoring. Concentrations of 1,4-dioxane in groundwater at the site exceed the associated current MTCA Method B groundwater cleanup level. Ongoing sampling is warranted to document the progress toward remediation of this compound to the ARAR standard and ensure that ICs prohibiting drinking of Area 8 groundwater remain in place until the ARAR standard is met. 1,4-Dioxane was not detected in seep water at a concentration above 1.0 μg/L during one-time sampling in 2007, indicating that groundwater is not discharging to surface water at concentrations above this reporting limit. No surface water cleanup standard has been established for 1,4-dioxane.

The remedy for Area 8 is functioning as intended by the OU 2 ROD. The ICs component of the selected remedy has been implemented and maintained and acts to prevent human exposures to COCs, including 1,4-dioxane, in soil and groundwater. The groundwater monitoring component of the remedy has also been implemented. Groundwater wells are sampled regularly and the results evaluated to assess the need for continued ICs. The results are also evaluated to assess the adequacy of monitoring, and the monitoring program is adjusted as necessary, with input from stakeholders and regulators. Further investigation of risks to human health and the environment from COCs in intertidal sediment, as required by the ROD, is underway in cooperation with regulators and stakeholders.

7.3.2 Continued Validity of ROD Assumptions

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid? Yes, the ARARs, exposure assumptions, toxicity data, and RAOs are still valid and protective of human health and the environment. Changes to the ARARs used to establish cleanup levels in the ROD are evaluated below and summarized in Table 7-6. The changes to the toxicity and exposure risk assumptions are also discussed in the following sections.

Review of ARARs and Toxicity Criteria

The ROD for Area 8 identified three COCs in soil based on residential land use: arsenic, cadmium (if ingested in homegrown produce), and chromium. However, arsenic was considered at or below background for soil and groundwater. In Area 8 groundwater, the risk assessment identified cadmium, chromium, and TCE as COCs with HQs greater than 1 and five additional COCs (carbon tetrachloride, chloroform, 1,2-DCA, 1,1-DCE, and 1,1,2-TCA) with cancer risks exceeding 1×10^{-5}, if the shallow aquifer were used for drinking water. The current analyte list for ongoing groundwater monitoring includes selected metals and VOCs related to TCE and its breakdown products.

A comparison of the ROD RGs with current ARARs (as of June 2014) for soil is discussed below. A comparison of ROD RGs with current ARARs (as of June 2014) for groundwater and surface water is provided in Table 7-6, and those with lower values that may impact the protectiveness of the remedy are discussed by media in the sections below.

Soil. The cadmium and chromium values (chromium [total] was assumed as 100 percent hexavalent chromium) used for site cleanup were 80 and 400 mg/kg, respectively, based on MTCA Method B (U.S. Navy, USEPA, and Ecology 1994). Current MTCA Method B soil values are 80 mg/kg for cadmium and 240 mg/kg for hexavalent chromium. Therefore, the lower hexavalent chromium value calls into question the protectiveness of the remedy. The chromium ROD RG was evaluated to assess whether it still meets the ROD's target HI of 1 for noncancer effects through the ingestion pathway (not as a carcinogen by inhalation). The assessed HQ of the RG is 2, which exceeds the target goal. However, because ICs are in place that restrict residential land use, the remedy remains protective.

Table 7-7 summarizes the chemicals with changes in toxicity criteria and the basis of the criteria change and provides the calculated health risks of the ROD RGs for chromium (the hexavalent form is the only ARAR that has changed of the three forms: trivalent, hexavalent, and chromium [total]), cis-1,2-DCE, and TCE for drinking water and TCE and PCE for surface water that would result in lower RGs using current ARARs (as of June 2014). Currently, chromium speciation is not performed, and analysis is for chromium (total) only, on the assumption that chromium (total) results represent 100 percent hexavalent chromium (as further discussed in Section 4.3.3). ROD RGs for these COCs were evaluated to assess whether they still meet the ROD's target risk of 1 x

10^{-5} and are within EPA's acceptable excess cancer risk range of 10^{-4} to 10^{-6}, or below an HI of 1 for noncancer effects. A discussion of the calculated risk levels listed in Table 7-7 that exceed target health goals are discussed below.

Groundwater. Table 7-6 compares current groundwater ARARs with those presented in the OU 2 ROD (U.S. Navy, USEPA, and Ecology 1994, Table 10-12). The current drinking water ARAR values are lower for hexavalent chromium, cis-1,2-DCE, and TCE. As listed in Table 7-7, the toxicity criteria have changed for hexavalent chromium, resulting in the lowering of the MTCA Method B value, and the assessed HQ of the RG is 2 for noncancer effects through the ingestion pathway (not as a carcinogen by inhalation). This value exceeds target goals. However, ICs are in place to prevent drinking, and the remedy remains protective. For TCE and cis-1,2-DCE, the RGs are based on MCLs, which have not changed. However, the current MTCA Method B values are lower. In accordance with Ecology's methodology (WAC 173-340-720[7][b]), the assessed risk of the TCE MCL of 5 μg/L is sufficiently protective at 1×10^{-6}. For cis-1,2-DCE, the assessed HQ of the RG is 4, which exceeds the target goal. However, because ICs are in place that prevent groundwater use as drinking water, the remedy remains protective.

1,4-Dioxane was analyzed in groundwater during 2007 and then added to LTM in 2011. Because it is a newly identified chemical, no cleanup level was established in the ROD. At the time of initial sampling in 2007, the MTCA Method B value was 4 μg/L, and it is currently 0.44 μg/L. Therefore, this 5-year review recommends that future monitoring for 1,4-dioxane use a laboratory analytical methods that can achieve a reporting limit of 0.4 μg/L.

Surface Water. As shown in Table 7-6, the current surface water ARAR values are lower for TCE and PCE. The marine AWQC for TCE changed from 81 to 30 μg/L and for PCE from 8.9 to 3.3 μg/L. As shown in Table 7-7, the assessed risk of the RGs is 3×10^{-6} for both TCE and PCE, which is below the target risk goal. Therefore, the remedy remains protective with regard to surface water exposures.

Sediment. As discussed in Section 7.1.2, the SMS was revised in September 2013, with an expanded emphasis on assessing human health risks. No numerical sediment RG was established in the ROD. The results of the LTM tissue and sediment sampling have been used to assess human health risks from exposure to marine sediment and tissue. As there are currently institutional controls in place that prohibit the harvesting of shellfish from Liberty Bay, the change in ARAR (i.e., the new SMS) does not call into question the current or short-term protectiveness of the remedy. The data gaps evaluation and sampling plan completed in collaboration with the stakeholders resulted in a field sampling effort designed to provide the data necessary to complete human health and ecological risk assessments consistent with the new SMS. The protectiveness of the remedy as it relates to the change in the SMS will be assessed upon completion of the risk assessments.

Review of Risk Assessment Assumptions – Exposure Parameters

Since the ROD was signed, additional subsistence ingestion rates are available to evaluate the shellfish consumption pathway, and the EPA default exposure factor for body weight has increased. Another factor that impacts availability of shellfish harvesting is whether the local health department declares that the area is open for harvesting based on evaluation of biotoxins and pollution. These changes to exposure parameters may impact the protectiveness of the remedy.

The baseline HHRA (U.S. Navy 1993b) did not find health risks in excess of target health goals from consumption of shellfish in Liberty Bay adjacent to NBK Keyport. The OU 2 ROD did not provide tissue-based RGs for shellfish. The ROD specified that post-ROD sediment and clam tissue samples from the Area 8 beach were to be evaluated, using risk assessment procedures, to assess whether health risks were present. This stipulation was based on concerns that COCs in groundwater discharging to Liberty Bay might increase and invalidate the 1993 baseline HHRA findings. The fish ingestion rate default of 54 g/day used in the original risk assessment has been revised for subsistence users. Current HHRAs would use higher ingestion rates for subsistence users.

In addition, the EPA (2014b) revised its default exposure factors for several parameters. For example, adult body weight changed from 70 to 80 kg, which, if adopted by Ecology, will increase or decrease the current MTCA Method B values, potentially impacting the protectiveness of the remedy.

Liberty Bay shellfish harvesting is currently closed because of pollution (septic and sewage discharges) and marine biotoxins (Chang 2015 and Maier 2015). Ecology has conducted water quality assessments in Liberty Bay and associated watersheds during 2004, 2008, and 2012, and 2015 data are currently under public review (Ecology 2015). The 2012 water quality data for bacteria in Liberty Bay ranges from Category 1 (meets tested standards for clean waters) to Category 5 (impaired waters) and can be accessed in Ecology’s 303(d)/305(b) Integrated Report database (Ecology 2015).

7.3.3 New Information

Has any other information come to light that could call into question the protectiveness of the remedy? Yes, there is new information regarding the remedy at OU 2 Area 8 that could impact the protectiveness of the remedy, including potential vapor intrusion at buildings based on changes in toxicity and current vapor intrusion guidance and data gaps for human health and ecological risk assessments.

Vapor Intrusion Evaluation

The determination as to whether a vapor intrusion evaluation is warranted was based on the following screening according to current vapor intrusion guidance (USEPA 2015b and Ecology 2009):

- If VOC concentrations in groundwater exceeded the calculated groundwater screening level protective of indoor air and the well is within 100 feet of an occupied building

- If VOC concentrations in soil gas exceed 10 times Ecology's industrial indoor air cleanup level or EPA's industrial indoor air regional screening level and the location is within 100 feet of an occupied building

- If VOC concentrations in indoor air exceed Ecology's industrial indoor air cleanup level or EPA's industrial indoor air regional screening level

Because no vapor intrusion evaluation has been conducted at Area 8, there is no soil gas or indoor air data to include in the screening. The only subsurface data available to evaluate the current vapor intrusion pathway are groundwater VOC results from LTM (U.S. Navy 2015a). Appendix B Table B-10 shows that TCE concentrations in groundwater over the last 5 years (wells MW8-8, MW8-9, MW8-11, MW8-12, and MW8-16) consistently exceed the TCE groundwater screening value of 5 μg/L considered protective using Ecology's industrial air value (as calculated in Section 7.1.3), and as shown on Figure C-48 of Appendix C, the interpreted TCE concentrations at 5 μg/L at well MW8-11 is less than 100 feet from Building 98 and well MW8-8 is approximately 100 feet from Building 82. Appendix B provides the historical and 2014 VOC groundwater concentrations and sampling locations for Area 8.

An evaluation of the vapor intrusion pathway is recommended because of detected VOC concentrations in groundwater in the vicinity of worker-occupied buildings. The data gaps for indoor air and soil gas and the presence of VOCs in groundwater could impact the protectiveness of the remedy regarding workers safety in nearby buildings.

Data Gaps Relating to Human Health and Ecological Risk Assessment

An evaluation of data gaps that could impact the protectiveness of the remedy at Area 8 was conducted as part of this 5-year review as specified by the Navy Remedial Project Manager, although it is not normally part of the 5-year review process. Described below are details of this evaluation, which included researching exposure pathways evaluated during the baseline risk assessment in the context of current LTM results. The following data gaps were identified for Area 8, and recommendations are made in Section 8 to address them:

- The exposure assessment and data collection related to human health and ecological risks warrant further investigation to complete the required post-ROD risk assessment. The need for additional investigation to support the risk assessment is based on a data gaps evaluation regarding the historical shellfish and sediment data, background data, sample area size, extent of contamination, and LTM program. This assessment has been conducted in workgroup meetings held by the Navy and attended by regulators and stakeholders.

- A vapor intrusion evaluation according to current vapor intrusion guidance has not been conducted for occupied buildings east of Bradley Road. This evaluation is recommended because buildings are adjacent to a landfill with elevated TCE concentrations in groundwater that exceed indoor air screening levels and an elevated historical TCE concentration in soil gas near a building located east of Bradley Road.

The baseline HHRA (U.S. Navy 1993b) evaluated the following pathways at Area 8 (as shown on Figure 3-6):

- Incidental ingestion of chemicals from soil by future residents

- Inhalation of chemicals in particulates in outdoor air by current/future workers

- Inhalation of chemicals in particulates in outdoor air by future residents

- Ingestion and inhalation of chemicals in groundwater by future residents

- Ingestion of chemicals in homegrown produce by future residents

- Incidental ingestion of contaminated surface water and sediment by future recreational visitors and residents while swimming, boating, fishing, or playing along the beach at Liberty Bay

- Ingestion of contaminated seafood by current/future recreational visitors, future residents, and current/future subsistence users in Liberty Bay

Human health cancer and noncancer risk target goals were exceeded for the future residential land use scenario, including arsenic, cadmium, chromium, 1,1-DCE, and TCE in groundwater and arsenic and cadmium in soil.

Ecological risks were not calculated at Area 8 because there is no terrestrial wildlife habitat, and chemical concentrations in Liberty Bay sediment did not exceed background or SQS values.

Based on human health risk results, chromium- and cadmium-contaminated soil was removed, and LTM of groundwater, seeps, sediment, and tissue and ICs restricting residential use and ingestion of groundwater were implemented as the remedy. RGs were established for COCs, including VOCs and metals in seeps and groundwater and SVOCs and metals in sediment and tissue.

In the 1993 risk assessment, no risk was found from exposure to chemicals in outdoor air for current/future workers or future residents. However, the vapor intrusion to indoor air pathway was not evaluated. The only recent subsurface data available to evaluate the current vapor intrusion pathway are groundwater VOC results from LTM (U.S. Navy 2015a). Based on review of current VOC concentrations in groundwater, the indoor air pathway for workers is potentially complete and recommended for further evaluation because occupied buildings in the vicinity of TCE groundwater results exceed industrial groundwater screening values protective of indoor air (see Vapor Intrusion section discussed previously). ICs are in place to prevent residential use. Therefore, the indoor air pathway for residents is incomplete.

In the 2001 PHA, ATSDR evaluated clam tissue data collected from Liberty Bay between 1996 and 2000 using the Suquamish Tribe ingestion rates of 142 and 292 g/day for a 79-kg adult and 24 g/day for a 30-kg child. It was concluded that chemicals present in native littleneck clams along the shoreline of NBK Keyport do not present a public health hazard to subsistence seafood consumers. In the 2013 PHA, ATSDR evaluated clam tissue data collected from Liberty Bay between 1996 and 2008 using Suquamish Tribe ingestion rates of 615 g/day for a 79-kg adult and 84 g/day for a 16.8-kg child. The report provided two conclusions, as follows:

- No current exposure to the contaminants was detected, and, therefore, there is no current health hazard. However, Pacific littleneck clams samples collected from seep areas near NBK Keyport (Area 8) exceeded health-based screening levels for several heavy metals. Eating clams from this area at Suquamish tribal subsistence quantities for longer than a year could harm people’s health.

- Because of the limitations of the shellfish data collected in the nearshore area of Liberty Bay between 1996 and 2008, ATSDR was unable to make general public health conclusions on future shellfish consumption.

ATSDR (2013) recommended sampling a larger area, collecting additional shellfish species, expanding the analyte list, and sampling during different seasons in order to remove data limitations.

Contamination from nonpoint sources carried by stormwater runoff has degraded the general water quality in Liberty Bay (ATSDR 2013). Microbial contamination is a recurring problem and often exceeds water quality standards. As a result, tribal, commercial, and recreational shellfish harvesting areas are restricted to a small fraction of the available historical areas (ATSDR 2013).

Based on the past exposure assumptions relative to the data collected and the remedy that is in place, the following pathways are considered incomplete or complete but insignificant:

- Incidental ingestion of chemicals from soil by future residents
- Inhalation of chemicals in particulates in outdoor air by current/future workers
- Inhalation of chemicals in particulates in outdoor air by future residents
- Inhalation of chemicals in indoor air by future residents
- Ingestion, inhalation, and dermal contact of chemicals in groundwater by future residents
- Ingestion of chemicals in homegrown produce by future residents

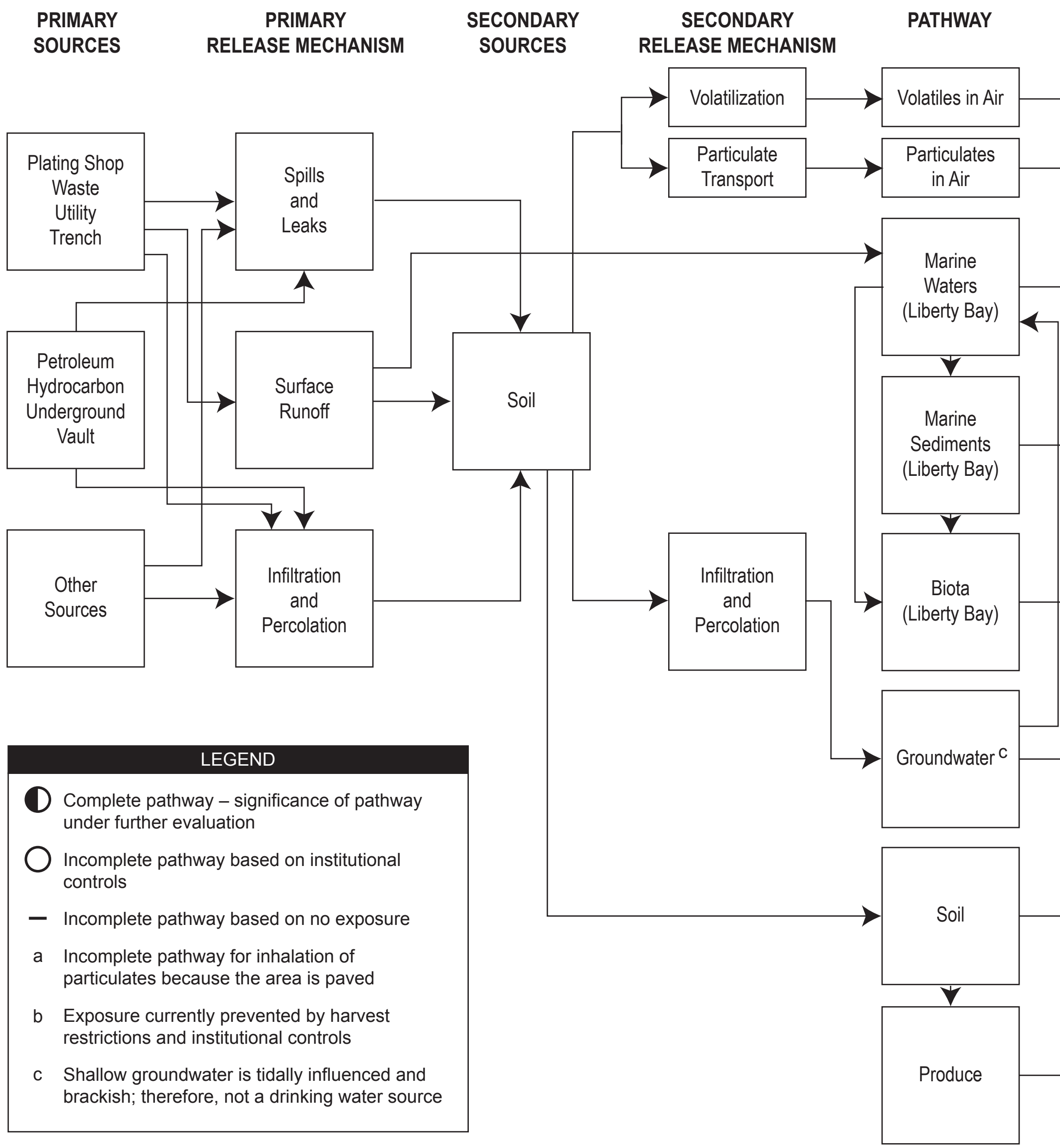
An exposure assessment for subsistence and recreational users and a data gaps evaluation regarding the historical shellfish and sediment data, background data, sample area size, extent of contamination, and the LTM program have been conducted in workgroup meetings in consultation with stakeholders and regulators. A sampling plan to collect additional analytical data from the intertidal zone of Area 8 is in progress. Field sampling is expected to occur in the summer of 2015. Supplemental human health and ecological risk assessments will be performed based on the new data collected. Figure 7-3 summarizes the remedy-in-place working CSM for Area 8 for use as a starting point for further CSM development and discussion in collaboration with stakeholders and regulators.

7.3.4 Technical Assessment Summary

The remedy at OU 2 Area 8 was implemented and has been operating for 20 years. The remedy is functioning as intended by the ROD. However, additional investigation (in progress) is needed to allow completion of human health and ecology risk assessments for the intertidal zone of Area 8. The results of the risk assessments will be used to assess whether contingent groundwater control actions established in the ROD should be implemented.

7.3.5 Risk Evaluations of Sediment and Clam Tissue at OU 2 Area 8

The ROD specified that post-ROD sediment and clam tissue samples from Liberty Bay were to be evaluated using risk assessment procedures to assess whether health risks were present. The results of the evaluation were to be used to assess whether further remedial actions were needed for controlling groundwater entering Liberty Bay. Human health and ecological risk assessments were performed in accordance with ROD requirement as part of the second and third 5-year



Pathway	Exposure Route	RECEPTORS: Current/Future – Excavation Workers	Current/Future – Office Workers	Future – Recreational Users	Future – Residents	Future – Subsistence Users
Volatiles in Air	Inhalation	○	◐	—	○	—
Particulates in Air	Inhalation	○	— [a]	—	○	—
Marine Waters (Liberty Bay)	Ingestion	—	—	◐	○	◐
	Dermal Contact	—	—	◐	○	◐
Marine Sediments (Liberty Bay)	Ingestion	—	—	◐	○	◐
	Dermal Contact	—	—	◐	○	◐
Biota (Liberty Bay)	Ingestion	—	—	◐ [b]	○	◐ [b]
Groundwater [c]	Ingestion	—	—	—	—	—
	Inhalation	—	—	—	—	—
	Dermal Contact	—	—	—	—	—
Soil	Ingestion	○	—	—	○	—
	Dermal Contact	○	—	—	○	—
Produce	Ingestion	—	—	—	○	—

U.S. NAVY

Figure 7-3
Remedy-in-Place Working OU 2 Area 8 Conceptual Site Model

NBK Keyport
FOURTH
FIVE-YEAR REVIEW

reviews (U.S. Navy 2005a and 2010a). The risk assessments performed for OU 2 Area 8 during the previous 5-year review did not adequately address the stakeholders concerns regarding potential impacts to human health and the environment. Completion of updated human health and ecological risk assessments has been postponed until additional data have been collected to further characterize the nature and extent of contamination per discussions among the Navy, EPA, Ecology, and the Suquamish Tribe. The results of the HHRA and ecological risk assessment are summarized in the third 5-year review available in Appendix A.

7.4 SITE 23

7.4.1 Functionality of Remedy for Site 23

Is the remedy functioning as intended by the decision documents? Yes.

The following paraphrased RAOs were established for Site 23:

- Reduce the likelihood of migration of any subsurface contaminants in the area of (former) Building 21, thereby reducing the potential risk to human health and the environment.

- Prevent human exposures to COCs in soil and groundwater by pathways such as ingestion of groundwater, inhalation of volatiles while showering, dermal contact with soil, or ingestion of soil.

The remedy for Site 23 is functioning as intended by the decision document. A site-specific assessment of risk to human health and the environment identified risks below MTCA Method C commercial and industrial scenarios (U.S. Navy 2000d). Basewide ICs, adopted as a component of the selected remedy, have been implemented and maintained and act to prevent human exposures to COCs in soil and groundwater at Site 23.

7.4.2 Continued Validity of Cleanup Assumptions

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid? Yes, the ARARs, exposure assumptions, and toxicity data are still valid and protective of human health and the environment. No RAOs were established at Site 23 because the risk-based evaluation performed following the time-critical removal action (U.S. Navy 2000d) found no unacceptable risks. The primary chemicals of potential concern at Site 23 were petroleum compounds, benzene, toluene, ethylbenzene, and xylenes, polycyclic aromatic hydrocarbons, and lead. The risk-based evaluation performed following the time-critical action concluded that there were no risks under a commercial and industrial exposure scenario and no significant risks under a residential scenario. Presently, the asphalt cap prevents exposure to soil contamination and ICs are in place that require maintenance of the asphalt, preventing future exposures to soil and minimizing the potential for leaching of contaminants to groundwater. Although ARARs, such as MTCA Method B and EPA risk-based screening levels, and toxicity criteria used in the residual risk evaluation would be different today, the ICs in place that prevent residential land use nonpermitted excavation, and groundwater use ensure the current and future protectiveness of the remedy.

7.4.3 New Information

Has any other information come to light that could call into question the protectiveness of the remedy? No, there is no new information regarding the remedy at Site 23 that could impact the protectiveness of the remedy.

7.4.4 Technical Assessment Summary

The remedy at Site 23 was implemented and has been operating for 15 years. The remedy is functioning as intended.

7.5 ISSUES

Table 7-8 lists the issues identified as a result of this 5-year review that appear to have the potential to affect the protectiveness of the remedies at NBK Keyport.

Table 7-8
Issues

No.	Issue[a]	Affects Protectiveness? Current	Future
Sitewide			
1	Changes to long-term monitoring are recommended in this 5-year review report, and the reporting limit for 1,4-dioxane is not low enough to meet the MTCA Method B value of 0.44 µg/L.	No	Yes
2	Ecology requested more rigorous long-term monitoring trend graphs for all areas. The use of one value to represent all reporting limits unrealistically biases the trend graphs.	No	No
OU 1			
3	Several deficiencies in the landfill cover were identified.	No[b]	Yes
4	Evaluation against current vapor intrusion guidance has identified potential data gaps regarding office worker exposure to potential VOCs in indoor air at facility buildings near OU 1 Area 1.	No[c]	Yes
5	Phytoremediation at OU 1 is not as effective at the south plantation as expected by regulators and stakeholders. The ROD requirements are being met, conditions are not worse than at the time of the ROD, and the ROD found that conditions at that time were protective. However, the restoration time frame selected in the ROD exceeds Ecology and EPA's current expectations of 30 to 50 years, and surface water ARARs at station MA12 are consistently exceeded.	No	No
6	PCB data from seep SP1-1, and in sediment at two stations, imply that PCB concentrations may be increasing.	No	Yes
OU 2 Area 2: No issue that impacts protectiveness			
OU 2 Area 8			
7	Evaluation against current vapor intrusion guidance has identified potential data gaps regarding office worker exposure to potential VOCs in indoor air at facility buildings.	No[c]	Yes
8	The human health and ecological risk assessments for intertidal sediment required by the ROD have been completed. However, the risk assessments were not approved by regulators and stakeholders.	No[d]	Yes
Site 23: No issue that impacts protectiveness.			

[a]The issues listed below have been identified to require follow-up action prior to the next 5-year review, but do not impact protectiveness:

- General:
  - The Kitsap County Health Department has expressed a desire for more in-depth and frequent information about the site.
  - The cumulative data tables presented in the long-term monitoring reports do not consistently show the "best value" results for instances of primary samples, dilutions, field duplicates, etc. Data validation qualifiers are sometimes reported, while laboratory qualifiers are tabulated in other cases. These issues are particularly applicable to historical data (especially pre-2009).
  - The ICs reports sent to Ecology and EPA do not always identify the latest versions of the ICs plan and regional ICs instruction that are being followed.

Table 7-8 (Continued)
Issues

- State and federal human health surface water quality criteria are in the process of public comment and revision.
- EPA human health exposure factors were revised in 2014, but Ecology does not concur with changes and does not include these revisions in the current MTCA Method B values.

- OU 1:
  - Changes to the monitoring program are recommended, including monitoring frequency revisions and discontinuation of some monitoring.
  - Hexavalent chromium concentrations found in sediment, soil, and solids have not been fully assessed with regard to potential sources or natural occurrence.
  - Ecology has expressed a concern that the work being performed by the U.S. Geological Survey should be subject to regulatory review under the Federal Facilities Agreement signed by the Navy, EPA, and Ecology.
  - Changes in the CVOC plume would be better tracked by estimating changes in CVOC mass over time.
- OU 2, Area 2: Changes are recommended to monitoring frequencies.

[b]Protective in the short term because damage is limited and will be repaired in the near future
[c]Protective in the short term because buildings are large and well ventilated at both Areas 1 and 8; VOC groundwater remedy in place, including long-term monitoring, which indicates concentrations are stable or decreasing
[d]ICs are in place to prevent exposure.

Notes:
ARARs - applicable or relevant and appropriate requirement
CVOC - chlorinated volatile organic compound
Ecology - Washington State Department of Ecology
EPA - U.S. Environmental Protection Agency
ICs - institutional controls
µg/L - microgram per liter
MTCA - Model Toxics Control Act
OU - operable unit
PCB - polychlorinated biphenyl
ROD - Record of Decision
VOCs - volatile organic compounds

8.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

This section presents the recommendations and follow-up actions identified as a result of the 5-year review process. Table 8-1 summarizes the sitewide recommendations and follow-up actions, as well as those for OU 1 and OU 2.

Table 8-1
Recommendations and Follow-Up Actions

No.	Recommendation/ Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Action: Affects Protectiveness? Current	Follow-Up Action: Affects Protectiveness? Future
Sitewide						
1	Revise the OU 1 and OU 2 long-term monitoring plans in collaboration with EPA, Ecology, and the Suquamish Tribe based on the 5-year review recommendations. Include in the plans the use of a laboratory analytical method that can achieve a reporting limit of 0.4 µg/L for 1,4-dioxane in groundwater to meet the MTCA Method B value of 0.44 µg/L.	NAVFAC NW	Ecology	12/31/2016	No	Yes
2	Long-term monitoring trend graphs will be completed according to Ecology's guidance on remediation by natural attenuation of petroleum-contaminated groundwater[a]. It is recommended that the actual reporting limits are used in the trend graphs, rather than using one value to represent all reporting limits. For those reporting limits that are unrealistically biasing trends, it is recommended that the nondetected result be removed in consultation with Ecology.	NAVFAC NW	Ecology	12/31/2016	No	No
OU 1						
3	Perform landfill cover repairs. Ensure that future institutional controls inspections of the landfill are comprehensive.	NAVFAC NW	Ecology	12/31/2018	No[b]	Yes
4	Perform the initial step of a vapor intrusion evaluation, including soil gas sampling adjacent to occupied buildings within 100 feet of groundwater wells exhibiting TCE concentrations exceeding 5 µg/L.	NAVFAC NW	Ecology	12/31/2018	No[c]	Yes

Table 8-1 (Continued)
Recommendations and Follow-Up Actions

No.	Recommendation/ Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Action: Affects Protectiveness? Current	Follow-Up Action: Affects Protectiveness? Future
5	a. Continue additional investigation to refine the conceptual site model regarding contaminant distribution at the south plantation and around well MW1-17. b. Clarify remedial action objectives as intended by the Record of Decision, including the surface water remediation goals and points of compliance for marsh water. c. Evaluate the feasibility of optimizing the remedial action at the south plantation to shorten the restoration time frame.	NAVFAC NW	Ecology	12/31/2018	No	No
6	Collect additional sediment samples at and in the vicinity of seep SP1-1 during the Phase II investigation and use the data to assess whether expanded, ongoing PCB monitoring should be initiated and risk assumptions reviewed.	NAVFAC NW	Ecology	12/31/2016	No	Yes
OU 2 Area 8						
7	Perform the initial step of a vapor intrusion evaluation, including soil gas sampling adjacent to occupied buildings within 100 feet of groundwater wells exhibiting TCE concentrations exceeding 5 µg/L.	NAVFAC NW	Ecology	12/31/2018	No[c]	Yes
8	In conjunction with EPA, Ecology, and the Suquamish Tribe, collect necessary data and complete the human health and ecological risk assessments for intertidal sediment. Assess the need to implement contingent groundwater control actions based on the results of the risk assessments.	NAVFAC NW	Ecology	12/31/2017	No[d]	Yes

[a]Ecology publication No. 05-09-091 dated July 2005
[b]Protective in the short term because damage is limited and will be repaired in the near future
[c]Protective in the short term because mass of contaminants at Area 1 or contaminant plume at Area 8 are over 100 feet away and buildings are large and well ventilated at both Areas 1 and 8
[d]Institutional controls are in place to prevent exposure.

9.0 CERTIFICATION OF PROTECTIVENESS

The overall sitewide remedies are protective in the short term. Exposure pathways that could result in unacceptable risks are being controlled and monitored while further information is obtained. To ensure future long-term protectiveness, further information will be obtained at OU 1 and OU 2 Area 8.

9.1 OU 1 AREA 1

The OU Area 1 RAOs are paraphrased below using summary statements (see the OU 1 ROD for the complete language of the RAOs), and implemented remedial actions were as follows:

- Prevent human exposure to groundwater as drinking water using ICs.
- Reduce VOC concentrations in groundwater using phytoremediation (planting of two plantations).
- Prevent human exposure to landfill vapors by removing buildings located above the landfill.
- Prevent human exposure to soil and landfill waste by placing an asphalt cover over the landfill.
- Prevent VOCs in groundwater from entering surface water by upgrading the tide gate.
- Prevent unacceptable risks to humans through ingestion of seafood and preventing sediment exposure by aquatic organisms by removing PCB-containing sediment from the marsh sediment.

All components of the OU 1 remedy have been implemented. Implementation of phytoremediation, PCB-contaminated sediment removal, and the tide gate upgrade were complete prior to the first 5-year review. ICs were also implemented prior to the first 5-year review, and LTM, maintenance, and inspection programs are in place. The landfill cover was upgraded during the second 5-year review period, and the Navy prepared and implemented a CRA plan in March 2003.

Overall, the remedy for OU 1 has been implemented as intended by the ROD. However, as found during the third 5-year review, the phytoremediation component of the remedy is not as effective as intended by the ROD.

The remedy at OU 1 is protective in the short term. Exposure pathways that could result in unacceptable risks are being controlled and monitored while further information is obtained. The office worker exposures to potential COCs in indoor air at buildings east of Bradley Road are protective in the short term because the mass of contamination is over 100 feet away from the occupied buildings, and most of the buildings are large and well ventilated. Damage to the landfill cap is limited and remains protective. In addition, an investigation of the former landfill to study the feasibility of optimizing the remedial action at the south plantation will be conducted. To ensure future long-term protectiveness, further information will be obtained by implementing Recommendations 2 and 3 in Table 8-1. Recommendation 2 calls for repair of damage to the landfill cap, and Recommendation 3 calls for performing the initial step of the vapor intrusion evaluation, including soil gas sampling adjacent to occupied buildings within 100 feet of monitoring wells with TCE concentrations exceeding 5 µg/L.

9.2 OU 2 AREA 2

The OU 2 Area 2 RAOs are paraphrased below using summary statements (see the OU 2 ROD for the complete language of the RAOs), and implemented remedial actions were as follows:

- Prevent human health exposures to TCE and vinyl chloride in soil and groundwater by pathways such as ingestion of groundwater, inhalation of volatiles while showering, or ingestion of soil or vegetables grown in the soil: ICs were put in place to prevent residential use of the site and/or domestic groundwater use.

- Restore the groundwater to drinking water quality: Groundwater wells were installed to monitor natural attenuation of VOCs to safe drinking water levels.

The remedy has been implemented and performed as intended by the ROD at Area 2. The remedy implemented at OU 2 Area 2 is protective of human health and the environment because RGs have been met for TCE and risk-based levels (MTCA Method B cleanup level) have been met for cis-1,2-DCE in groundwater, and exposure pathways that could result in unacceptable risks are being controlled and monitored.

9.3 OU 2 AREA 8

The OU 2 Area 8 RAOs are paraphrased below using summary statements (see the OU 2 ROD for the complete language of the RAOs), and implemented remedial actions were as follows:

- Prevent human exposure to soil and groundwater as drinking water: Hot spot soil removal was conducted, and ICs were put in place to prevent residential use and/or domestic groundwater use.

- Restore the groundwater to drinking water quality: Groundwater wells were installed to monitor natural attenuation of VOCs and metals to safe drinking water levels.

- Protect sediments and surface water quality offshore of Area 8 in Liberty Bay from contaminants in groundwater that could cause future adverse impacts or human health risks. Conduct LTM of groundwater, seeps, and sediment and tissue in the intertidal zone of Area 8. Assess risks to human health and the environment using the sediment and tissue monitoring data. Implement contingent groundwater control actions if Area 8 groundwater is demonstrated to be a significant source of the chemicals that cause risk in sediments or tissue.

The remedy was implemented and has been operating for 20 years. The remedy is functioning as intended by the ROD. However, additional investigation (in progress) is needed to allow completion of human health and ecology risk assessments for the intertidal portion of Area 8. The results of the risk assessments will be used to assess whether contingent groundwater control actions established in the ROD should be implemented.

The remedy implemented at OU 2 Area 8 is protective in the short term. Exposure pathways that could result in unacceptable risks are being controlled and monitored while further information is obtained. The office worker exposures to potential COCs in indoor air at buildings are protective in the short term because the occupied buildings within 100 feet of the contaminant plume are large and well ventilated. To ensure future long-term protectiveness, further information will be obtained by performing the initial step of the vapor intrusion evaluation, including soil gas sampling adjacent to occupied buildings within 100 feet of monitoring wells with TCE concentrations exceeding 5 µg/L, sampling marine surface water, sediment, and clam tissue to generate new data representative of current COC levels from the intertidal zone, and completing human health and ecological risk assessments (as required by the ROD) on the new data generated.

9.4 SITE 23

The Site 23 RAOs are paraphrased below using summary statements and the removal action conducted is also summarized:

> Reduce the likelihood of migration of any subsurface contaminants, thereby reducing the potential risk to human health and the environment: Hot spot soil removal was conducted, and ICs were put in place to prevent human contact with soil and residential use and/or domestic use of groundwater.

The remedy was implemented and has been operating for 15 years. The remedy is functioning as intended and is protective. Exposure pathways that could result in unacceptable risks are being controlled and monitored through ICs that are inspected regularly.

10.0 NEXT REVIEW

The next 5-year review is tentatively scheduled for completion in December 2020. It is anticipated that the recommendations and follow-up actions presented in Table 8-1 of this 5-year review will be addressed by the Navy at the milestone date and prior to the next 5-year review. Below is a summary of the next steps to be accomplished by year:

- **December 2016** - Revise the OU 1 and OU 2 LTM plans in collaboration with EPA, Ecology, and the Suquamish Tribe based on the 5-year review recommendations. Include in the LTM plans the use of a laboratory analytical method that can achieve a reporting limit of 0.4 µg/L for 1,4-dioxane in groundwater to meet the MTCA Method B value of 0.44 µg/L sitewide. LTM trend graphs will be completed using actual reporting limits and according to Ecology’s guidance on remediation by natural attenuation of petroleum-contaminated groundwater. Additional sediment samples will be collected at, and in the vicinity of seep sampling location SP1-1 during the Phase II investigation and data will be used to assess whether expanded, on-going PCB monitoring should be initiated, and whether risk assumptions should be reviewed.

- **December 2017** - Collect necessary data and complete the human health and ecological health risks for intertidal sediment OU 2 Area 8.

- **December 2018** - Perform landfill cover repairs at OU 1 and a vapor intrusion evaluation at OU 1 and OU 2 Area 8, document agreement between the Navy and regulators on points of compliance at OU 1, including the surface water RGs and points of compliance for marsh water, and evaluate the feasibility of optimizing the remedial action at the south plantation to shorten the restoration time frame. Perform additional investigation to refine the CSM regarding contaminant distribution at the south plantation and around well MW1-17.

- **June 2019** - Initiate fifth 5-year review.

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APPENDIX A

Frequently Referenced Documents
(CD attached)

APPENDIX B

Cumulative Data for OU 1 (Area 1) and OU 2 (Areas 2 and 8)

CONTENTS

TABLES

CHEMICAL AND CAS ID CROSSWALK TABLE

CAS ID	Chemical Name	Abbreviation
7440-43-9	cadmium	Cd
16065-83-1	chromium (III)	CrIII or trivalent chromium
7440-47-3	chromium (total)	Cr(t)
18540-29-9	chromium (VI)	CrVI or hexavalent chromium
75-34-3	dichloroethane;1,1-	1,1-DCA
107-06-2	dichloroethane;1,2-	1,2-DCA
75-35-4	dichloroethylene;1,1-	1,1-DCE
156-59-2	dichloroethylene;1,2-,cis	cis-1,2-DCE
156-60-5	dichloroethylene;1,2-,trans	trans-1,2-DCE
123-91-1	dioxane; 1,4	No abbreviation
1336-36-3	polychlorinated biphenyls	PCBs
127-18-4	tetrachloroethylene	PCE
71-55-6	trichloroethane;1,1,1-	1,1,1-TCA
79-01-6	trichloroethylene	TCE
75-01-4	vinyl chloride	VC

Note: CAS – Chemical Abstract Service

Table B-1
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
1MW-01	08/25/95	14	1 U	**5.1**	**590 J**	**180 J**	1 U	1 U	1 U	**1000 J**
	12/06/95	1	1 U	1 U*	**87 J**	7.7	1 U	1 U	1 U	**210 J**
	03/12/96	8.5	0.5 U	**2.6**	**450 J**	**120 J**	0.5 U	0.5 U	0.62	**710 J**
	06/26/96	15	0.5 U	**3.2**	**460 J**	**220 J**	0.5 U	0.5 U	.51 U	**1200 J**
	06/11/99	19	3 U	**4**	**310**	**170**	3 U	3 U	3 U	**960**
	10/20/99	17	0.5 U	**2.9**	**320**	**190**	0.5 U	0.5 U	0.5 U	**970**
	04/25/00	18	0.5 U	**3.1**	**380 J**	**210 J**	0.5 U	0.5 U	0.5 U	**1200 J**
	06/07/00	13	0.5 U	**1.7**	**240 J**	**210 J**	0.5 U	0.5 U	0.58	**1200 J**
	07/24/00	25 U	25 U *	25 U *	**280 J**	**170 J**	25 U *	25 U	25 U *	**920 J**
	10/31/00	17	1 U	**2**	**270**	**160**	1 U	1 U	1 U	**1300**
	04/27/01	17	1 UJ	**3.9**	**250 J**	**170 J**	1 U	1 UJ	0.6 J	**770 J**
	06/20/01	19	0.58 U	**2.5 J**	**240**	**170**	0.55 U	0.56 U	0.59 U	**860**
	07/30/01	14 J	1 U	**2.4**	**240 J**	**170**	1 U	1 U	1 U	**1500 J**
	10/29/01	14 J	1 U	**1.5**	**160 J**	**130**	1 U	1 U	1 U	**970 J**
	04/30/02	16 J	2.5 U	**2.6 J**	**280 J**	**180 J**	2.5 U	2.5 U	2.5 U	**750 J**
	06/19/02	12 D	2.5 U	**1.7 JD**	**170 D**	**130 D**	2.5 U	2.5 U	2.5 U	**970 D**
	07/23/02	15 J	2.5 U	**2.6 J**	**280 J**	**200 J**	2.5 U	2.5 U	2.5 U	**1100 J**
	10/24/02	15 J	2 U	2 U *	**180 J**	**130 J**	2 U	2 U	2 U	**570 J**
	04/29/03	10 D	1.0 U	**1.4 D**	**160 D**	94 D	1.0 U	1.0 U	1.0 U	**780 D**
	10/14/03	14	2.5 U	**1.4 J**	**140**	**140**	2.5 U	2.5 U	2.5 U	**840**
	04/22/04	12	0.12 U	**2 J**	**150**	**130**	0.5 U	0.5 U	0.31 J	**750**
	10/13/04	15	0.12 U	**1.2**	**130 J**	**140 J**	0.11 U	0.12 U	0.23 J	**900 J**
	04/14/05	0.4	0.2 U	0.2 U	0.4	0.6	0.2 U	0.2 U	0.2 U	**4.8**
	10/13/05	13	0.2 U	**0.9**	**100**	91	0.2 U	0.2 U	0.2 U	**830**
	07/10/06	11 DJ	2.5 UJ	**1.1 DJ**	**72 DJ**	**100 DJ**	2.5 UJ	2.5 UJ	2 JD	**820 DJ**
	10/16/06	12	0.5 U	**0.52**	56	92 D	0.5 U	0.5 U	0.14 J	**660 D**
	06/13/07	11	0.5 U	**0.68**	66 D	84 D	0.5 U	0.5 U	0.18 J	**600 D**
	10/18/07	13	0.5 U	**0.63**	69	86 D	0.5 U	0.5 U	0.15 J	**540 D**
	05/13/08	10 D	1.0 U	0.46 D	33 D	67 D	1 U	1 U	0.16 JD	**580 D**
	10/28/08	10 D	1.0 U	0.46 JD	39 D	71 D	1 U	1 U	1 U	**490 D**
	06/18/09	9.6	1 U	0.46	43	73	1 U	1 U	1 U	**570**
	10/27/09	8.3	1 U	0.2 J	14	46	1 U	1 U	1 U	**420**
	06/15/10	9.2	0.5 U	0.46 J	39 J	62 J	0.5 U	0.5 U	0.17 J	**380 J**
	10/25/10	8.4 J	1.3 U	0.4 J	31 J	61 J	1.3 U	1.3 U	1.3 U	**400 J**
	07/18/11	9.1	0.5 U	0.39 J	37	67	0.5 U	0.5 U	0.14 J	**370**
	10/25/11	8.1	0.5 U	0.27 J	31	60	0.5 U	0.5 U	0.5 U	**280**

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
1MW-01	06/12/12	8.4	0.5 U	0.26 J	24	49	0.5 U	0.5 U	0.11 J	**290**
(cont.)	06/23/14	6.1	0.5 U	0.19 J	17	35	0.5 UJ	0.5 U	0.5 U	**280**
MW1-02	08/28/95	1 U	1 U	**4.2**	**1400 J**	23	1 U	1 U	**36 J**	**150 J**
	12/06/95	1 U	1 U	**3.5**	**1300 J**	22	1 U	1 U	**35 J**	**140 J**
	03/11/96	0.5 U	0.5 U	**4.8**	**1800 J**	30 J	0.5 U	0.5 U	**41**	**200 J**
	06/25/96	0.23 J	0.5 U	**5.1 J**	**1500 J**	31 J	0.5 U	0.5 U	**43 J**	**180 J**
	06/11/99	3 U	3 U	**5**	**980**	26	3 U	3 U	**27**	**160**
	10/20/99	0.5 U	0.5 U	**3.4**	**1000**	21	0.5 U	0.5 U	**23**	**110**
	04/25/00	0.5 U	0.5 U	**6**	**1900 J**	49 J	0.5 U	0.5 U	**13**	**230 J**
	06/08/00	0.30 J	0.20 J	**3.2 J**	**890 J**	21 J	0.5 U	0.5 U	**22 J**	**110 J**
	07/24/00	25 U	25 U *	25 U *	**750 J**	25 U	25 U *	25 U	25 U *	**87 J**
	10/31/00	1 U	1 U	**2.2**	**810**	15	1 U	1 U	**12**	**85**
	04/26/01	1 U	1 UJ	**6.3**	**1200 J**	44	1 U	1 UJ	**21**	**120 J**
	06/20/01	0.91 U	1.2 U	**3.6 J**	**950**	18	1.1 U	1.2 U	**19**	**89**
	07/30/01	1 U	1 U	**2.1**	**660 J**	43 J	1 U	1 U	**19**	**130 J**
	10/29/01	1 U	1 U	**2.4**	**700 J**	18	1 U	1 U	**14**	**93**
	04/30/02	2.5 U	2.5 U	**3.6 J**	**1200 J**	29 J	2.5 U	2.5 U	**5 J**	**140 J**
	06/19/02	0.26 J	1.0 U	**2.2 D**	**660 D**	13 D	1.0 U	1.0 U	**15 D**	**75 D**
	07/23/02	1 U	1 U	**2.6 J**	**720 J**	16 J	1 U	1 U	**17 J**	**100 J**
	10/24/02	2.5 U	2.5 U	**2.7 J**	**910 J**	17 J	2.5 U	2.5 U	**21 J**	**120 J**
	04/30/03	2.0 U	2.0 U	**3.4 D**	**870 D**	18 D	2.0 U	2.0 U	**13 D**	**130 D**
	10/15/03	0.26 J	0.5 U	**2.6**	**710**	15	0.5 U	0.5 U	**19**	**120**
	04/22/04	0.37 J	0.12 U	**3.9**	**1200**	22	0.5 U	0.5 U	**14**	**200**
	10/13/04	0.45 J	0.12 U	**3.6**	**930 J**	23	0.11 U	0.12 U	**6.6**	**160 J**
	04/12/05	0.3	0.2 U	**2.2**	**690**	15	0.2 U	0.2 U	**13**	**180**
	10/12/05	0.4	0.2 U	**2.9**	**810**	20	0.2 U	0.2 U	4.1	**140**
	07/10/06	2.5 U	2.5 U	**2.8 D**	**660 D**	17 D	2.5 U	2.5 U	2 JD	**150 D**
	10/16/06	0.33 J	0.5 U	**2**	**560 D**	16	0.5 U	0.5 U	1.3	**110 D**
	06/13/07	0.36 JD	1 U	**2.1 D**	**680 D**	16 D	1 U	1 U	**5.2 D**	**140 D**
	10/18/07	0.28 JD	1 U	**1.9 D**	**590 D**	15 D	1 U	1 U	**9.5 D**	**98 D**
	05/08/08	0.28 J	0.5 U	**1.8**	**460 D**	13	0.5 U	0.5 U	**7.5**	**110 D**
	10/28/08	0.25 JD	1.3 U	**1.8 D**	**420 D**	11 D	1.3 U	1.3 U	**9.1 D**	**88 D**
	06/19/09	0.24 J	1 U	**1.5**	**470**	12	1 U	1 U	**6.4**	**91**
	10/27/09	0.26 J	1 U	**1.8**	**440**	11	1 U	1 U	**6.2**	**91**
	06/15/10	0.27 J	0.5 U	**1.9**	**490 J**	13	0.5 U	0.5 U	**7.5**	**92 J**
	10/25/10	0.24 J	1 U	**1.4 J**	**410 J**	10 J	1 U	1 U	**5.8 J**	**96 J**
	07/19/11	0.37 J	0.5 U	**1.7**	**440**	14	0.5 U	0.5 U	3.2	**94**

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
MW1-02 (cont.)	10/25/11	0.28 J	0.5 U	**1.1**	**360**	9.9	0.5 U	0.5 U	2.3	**67**
	06/12/12	0.35 J	0.5 U	**1.8**	**450**	14	0.5 U	0.5 U	**5.8**	**81**
	06/23/14	0.34 J	0.5 U	**1.5**	**390**	13	0.5 UJ	0.5 U	4.7	**110**
MW1-03	03/08/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/21/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	09/11/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/21/99	NA	NA	NA	NA	NA	NA	NA	NA	NA
	10/20/99	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.7	0.5 U
	04/25/00	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/24/00	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/31/00	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	04/27/01	1 U	1 UJ	1 U *	1 U	1 U	1 U	1 UJ	1 U	1 U *
	07/30/01	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	10/29/01	1 U	1 U	1 U *	1	1.1	1 U	1 U	1 U	**3.3**
	04/30/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/23/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/24/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/29/03	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/14/03	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/21/04	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/13/04	0.091 U	0.12 U	0.12 U	0.12 U	0.15 U	0.11 U	0.12 U	0.12 U	0.23 J
	04/12/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	10/12/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/12/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/16/06	0.5 U	0.5 U	0.3 U	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U	0.09 J
	06/13/07	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/19/07	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	05/07/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/28/08	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/19/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/27/09	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/15/10	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/25/10	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/18/11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/25/11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/12/12	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/23/14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
MW1-04	08/23/95	1 U	1 U	**7.7**	**6400 J**	80 J	2.2	1 U	**11000 J**	**2000 J**
	12/05/95	1 U	1 U	**5.2**	**3900 J**	500 U *	1.7	1 U	**8600 J**	**2800 J**
	03/05/96	.67 J	0.5 UJ	**5.6 J**	**3500 J**	56 J	0.96 J	0.5 UJ	**6300 J**	**1100 J**
	06/20/96	0.64	0.5 U	**13**	**5900 J**	41	4	0.5 U	**22000 J**	**970 J**
	06/14/99	2 J	3 U	**24**	**12000**	**140**	4	3 U	**26000 E**	**1500**
	10/21/99	0.8	0.5 U	**10**	**5300**	70	0.7	0.5 U	**3600**	**1100**
	04/26/00	1.4	0.5 U	**16**	**8500 J**	250 U *	250 U *	250 U *	**18000 J**	**860 J**
	06/13/00	250 U	250 U *	250 U *	**15000 J**	**100 J**	250 U *	250 U *	**38000**	**1300**
	07/25/00	250 U	250 U *	250 U *	**8500 J**	250 U *	250 U *	250 U *	**18000 J**	**860 J**
	11/09/00	1 U	1 U	**0.9 J**	**660**	12	1 U	1 U	**490**	**190**
	04/27/01	1 U	1 UJ	**6.6**	**3700 J**	74 J	0.8 J	1 UJ	**3900 J**	**700 J**
	06/20/01	4.6 U	5.7 U *	**18 J**	**12000**	**110**	5.5 U *	5.6 U	**13000**	**1700**
	07/31/01	1 U	1 U	**2.9**	**2200 J**	95 J	0.6 J	1 U	**2700 J**	**400 J**
	10/30/01	1 U	1 U	**0.5 J**	**270 J**	3	1 U	1 U	**170**	**49**
	05/01/02	2.5 U	2.5 U	2.5 U *	**600 J**	3.7 J	2.5 U	2.5 U	**730 J**	**54 J**
	06/17/02	50 U	50 U *	**30 J**	**15000 D**	**100 D**	50 U *	50 U	**42000 D**	**970 D**
	07/25/02	1 U	1 U	**1.1 J**	**600 J**	2.7 J	1 U	1 U	**580 J**	**95 J**
	10/25/02	0.5 U	0.5 U	**0.8**	**430 J**	3.9	0.5 U	0.5 U	**490 J**	**36 J**
	04/29/03	25 U	25 U *	25 U *	**7000 D**	53 D	25 U *	25 U	**11000 D**	**1100 D**
	10/15/03	13 U	13 U *	**9.0 J**	**4000**	50	13 U *	13 U	**2500**	**1800**
	04/21/04	9.1 U	12 U *	**18 J**	**8100**	71	11 U *	12 U	**20000**	**460**
	10/14/04	1.2	0.12 U	**28**	**15,000 J**	94 J	3.8	0.12 U	**22,000 J**	**770 J**
	04/13/05	0.2 U	0.2 U	200 U *	**10,000**	200 U *	2.3	0.2 U	**16,000**	**800**
	10/13/05	0.2 U	0.2 U	**13**	**8,600**	100 U	1.5	0.2 U	**7,800**	**1,900**
	07/12/06	50 U	50 U *	**16 JD**	**6,300 D**	53 D	50 U *	50 U	**14,000 D**	**540 D**
	10/17/06	0.23 J	0.5 U	**17**	**11,000 D**	77 D	0.63	0.5 U	**3,000 D**	**4,500 D**
	06/14/07	100 U	100 U *	100 U *	**11,000 D**	72 JD	100 U *	100 U	**24,000 D**	**850 D**
	10/17/07	10 U	10 U *	**5 D**	**3,400 D**	23 D	10 U *	10 U	**3,100 D**	**240 D**
	05/07/08	50 U	50 U *	**18 JD**	**7,500 D**	73 D	50 U *	50 U	**24,000 D**	**410 D**
	10/28/08	13 U	13 U *	**4.5 JD**	**3,400 D**	23 D	13 U *	13 U	**6,600 D**	**180 D**
	06/25/09	50 U	50 U *	**23**	**12,000**	93	50 U *	50 U	**30,000**	**510**
	10/27/09	5 U	5 U	**3.4 J**	**1,600**	10	5 U	5 U	**2,000**	**100**
	06/16/10	50 U	50 U *	**25 J**	**17,000 J**	**170 J**	50 U *	50 U	**32,000 J**	**960 J**
	10/25/10	13 U	13 U *	**4.8 J**	**2,700 J**	21 J	13 U *	10 U	**5,400 J**	**130 J**
	07/18/11	50 U	50 U *	**17 J**	**11,000**	95	50 U *	50 U	**22,000**	**440**
	10/25/11	2.5 U	2.5 U	**1.6 J**	**840**	6.3	2.5 U	2.5 U	**390**	**56**
	06/12/12	25 U	25 U *	**7 J**	**7,000**	46	25 U *	25 U	**16,000**	**130**

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
MW1-04 (cont.)	06/17/13	25 U	25 U *	**8.5 J**	**7,700**	46	25 U *	25 U	**15,000**	**130**
	06/17/14	10 U	10 U *	**4.2 J**	**3,500**	27	10 U *	10 U	**6,100**	**110**
MW1-05	08/23/95	5.8 J	1 U	1 U *	17	1.3	1 U	1 U	1.9	**140**
	12/05/95	110 J	1 U	1 U *	**74 J**	16	1 U	1 U	**7.3**	**4300 J**
	03/06/96	34	0.5 U	0.5 U	60	7	0.5 U	0.5 U	3	**1100**
	06/20/96	29 J	0.5 U	0.24 J	**93 J**	6.5	0.5 U	0.5 U	1.7	**1500 J**
	06/14/99	9	3 U	3 U *	9	2 J	3 U	3 U	2 J	**260**
	10/21/99	9.6	0.5 U	0.5 U	0.50	0.50	0.5 U	0.5 U	0.5 U	**18**
	04/25/00	1.1	0.5 U	0.5 U	1.2	0.5 U	0.5 U	0.5 U	0.5 U	**30**
	06/07/00	6.9	0.5 U	0.5 U	1.8	0.64	0.5 U	0.5 U	1.6	**22**
	07/25/00	1.8	0.5 U	0.5 U	3.4	0.5 U	0.5 U	0.5 U	0.5 U	**31**
	11/06/00	1.7	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	**7**
	04/26/01	1 U	1 UJ	1 U *	1 U	1 U	1 U	1 UJ	1 U	**24**
	06/20/01	1.5	0.12 U	0.12 U	0.46 J	0.28 J	0.11 U	0.12 U	0.46 J	**32**
	07/31/01	0.5 J	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	**13**
	10/30/01	1.7	1 U	1 U *	0.5 J	1 U	1 U	1 U	1 U	**3.5**
	05/01/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**1.7**
	06/17/02	0.93	0.5 U	0.5 U	0.74	0.16 J	0.5 U	0.5 U	0.85	**11**
	07/24/02	0.65	0.5 U	0.5 U	0.63 J	0.5 U	0.5 U	0.5 U	0.66	**2.5**
	10/25/02	15	0.5 U	0.5 U	0.82	0.5 U	0.5 U	0.5 U	0.8	**5.6**
	04/29/03	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**5.1**
	10/15/03	2.0	0.5 U	0.5 U	0.41 J	0.22 J	0.5 U	0.5 U	0.24 J	**3.1**
	04/22/04	0.24 J	0.12 U	0.12 U	0.27 J	0.14 U	0.11 U	0.12 U	0.24 J	**0.83**
	10/14/04	1.4	0.12 U	0.12 U	0.56	0.31 J	0.11 U	0.12 U	0.55	**2**
	04/13/05	0.2 U	0.2 U	0.2 U	2	0.2 U	0.2 U	0.2 U	**10**	**0.9**
	10/12/05	3.0	0.2 U	0.2 U	0.7	0.2 U	0.2 U	0.2 U	0.5	**5.9**
	07/12/06	0.48 J	0.5 U	0.2 U	0.40 J	0.5 U	0.5 U	0.5 U	0.5 U	**0.91**
	10/16/06	6.8	0.5 U	0.3 U	0.9	0.4 J	0.5 U	0.5 U	0.65	**11**
	06/14/07	0.44 J	0.5 U	0.5 U	0.27 J	0.5 U	0.5 U	0.5 U	0.27 J	**0.7**
	10/17/07	2.1	0.5 U	0.2 U	0.55	0.17 J	0.5 U	0.5 U	0.34 J	**4**
	05/12/08	0.16 J	0.5 U	0.2 U	0.26 J	0.10 J	0.5 U	0.5 U	0.27 J	0.42
	10/29/08	1.4	0.5 U	0.5 U	0.54	0.24 J	0.5 U	0.5 U	0.39 J	**2.2**
	06/26/09	3.4	0.5 U	**0.59**	0.51	0.59	0.5 U	0.5 U	0.47 J	**6.6**
	10/27/09	0.97	0.5 U	0.5 U	0.44 J	0.23 J	0.5 U	0.5 U	0.44 J	**1.9**
	06/16/10	2.6	0.5 U	0.5 U	0.62	0.55	0.5 U	0.5 U	0.52	**8.1**
	10/25/10	0.37 J	0.5 U	0.5 U	0.35 J	0.5 U	0.5 U	0.5 U	0.32 J	**0.74**
	07/18/11	1.9	0.5 U	0.5 U	0.6	0.47 J	0.5 U	0.5 U	0.42 J	**9.4**

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
MW1-05 (cont.)	10/26/11	1.4	0.5 U	0.5 U	0.46 J	0.16 J	0.5 U	0.5 U	0.4 J	**3.6**
	06/12/12	0.25 J	0.5 U	0.5 UJ	0.24 J	0.1 J	0.5 U	0.5 U	0.27 J	**2.2**
	06/17/13	0.1 J	0.5 U	0.5 U	0.19 J	0.5 U	0.5 U	0.5 U	0.16 J	0.31 J
	06/17/14	0.78	0.5 U	0.5 U	0.85	0.2 J	0.5 U	0.5 U	0.24 J	**17**
MW1-09	08/21/95	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	12/05/95	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	03/05/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/07/00	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 J	0.5 U
	06/17/02	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.2 U
	04/23/04	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.2 U
	07/13/06	0.5 UJ	0.5 UJ	0.2 UJ	0.17 J	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.2 UJ
	05/12/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/16/10	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/14/12	0.5 U	0.5 U	0.5 UJ	0.14 J	0.5 U	0.17 J	0.5 U	0.5 U	0.5 U
	06/24/14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U
MW1-16	08/31/95	**12000 J**	**15 J**	**680 J**	**14000 J**	**520 J**	0.51 J	**5600 J**	**250 J**	**12000 J**
	06/20/96	**30000 J**	**35 J**	**180 J**	**3100 J**	**180 J**	1.3 J	**430 J**	**34 J**	**2200 J**
	06/14/99	**15000**	**17**	**48**	**6800**	**160**	1 J	140	**530**	**1700**
	10/21/99	**6500**	**9**	**5**	28	26	1.2	23	**9.2**	**28**
	04/26/00	**1700 J**	0.5 U	0.5 U	**70 J**	7.4	0.69	16	3.3	**4.3**
	06/07/00	**2500**	2.7	**2 J**	13	13	1 J	29	**20**	**6.6**
	07/25/00	**2300 J**	50 U *	50 U *	50 U	50 U	50 U *	50 U	50 U *	50 U *
	11/06/00	**3900**	4.2	**1.3**	12	16	1 U	21 J	4.1	1 U *
	04/27/01	**1100 J**	1.6 J	1 U *	2.4	7.5	0.4 J	7.2 J	2.2	**19**
	06/20/01	**2900**	**7 J**	**23 J**	**9300**	98	5.5 U *	28	**370**	**1400**
	07/31/01	**1900 J**	1.9	**2.2**	60	12	1 U	15	**8.3**	**68 J**
	10/30/01	**3400 J**	4.1	**2.1**	13	17	1 U	13	3.5	**11**
	05/01/02	**1200 J**	2.5 U	2.5 U *	3.9 J	7.9 J	2.5 U	5.6 J	2.5 U	**2.7 J**
	06/17/02	**10000 D**	50 U *	**42 J**	**24000 D**	**240 D**	50 U *	38 J	**150 D**	**3000D**
	07/24/02	**3200 J**	5 U *	5 U *	**340 J**	17 J	5 U	10 J	**5.5 J**	**86 J**
	10/25/02	**9000 J**	25 U *	25 U *	**190 J**	38 J	25 U *	25 U	25 U *	**80 J**
	04/29/03	330 D	0.5 U	0.5 U	1.6	3.9	0.5 U	0.52	1.3	**2.1**
	10/15/03	**1700**	5.0 U	5.0 U *	6.2	13	5.0 U	5.3	2.4 J	**5.5**
	04/21/04	160	0.21 J	0.24 J	1.8	3	0.13 J	0.20 J	1	**1.7**
	10/13/04	**4200 J**	3.7	**1.1**	11	23	0.42 J	10	4.5	**9.3**
	04/13/05	88	0.2 U	0.2 U	1.2	2.8	0.2 U	0.2 U	0.6	**0.6**
	10/13/05	220	0.2 J	0.2 J	13 J	7.0 J	0.2 U	0.2 U	2.0 J	**5.9 J**

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
MW1-16 (cont.)	07/14/06	240 D	1 U	0.40 D	3.3 D	3.2 D	1 U	1 U	1.2 D	**2.8 D**
	10/17/06	**1000 D**	0.47 J	**0.63**	**440 D**	26	0.13 J	0.23 J	2.6	**290 D**
	06/14/07	40	0.5 U	0.13 J	1.6	2.2	0.5 U	0.5 U	0.7	**0.89**
	10/17/07	98 D	2.5 U	1 U *	6.5 D	6.1 D	2.5 U	2.5 U	1.8 JD	**2.5 D**
	05/12/08	17	0.5 U	0.14 J	1.1	1.9	0.5 U	0.5 U	0.65	**0.68**
	10/29/08	68 D	0.14 JD	0.20 JD	12 D	6.7 D	1.0 U	1.0 U	1.0 D	**6.3 D**
	06/25/09	37	0.5 U	0.23	29	2.6	0.5 U	0.08 J	3.1	**11**
	10/27/09	68	1 U	0.4 J	35	4.2	1 U	1 U	3.2	**13**
	06/16/10	92 J	0.5 U	0.5 U	0.95	2.8	0.5 U	0.2 J	0.57	0.47 J
	10/25/10	52	0.5 U	0.08 J	8.1	2.2	0.5 U	0.5 U	0.43 J	**4**
	07/18/11	5.3	0.5 U	0.1 J	1.6	1.1	0.5 U	0.5 U	0.39 J	**0.72**
	10/25/11	**1,500**	1.3 J	**1.2 J**	**1,300**	34	2.5 U	0.85 J	1.4 J	**360**
	06/12/12	28	0.5 U	0.5 UJ	1.3	0.65	0.5 U	0.5 U	0.21 J	0.26 J
	06/17/13	15	0.5 U	0.15 J	14	1.8	0.5 U	0.5 U	0.32 J	**4.8**
	06/17/14	2.5	0.5 U	0.5 U	0.63	0.39 J	0.5 U	0.5 U	0.11 J	0.29 J
MW1-17	08/29/95	1 U	1 U	1 U *	6.4	0.93 J	1 U	1 U	1 U	**6.9**
	12/04/95	1 U	1 U	1 U *	5.1	1 U	1 U	1 U	1 U	**4.3**
	03/06/96	0.5 U	0.5 U	0.5 U	0.32 J	0.29 J	0.5 U	0.5 U	0.5 U	0.47 J
	06/24/96	0.5 U	0.20 J	0.5 U	1.4 U	0.51	0.40 J	0.5 U	0.5 U	1.2 U *
	06/07/00	0.10 J	0.5 U	0.5 U	0.5 U	0.64	0.5 U	0.5 U	0.30 J	0.5 U *
	06/20/01	0.12 J	0.12 U	0.12 U	0.12 U	0.71	0.11 U	0.12 U	0.12 U	0.22 U
	06/17/02	0.11 J	0.5 U	0.5 U	0.5 U	0.43 J	0.5 U	0.5 U	0.5 U	**0.66**
	04/29/03	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**1.4**
	04/22/04	0.091 U	0.12 U	0.12U	3.4	0.31 J	0.5 U	0.5 U	0.89	**3.8**
	04/14/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/10/06	0.5 UJ	0.5 UJ	0.25 J	50 J	0.23 J	0.5 UJ	0.5 UJ	0.5 UJ	**14 J**
	06/14/07	0.5 U	0.5 U	0.31 J	**76 D**	0.5 U	0.5 U	0.5 U	0.5 U	**14**
	05/07/08	0.5 U	0.5 U	0.19 J	33	0.14 J	0.5 U	0.5 U	0.5 U	**5.9**
	06/18/09	0.5 U	0.5 U	0.43	**100**	0.22 J	0.5 U	0.5 U	0.13 J	**18**
	06/15/10	0.5 U	0.5 U	0.42 J	61 J	0.16 J	0.5 U	0.5 U	0.5 U	**15**
	07/18/11	0.5 U	0.5 U	0.42 J	**90**	0.18 J	0.5 U	0.5 U	0.5 U	**15**
	06/12/12	0.5 U	0.5 U	**1.4 J**	**360**	0.34 J	0.5 U	0.5 U	0.2 J	**40**
	06/17/13	0.5 U	0.5 U	**1.9**	**430**	0.55	0.5 U	0.5 U	0.46 J	**89**
	06/18/14	0.5 U	0.5 U	**1.5**	**360**	0.31 J	0.5 U	0.5 U	0.5 U	**62**
MW1-20	08/30/95	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	12/08/95	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	03/11/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
MW1-20 (cont.)	06/27/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/21/99	NA	NA	NA	NA	NA	NA	NA	NA	NA
	10/21/99	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/26/00	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/25/00	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/31/00	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	04/27/01	NA	NA	NA	NA	NA	NA	NA	NA	NA
	07/31/01	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	10/30/01	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	05/01/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/25/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/25/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/29/03	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/14/03	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/21/04	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	10/13/04	0.091 U	0.12 U	0.12 U	0.12 U	0.15 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/13/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	10/12/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/12/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/16/06	0.5 U	0.5 U	0.3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.05 J
	06/13/07	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/19/07	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	05/07/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/28/08	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/24/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/27/09	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/15/10	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/25/10	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/18/11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/25/11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/12/12	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/17/13	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/17/14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MW1-25	08/17/95	4.8	1 U	**7.3**	**440 R**	35 R	1 U	1 U	**98 R**	**340 R**
	12/06/95	3.9	1 U	**6.1**	**630 R**	38 R	1 U	1 U	**74 R**	**230 R**
	03/11/96	0.50 U	0.50 U	**1.1**	**260**	6.3	0.50 U	0.50 U	**11**	**44**
	06/25/96	0.50 U	0.50 U	**4.7 J**	**630 R**	45 R	0.50 U	0.50 U	**74 R**	**240 R**

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
MW1-25 (cont.)	06/08/00	6.9	0.30 J	**7.2**	**2000**	41	0.50 U	0.50 U	**39**	**260**
	08/06/02	8.6 J	10 U *	**7.6 J**	**2000 D**	41 D	10 U *	10 U	**20 D**	**240 D**
	06/19/03	67 U	NA	67 U *	**1800**	34	67 U *	67 U	**14**	**210**
	04/22/04	5.9 D	2.5 U	**6.6 D**	**1600 D**	33 D	2.5 U	2.5 U	**7.5 D**	**170 D**
	07/13/06	6 D	5 U	**7.3 D**	**1,700 D**	37 D	5 U *	5 U	4.3 JD	**270 D**
	05/08/08	4.5 D	2.5 U	**4.8 D**	**1,200 JD**	28 D	2.5 U	2.5 U	1.3 JD	**210 D**
	06/16/10	4.2 J	2.5 U	**5.1 J**	**1,400 J**	28 J	2.5 U	2.5 U	1.9 J	**180 J**
	06/23/14	4.9	2.5 U	**5.7**	**1,300**	27	2.5 UJ	2.5 U	0.95 J	**220**
MW1-28	12/07/95	1.1	1 U	**5.1**	**720 R**	58 R	1 U	1 U	2.3	**420 R**
	03/08/96	2.1	0.50 U	**5**	**320**	78	0.50 U	0.50 U	1.6	**480**
	06/25/96	2.4 J	0.50 U	**6.3 J**	**540 R**	78 R	0.50 U	0.50 U	2.2 J	**480 R**
	09/09/96	2.3	0.50 U	**5.4**	**510 R**	66 R	0.50 U	0.50 U	1.2	**540 R**
	06/07/00	3.2	0.50 U	**5.1**	**1300 J**	74	0.50 U	0.50 U	0.81	**520**
	08/06/02	4.6 J	10 U *	**5.4 J**	**1500 D**	84 D	10 U *	10 U	10 U *	**600 D**
	06/19/03	50 U	NA	50 U *	**1200**	34	50 U *	50 U	50 U *	**470**
	04/22/04	3.9	0.50 U	**5.3**	**1300 D**	71 D	0.50 U	0.50 U	0.52	**540 D**
	07/13/06	6.1 D	5 U	**7.2 D**	**1,500 D**	94 D	5 U	5 U	1.6 JD	**710 D**
	05/08/08	6.1 D	2.5 U	**5.7 D**	**1,400 D**	78 D	2.5 U	2.5 U	0.90 JD	**650 D**
	06/17/10	6.3 J	2.5 U	**6.4 J**	**1,700 J**	94 J	2.5 U	2.5 U	0.7 J	**550 J**
	06/24/14	6.2 J	2.5 U	**5.9 J**	**1,600 J**	94 J	2.5 UJ	2.5 U	0.75 J	**560 J**
MW1-38	06/19/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/27/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	09/10/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/23/04	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/13/06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	05/12/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/17/10	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/13/12	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/24/14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U
MW1-39	06/17/96	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.80**
	06/27/96	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	1 U *
	09/10/96	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.76**
	06/08/00	0.50 U	0.50 U	0.50 U	0.40 J	0.50 U	0.50 U	0.50 U	0.50 U	**2**
	08/06/02	0.50 U	0.50 U	0.50 U	0.32 J	0.50 U	0.50 U	0.50 U	0.50 U	**1.8**
	06/19/03	1.0 U	NA	1.0 U *	0.56	1.0 U	1.0 U	1.0 U	1.0 U	**1.3**
	04/23/04	0.50 U	0.50 U	0.50 U	0.33 J	0.50 U	0.50 U	0.50 U	0.50 U	**2**
	07/13/06	0.5 U	0.5 U	0.2 U	0.45 J	0.5 U	0.5 U	0.5 U	0.5 U	**2.7**

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
MW1-39 (cont.)	05/12/08	0.5 U	0.5 U	0.2 U	0.43 J	0.5 U	0.5 U	0.5 U	0.5 U	**2.3**
	06/17/10	0.5 U	0.5 U	0.5 U	0.6	0.5 U	0.5 U	0.5 U	0.5 U	**1.9**
	06/13/12	0.5 U	0.5 U	0.5 U	0.9	0.5 U	0.5 U	0.5 U	0.5 U	**2**
	06/24/14	0.5 U	0.5 U	0.5 U	0.94	0.5 U	0.5 UJ	0.5 U	0.5 U	**2.1**
MW1-41	06/21/99	NA	NA	NA	NA	NA	NA	NA	NA	NA
	10/21/99	0.5 U	0.5 U	0.5 U	0.60	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/26/00	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/08/00	0.20 J	0.5 U	0.5 U	0.82	0.5 U	0.5 U	0.5 U	0.5 U	**0.53**
	07/24/00	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	11/02/00	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	04/26/01	1 U	1 UJ	1 U *	1 U	1 U	1 U	1 UJ	1 U	1 U *
	06/20/01	0.10 J	0.12 U	0.12 U	0.40 J	0.14 U	0.11 U	0.12 U	0.12 U	0.40 J
	07/30/01	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	**0.6 J**
	10/29/01	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	**0.5 J**
	04/30/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/19/02	0.5 U	0.5 U	0.5 U	0.41 J	0.5 U	0.5 U	0.5 U	0.5 U	0.43 J
	07/23/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/25/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/30/03	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/15/03	0.5 U	0.5 U	0.5 U	0.37 J	0.5 U	0.5 U	0.5 U	0.5 U	0.28 J
	04/22/04	0.091 U	0.12 U	0.12 U	0.30 J	0.14 U	0.11 U	0.12 U	0.12 U	0.30 J
	10/13/04	0.1 J	0.12 U	0.12 U	0.41 J	0.15 U	0.11 U	0.12 U	0.12 U	0.35 J
	04/12/05	0.2 U	0.2 U	0.2 U	0.3	0.2 U	0.2 U	0.2 U	0.2 U	0.3
	10/12/05	0.2 U	0.2 U	0.2 U	0.5	0.2 U	0.2 U	0.2 U	0.2 U	0.3
	07/10/06	0.5 U	0.5 U	0.2 U	0.26 J	0.5 U	0.5 U	0.5 U	0.5 U	0.23
	10/16/06	0.5 U	0.5 U	0.3 U	0.34 J	0.5 U	0.5 U	0.5 U	0.5 U	0.22
	06/13/07	0.5 U	0.5 U	0.2 U	0.25 J	0.5 U	0.5 U	0.5 U	0.5 U	0.21
	10/18/07	0.5 U	0.5 U	0.2 U	0.31 J	0.5 U	0.5 U	0.5 U	0.5 U	0.18 J
	05/08/08	0.5 U	0.5 U	0.2 U	0.27 J	0.11 J	0.5 U	0.5 U	0.5 U	0.19 J
	10/28/08	0.080 J	0.5 U	0.5 U	0.32 J	0.12 J	0.5 U	0.5 U	0.5 U	0.16 J
	06/19/09	0.5 U	0.5 U	0.2 U	0.26 J	0.07 J	0.5 U	0.5 U	0.5	0.2
	10/27/09	0.5 U	0.5 U	0.5 U	0.28 J	0.1 J	0.5 U	0.5 U	0.5 U	0.17 J
	06/15/10	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J
	10/25/10	0.5 U	0.5 U	0.5 U	0.29 J	0.5 U	0.5 U	0.5 U	0.5 U	0.18 J
	07/18/11	0.5 U	0.5 U	0.5 U	0.26 J	0.08 J	0.5 U	0.5 U	0.5 U	0.16 J
	10/25/11	0.5 U	0.5 U	0.5 U	0.23 J	0.09 J	0.5 U	0.5 U	0.5 U	0.12 J

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		**800**	**5**	**0.5**	**70**	**100**	**5**	**200**	**5**	**0.50**
RG (Surface Water)		**NE**	**59**	**1.9**	**NE**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
Navy Well #5	12/08/95	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	03/03/98	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/02/99	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/07/00	0.5 U	0.5 U	0.5 U	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/19/01	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	06/27/02	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/30/03	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/23/04	0.091 U	0.12 U	0.12 U	0.14 J	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	06/16/04	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/14/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/14/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/15/07	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U *
	05/09/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/18/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/16/10	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/18/11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/13/12	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/19/13	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U
	06/24/14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U
PUD Well	12/08/95	1 U	1 U	1 U *	1 U	1 U	1 U	1 U	1 U	1 U *
	03/03/98	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/02/99	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/08/00	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/19/01	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	07/01/02	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/30/03	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/23/04	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/14/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/14/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/14/07	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	05/09/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/17/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/16/10	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/19/11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/13/12	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/19/13	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U
	06/25/14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U

Table B-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2014

Notes:
Shaded row indicates data evaluated in this 5-year review period.
Bolded value exceeds or is equal to the RG for drinking water.
Yellow highlighted value exceeds or is equal to the surface water RG.
Data from 1995 to April 2004 are from U.S. Navy 2005a, from October 2004 through 2008 are from U.S. Navy 2008a and 2009g, from 2009 are from U.S. Navy 2009h, and from 2010 through 2014 are from U.S. Navy 2015a.
* - The reporting limit exceeds the RG
D - The reported result is from a dilution.
DCA - dichloroethane
DCE - dichloroethene
E - The value shown exceeds the instrument calibrating range.
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
MDL - method detection limit
µg/L - microgram per liter
MRL - method reporting limit
NA - not analyzed
PCE - tetrachloroethene
R - Quality control indicates the data are not usable.
RG - remediation goal
TCA - trichloroethane
TCE - trichloroethene
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table B-2
Summary of 1,4-Dioxane Analytical Results for OU 1 Groundwater Sampling in 2006, 2012, and 2014

Location	Sampling Date	1,4-Dioxane[a] (µg/L)
1MW-01	07/10/06	1.1
MW1-02	07/10/06	14
MW1-03	07/12/06	1.0 U*
MW1-04	07/12/06	1.0 U*
MW1-05	07/12/06	1.0 U*
MW1-09	07/13/06	1.0 U*
	06/14/12	1.0 U*
	06/24/14	1.0 U*
MW1-16	07/14/06	1.0 U*
MW1-17	07/10/06	1.0
MW1-20	07/12/06	1.0 U*
MW1-25	07/13/06	29
MW1-28	07/13/06	29
MW1-38	07/13/06	4.1
	06/13/12	2.5
	06/24/14	2.3
MW1-39	07/13/06	1.9
	06/13/12	1.2
	06/24/14	1.1
MW1-41	07/10/06	8.5
Navy Well #5	07/14/06	1.0 U*
	06/24/14	1.0 U*
PUD Well	07/14/06	1.0 U*
	06/25/14	1.0 U*

[a]No remediation goal was established for 1,4-dioxane. The current Model Toxics Control Act cleanup level for 1,4-dioxane is 0.44 µg/L.

Notes:
*Reporting limit exceeds MTCA Method B cleanup level.
Shaded row indicates data evaluated in this 5-year review period.
Data from 2006 are from U.S. Navy 2007b and from 2012 and 2014 are from U.S. Navy 2015a.
µg/L - microgram per liter
U - The compound was analyzed for, but was not detected ("nondetected") at or above the method reporting limit/method detection limit.

Table B-3
Summary of Piezometer and Passive Sampler Volatile Organic Compounds Detected in Groundwater at OU 1

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,2-DCA	1,1,1-TCA	1,1-DCA	1,1-DCE	cis-1,2-DCE	PCE	trans-1,2-DCE	TCE	Vinyl chloride
RG (Drinking water)		**5**	**200**	**800**	**0.5**	**70**	**5**	**100**	**5**	**0.5**
RG (Surface water)		**59**	**41,700**	**--**	**1.9**	**--**	**4.2**	**33,000**	**56**	**2.9**
North Plantation										
P1-1	6/14/2010	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
	6/20/2011	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
	6/4/2012	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
	7/9/2013	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
	6/24/2014	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
P1-3	6/14/2010	<0.2	<0.1	0.2	<0.1	<0.1	<0.1	0.2	<0.1	<0.2
	6/20/2011	<0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4
	6/4/2012	<0.2	<0.1	E0.1	<0.1	0.2	<0.1	0.2	<0.1	<2.0 *
	7/9/2013	<2.0	<1.0	<1.0	<1.0 *	<1.0	<1.0	<1.0	<1.0	<2.0 *
	6/24/2014	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
P1-4	6/14/2010	<4.0	<2.0	<2.0	<2.0 *	**1,200**	<2.0	16.9	<2.0	**314**
	6/20/2011	<20.0 *	<10.0	<10.0	<10.0 *	**895**	<10.0 *	28.7	<10.0 *	**192**
	6/4/2012	<20.0 *	<10.0	<10.0	<10.0 *	**1,000**	<10.0 *	15.5	<10.0 *	**249**
	7/9/2013	<20.0 *	<10.0	<10.0	<10.0 *	**630**	<10.0 *	14	<10.0 *	**146**
	6/24/2014	<2.0	<1.0	<1.0	**1.3**	**686**	<1.0	11	<1.1	**294**
P1-5	6/14/2010	<4.0	<2.0	<2.0	<2.0 *	<2.0	<2.0	<2.0	<2.0	<4.0 *
	6/20/2011[a]	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
	6/20/2011	<4.0	<2.0	<2.0	<2.0 *	<2.0	<2.0	<2.0	<2.0	<4.0 *
	6/4/2012	0.4	<0.1	0.1	<0.1	0.2	<0.1	0.5	<0.1	<0.2
	7/9/2013	0.4	<0.1	0.1	<0.1	0.1	<0.1	0.4	<0.1	<0.2
	6/24/2014	E0.4	<0.1	0.2	<0.1	0.1	<0.1	0.4	<0.1	<0.2
South Plantation										
P1-6	6/15/2010	<20.0 *	<10.0	211	<10.0 *	**8,600**	<10.0 *	78.2	**23.2**	**2,860**
	6/21/2011	<20.0 *	<10.0	74.3	<10.0 *	**2,020**	<10.0 *	32	<10.0 *	**1,470**
	6/6/2012	<20.0 *	<10.0	4.2	<10.0 *	**78.5**	<10.0 *	<10.0	<10.0 *	**151**
	7/10/2013	<20.0 *	<10.0	35.1	<10.0 *	**1,540**	<10.0 *	18.1	<10.0 *	**1,060**
	6/23/2014	<20.0 *	<10.0	172	<10.0 *	**3,420**	<10.0 *	60.7	<10.0 *	**3,800**
P1-7	6/15/2010	<100 *	<50.0	<50.0	<50.0 *	**27,700**	<50.0 *	**184**	**10,900**	**3,480**
	6/21/2011	<200 *	<100	<100	<100 *	**18,500**	<100 *	**305**	**7,580**	**1,640**
	6/5/2012	<200 *	<100	<100	<100 *	**19,000**	<100 *	**129**	**9,230**	**2,380**
	6/5/2012[a]	<200 *	<100	<100	<100 *	**20,200**	<100 *	**125**	**9,950**	**2,530**
	7/10/2013	<200 *	<100	<100	<100 *	**53,500**	<100 *	**259**	**23,900**	**4,360**
	6/23/2014	<200 *	<100	<100	<100 *	**55,700**	<100 *	**305**	**33,800**	**6,850**
P1-8	6/15/2010	<2.0	<1.0	<1.0	<1.0 *	**188**	<1.0	<1.0	<1.0	**147**
	6/21/2011	<20.0 *	<10.0	<10.0	<10.0 *	**9,090**	<10.0 *	70.5	<10.0 *	**774**
	6/6/2012	<20.0 *	<10.0	<10.0	<10.0 *	39.1	<10.0 *	<10.0	<10.0 *	**120**

Table B-3 (Continued)
Summary of Piezometer and Passive Sampler Volatile Organic Compounds Detected in Groundwater at OU 1

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,2-DCA	**1,1,1-TCA**	**1,1-DCA**	**1,1-DCE**	**cis-1,2-DCE**	**PCE**	**trans-1,2-DCE**	**TCE**	**Vinyl chloride**
RG (Drinking water)		**5**	**200**	**800**	**0.5**	**70**	**5**	**100**	**5**	**0.5**
RG (Surface water)		**59**	**41,700**	**--**	**1.9**	**--**	**4.2**	**33,000**	**56**	**2.9**
P1-8 (cont.)	7/10/2013	<20.0 *	<10.0	<10.0	<10.0 *	20.9	<10.0 *	<10.0	<10.0 *	**99.7**
	7/10/2013[a]	<20.0 *	<10.0	<10.0	<10.0 *	61.4	<10.0 *	<10.0	<10.0 *	**142**
	6/23/2014	<2.0	<1.0	<1.0	<1.0 *	18.7	<1.0	<1.0	<1.0	**88**
P1-9	6/14/2010	<20.0 *	<10.0	<10.0	<10.0 *	**7,090**	<10.0 *	28.8	**1,720**	**660**
	6/21/2011	<400 *	<200	<200	<200 *	**30,900**	<200 *	**262**	**10,200**	**2,590**
	6/5/2012	<400 *	<200	<200	<200 *	**495**	<200 *	<10.0	**193**	**107**
	6/5/2012[a]	<400 *	<200	<200	<200 *	**1,430**	<200 *	11.3	**581**	**219**
	7/10/2013[b]	<2.0	<1.0	<1.0	<1.0 *	**397**	<1.0	4.2	**95.3**	**54.4**
	6/23/2014	<2.0	<1.0	<1.0	**1.7**	**1,740**	<1.0	17.8	**906**	**356**
P1-10	6/14/2010	<20.0 *	<10.0	<10.0	<10.0 *	**940**	<10.0 *	16.2	**4,130**	**43.2**
	6/21/2011	<20.0 *	<10.0	<10.0	<10.0 *	**936**	<10.0 *	12.7	**423**	**182**
	6/5/2012	<20.0 *	<10.0	<10.0	<10.0 *	**4,390**	<10.0 *	19.6	**92.7**	**996**
	7/10/2013	<20.0 *	<10.0	<10.0	<10.0 *	**1,660**	<10.0 *	20	**84.2**	**787**
	6/23/2014	<20.0 *	<10.0	<10.0	<10.0 *	**1,040**	<10.0 *	17.7	**287**	**1,150**
S-1	6/18/2010	<0.2	<0.1	1.4	<0.1	5.3	<0.1	0.8	0.7	**13.4**
	10/19/2012	<0.2	<0.1	0.7	<0.1	7.9	<0.1	0.3	3.6	0.2
	7/18/2013[a]	<0.2	<0.1	1	<0.1	1.1	<0.1	0.1	<0.1	1.4
S-2	6/18/2010	<2.0	<1.0	2.1	<1.0 *	**549**	<1.0	21.8	**41.7**	**91**
	10/19/2012	<0.2	<0.1	1.1	<0.1	13.4	<0.1	1.2	**5.5**	**0.9**
	10/19/2012[a]	<0.2	<0.1	0.8	<0.1	6.4	<0.1	0.2	1.4	**1**
	7/18/2013	<0.2	<0.1	0.6	<0.1	1.3	<0.1	<0.1	0.2	**2.2**
	9/4/2014	--	<0.1	0.6	<0.1	1.1	<0.1	<0.1	0.1	**2.1**
S-2B	6/18/2010	<0.2	<0.1	2.8	<0.1	25.7	<0.1	2.2	1.9	**15.1**
	10/19/2012	<0.2	<0.1	1	<0.1	0.6	<0.1	0.5	0.2	**0.8**
	7/18/2013	<0.2	<0.1	12.8	<0.1	2	<0.1	2.7	0.3	**216**
	9/4/2014	--	<1.0	10.3	<1.0 *	<1.0	<1.0	1.9	<1.0	**16**
S-3	6/18/2010	<2.0	<1.0	63.5	<1.0 *	13.3	<1.0	6.7	<1.0	**181**
	10/19/2012	<0.2	<0.1	0.2	<0.1	0.8	<0.1	0.8	0.2	0.4
	7/18/2013	<0.2	<0.1	0.2	<0.1	0.3	<0.1	0.3	0.1	**0.9**
	9/4/2014	--	<0.1	0.1	<0.1	0.2	<0.1	0.1	<0.1	0.4
S-3B	6/18/2010	<0.2	<0.1	0.3	<0.1	27.6	<0.1	1.6	3.2	**14.3**
	10/19/2012	<0.2	<0.1	0.3	<0.1	4.5	<0.1	0.2	1	0.4
	7/18/2013	<0.2	<0.1	0.1	<0.1	1.2	<0.1	<0.1	<0.1	**0.8**
	9/4/2014	--	<0.1	0.1	<0.1	1.1	<0.1	<0.1	<0.1	<0.2
S-4	6/18/2010	<0.2	<0.1	<0.1	<0.1	3.9	<0.1	0.4	0.1	**5.8**
	10/19/2012	<20.0 *	<10.0	11.3	**64**	**73,200**	<10.0 *	**492**	**23,200**	**5,130**
	10/19/2012[a]	<20.0 *	<10.0	10.3	13.7	**20,900**	<10.0 *	89.9	**141**	**3,200**

Table B-3 (Continued)
Summary of Piezometer and Passive Sampler Volatile Organic Compounds Detected in Groundwater at OU 1

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,2-DCA	**1,1,1-TCA**	**1,1-DCA**	**1,1-DCE**	**cis-1,2-DCE**	**PCE**	**trans-1,2-DCE**	**TCE**	**Vinyl chloride**
RG (Drinking water)		**5**	**200**	**800**	**0.5**	**70**	**5**	**100**	**5**	**0.5**
RG (Surface water)		**59**	**41,700**	**--**	**1.9**	**--**	**4.2**	**33,000**	**56**	**2.9**
S-4 (cont.)	7/18/2013	<20.0 *	<10.0	<10.0	<10.0 *	**3,120**	<10.0 *	21.6	<10.0 *	**108**
	9/4/2014	--	<100	<100	<100 *	**46,000**	<100 *	**302**	<100 *	**13,200**
S-4B	6/18/2010	<0.2	<0.1	<0.1	<0.1	1	<0.1	<0.1	0.2	<0.2
	10/19/2012	<2.0	<1.0	<1.0	<1.0 *	**297**	<1.0	<1.0	2	**80.1**
	7/18/2013	<2.0	<1.0	<1.0	<1.0 *	**422**	<1.0	3.3	**40.5**	**122**
	9/4/2014	--	<1.0	<1.0	<1.0 *	**416**	<1.0	1.5	<1.0	**191**
S-5	6/18/2010	<0.2	<0.1	<0.1	<0.1	1.2	<0.1	<0.1	0.4	0.3
	10/19/2012	<2.0	<1.0	<1.0	<1.0 *	**1,210**	<1.0	4.4	**111**	**51.7**
	7/18/2013	<0.2	<0.1	<0.1	0.2	19.5	<0.1	0.1	2.7	**23.7**
	9/4/2014	--	<1.0	<1.0	**1.3**	**1,350**	<1.0	4.7	6.5	**43.7**
S-5B	6/18/2010	<2.0	<1.0	<1.0	**5.4**	**3,020**	<1.0	**146**	**4,550**	**576**
	10/19/2012	<2.0	<1.0	<1.0	<1.0 *	**434**	<1.0	3	1.9	**418**
	7/18/2013	<0.2	<0.1	<0.1	<0.1	11.6	<0.1	<0.1	<10.0 *	**1.1**
	7/18/2013[a]	<2.0	<1.0	<1.0	<1.0	**131**	<1.0	2	<1.0	**954**
	9/4/2014	--	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	**1.5**
S-6	6/18/2010	<0.2	<0.1	<0.1	<0.1	1.3	<0.1	<0.1	1	<0.2
	10/19/2012	<0.2	<0.1	<0.1	<0.1	9.8	<0.1	<0.1	**5**	**0.8**
	7/18/2013	<0.2	<0.1	<0.1	<0.1	4.9	<0.1	<0.1	0.9	**2.1**
	9/4/2014	--	<0.1	<0.1	<0.1	3.1	<0.1	0.1	0.6	**1.9**

[a]Reported in the USGS database, but not included in the Huffman 2014 report
[b]Data were reported in USGS database, and Huffman 2014 did not match. USGS database results were used.

Notes:
Bolded value exceeds or is equal to the RG for drinking water.
Yellow highlighted value exceeds or is equal to the surface water RG.
* - The reporting limit exceeds the RG
< - not detected
DCA - dichloroethane
DCE - dichloroethene
E - estimated
µg/L - microgram per liter
PCE - tetrachloroethene
RG - remediation goal
TCA - trichloroethane
TCE - trichloroethene

Table B-4
Summary of Analytical Results for OU 1 Surface Water and Seep Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	**1,2-DCA**	**1,1-DCE**	**cis-1,2-DCE**	**trans-1,2-DCE**	**PCE**	**1,1,1-TCA**	**TCE**	**Vinyl Chloride**
Remediation Goal		**N/A**	**59**	**1.9**	**N/A**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
DB14	09/05/95	1 U	1 UJ	1 U	1 U	1 UJ	1 U	1 U	1U	1 U
	12/04/95	1 U	1 U	1 U	1.9	1U	1 U	1 U	1 U	1 U
	03/13/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/01/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/06/00	0.5 U	0.5 U	0.5 U	0.59	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/22/01	0.091 U	0.12 U	0.12 U	0.7	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	06/19/02	0.50 U	0.5 U	0.5 U	0.53	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/29/03	0.50 U	0.50 U	0.50 U	1.8	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
	04/23/04	0.50 U	0.50 U	0.50 U	0.63	0.50 U	0.50 U	0.50 U	0.12 J	0.50 U
	04/14/05	0.2 U	0.2 U	0.2 U	0.6	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/12/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/15/07	0.5 U	0.5 U	0.5 U	1.1	0.5 U	0.5 U	0.5 U	0.18 J	0.16 J
	05/09/08	0.5 U	0.5 U	0.2 U	0.13 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/25/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/17/10	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/19/11	0.5 U	0.5 U	0.5 U	0.07 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/18/14	0.5 U	0.5 U	0.5 U	0.07 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
MA09	09/05/95	1 U	1 UJ	1 U	4	1 UJ	1 U	1 U	1 U	1.3
	12/05/95	1 U	1 U	1 U	14	1 U	1 U	1 U	1 U	**5.4**
	03/14/96	0.29 J	0.5 U	0.5 U	11	0.5 U	0.5 U	0.5 U	1.2	**8**
	07/02/96	0.5 U	0.5 U	0.5 U	0.79	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/06/00	0.5 U	0.5 U	0.5 U	3	0.5 U	0.5 U	0.5 U	0.63	0.64
	06/22/01	1.2	0.12 U	0.12 U	37	0.51	0.11 U	0.12 U	4.7	**8.3**
	06/27/02	0.13 J	0.5 U	0.5 U	6.3	0.5 U	0.5 U	0.5 U	0.82	1.4
	04/29/03	0.50 U	0.50 U	0.50 U	18	0.50 U	0.50 U	0.50 U	3.5	**4.9**
	04/21/04	0.22 J	0.50 U	0.50 U	15	0.21 J	0.50 U	0.50 U	3.2	1.9
	04/14/05	0.2 J	0.2 U	0.2 U	14 J	0.2 J	0.2 U	0.2 U	3.1 J	2.5 J
	07/12/06	0.5 U	0.5 U	0.2 U	2.3	0.5 U	0.5 U	0.5 U	0.5 U	0.3
	06/15/07	0.5 U	0.5 U	0.5 U	10	0.5 U	0.5 U	0.5 U	1.6	1.8
	5/9/2008	0.5 U	0.5 U	0.2 U	6.3	0.09 J	0.5 U	0.5 U	1.3	1.2
	06/24/09	0.5 U	0.5 U	0.2 U	12	0.11 J	0.5 U	0.5 U	2.3	1.6
	06/16/10	0.11 J	0.5 U	0.5 U	23	0.21 J	0.5 U	0.5 U	2.9	2.5
	07/19/11	0.5 U	0.5 U	0.5 U	0.88	0.5 U	0.5 U	0.5 U	0.13 J	0.11 J
	6/13/12	0.08 J	0.5 U	0.5 U	29	0.24 J	0.5 U	0.5 U	3.7	2.7
	06/17/13	0.5 U	0.5 U	0.5 U	9.7	0.1 J	0.5 U	0.5 U	1.7	0.49 J
	06/18/14	0.5 U	0.5 U	0.5 U	12	0.12 J	0.5 U	0.5 U	2.2	0.95
MA11	09/06/95	1 U	1 U	1 U	0.51 J	1 UJ	1 U	1 U	1 U	1 U
	12/06/95	1 U	1 U	1 U	10	1 U	1 U	1 U	1 U	**3.5**
	03/13/96	0.43 J	0.5 U	0.5 U	13	0.5 U	0.5 U	0.5 U	0.5 U	**5.9**
	07/02/96	0.5 U	0.5 U	0.5 U	0.52	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/06/00	1.2	0.5 U	0.5 U	33	0.56	0.5 U	0.5 U	7.9	**9.2**

Table B-4 (Continued)
Summary of Analytical Results for OU 1 Surface Water and Seep Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
Remediation Goal		**N/A**	**59**	**1.9**	**N/A**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
MA11 (cont.)	06/22/01	0.16 J	0.12 U	0.12 U	4.6	0.14 U	0.11 U	0.12 U	0.66	0.98
	06/19/02	0.54	0.5 U	0.5 U	22	0.24 J	0.5 U	0.5 U	4.2	**5.6**
	04/30/03	0.50 U	0.50 U	0.50 U	33	0.50 U	0.50 U	0.50 U	6.1	**6.0**
	04/21/04	0.33 J	0.50 U	0.50 U	23	0.31 J	0.50 U	0.50 U	4.9	**4.0**
	04/14/05	0.2 U	0.2 U	0.2 U	11	0.2 U	0.2 U	0.2 U	2.5	1.4
	07/12/06	0.5 U	0.5 U	0.2 U	0.14 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/15/07	0.5 U	0.5 U	0.5 U	0.54	0.5 U	0.5 U	0.5 U	0.5 U	0.07 J
	05/09/08	0.07 J	0.5 U	0.2 U	10	0.15 J	0.5 U	0.5 U	2.1	1.8
	06/24/09	0.5 U	0.5 U	0.2 U	3.8	0.5 U	0.5 U	0.5 U	0.67	0.38
	06/16/10	0.5 U	0.5 U	0.5 U	12	0.5 U	0.5 U	0.5 U	1.6	1.4
	07/19/11	0.5 U	0.5 U	0.5 U	0.15 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/14/12	0.5 U	0.5 U	0.5 UJ	19	0.21 J	0.5 U	0.5 U	2.8	1.2
	06/17/13	0.5 U	0.5 U	0.5 U	0.19 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/18/14	0.5 U	0.5 U	0.5 U	8.1	0.5 U	0.5 U	0.5 U	1.5	0.61
MA12	03/14/96	5 U	0.5 U	0.56	180 J	1.6	0.5 U	0.5 U	26	**56 J**
	07/01/96	11	0.5 U	1	480 J	3.5	0.5 U	0.5 U	**64 J**	**56 J**
	06/11/99	15	3 U	**2 J**	710	8	3 U	3 U	**130**	**150**
	10/20/99	12	0.5 U	**1.9**	600	5.5	0.5 U	0.5 U	**110**	**130**
	04/25/00	21	0.5 U	1.3	630 J	10	0.5 U	0.5 U	**190 J**	**250 J**
	06/06/00	16	5 U	5 U *	670	5.5	5 U *	5 U	**110**	**140**
	07/25/00	25 U	25 U	25 U *	750 J	25 U	25 U *	25 U	**180 J**	**140 J**
	11/09/00	14	1 U	1.2	680	5.2	1 U	1 U	**170**	**140**
	04/27/01	15	1 UJ	1.6	600J	12	1 U	1UJ	**100J**	**92 J**
	06/22/01	15	0.29 U	0.98 J	520	6.8	0.28 U	0.28 U	**62**	**80**
	07/31/01	17	1 U	1.1	500 J	28 J	1 U	1 U	**90**	**150**
	10/30/01	6.8	1 U	0.8 J	260 J	2.7	1 U	1 U	**82**	**67**
	05/01/02	7 J	1 U	1 U	440 J	3.1 J	1 U	1 U	**96 J**	**49 J**
	06/19/02	7.2	0.5 U	0.7	340 D	3.0	0.5 U	0.5 U	53 D	**57 D**
	07/25/02	8.3 J	1 U	1.2 J	580 J	4.7 J	1 U	1 U	**86 J**	**94 J**
	10/25/02	5.1 J	1.3 U	1.3 U	420 J	2.7 J	1.3 U	1.3 U	**59 J**	**55 J**
	04/30/03	4.0 D	1.0 U	1.0 U	390 D	2.8 D	1.0 U	1.0 U	**60 D**	**49 D**
	10/23/03	3.5	0.50 U	0.52	160	1.3	0.50 U	0.50 U	28	**45**
	04/21/04	5.7	0.50 U	0.81	430 D	3.2	0.50 U	0.50 U	**83 D**	**46**
	10/14/04	11	0.12 U	**2**	660 J	4.7	0.11 U	0.12 U	**57**	**110 J**
	04/14/05	7.3	0.2 U	0.8	450	5.4	0.2 U	0.2 U	**83**	**51**
	10/13/05	4.9	0.4	1.3	540	4.8	0.2 U	0.2 U	47	**92**
	07/12/06	6.0 D	2.5 U	**2.3 D**	800 D	11 D	2.5 U	2.5 U	**110 D**	**120 D**
	10/17/06	3.3	0.5 U	1.2 D	460 D	4.1	0.5 U	0.5 U	**59**	**75**
	06/15/07	3.9 D	1.0 U	1.3 D	840 D	5.6 D	1.0 U	1.0 U	**150 D**	**120 D**
	10/18/07	0.67	0.5 U	0.29	130 D	0.83	0.5 U	0.5 U	12	**28**
	05/09/08	4.3 D	1.0 U	1.3 D	670 D	5.8 D	1.0 U	1.0 U	**140 D**	**93 D**

Table B-4 (Continued)
Summary of Analytical Results for OU 1 Surface Water and Seep Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
Remediation Goal		N/A	59	1.9	N/A	33,000	4.2	41,700	56	2.9
MA12 (cont.)	10/28/08	3.0 D	1.3 U	1.2 JD	400 D	3.1 D	1.3 U	1.3 U	**65 D**	**49 D**
	06/17/09	3.9 D	2.5 U	**1.9 D**	1000 D	9 D	2.5 U	2.5 U	**170 D**	**110 D**
	10/27/09	2.1	0.5 U	1.0	320	2.4	0.5 U	0.5 U	53	**67**
	06/16/10	2.7 J	1.3 U	1.1 J	670 J	4.8 J	1.3 U	1.3 U	**87 J**	**65 J**
	10/25/10	0.67	0.5 U	0.32 J	170 J	1.0	0.5 U	0.5 U	28	**27**
	07/19/11	2.3	1.0 U	0.98 J	670	4.4	1.0 U	1.0 U	**100**	**91**
	10/25/11	2.5	0.5 U	1.1	440	3.8	0.5 U	0.5 U	**67**	**63**
	06/12/12	1.8	1.0 U	1.4	830	5.8	1.0 U	1.0 U	**120**	**68**
	06/17/13	1.2	1.0 U	1.5	750	5.1	1.0 U	1.0 U	**140**	**48**
	06/18/14	0.67	0.5 U	0.82	480 D	3.4	0.5 U	0.5 U	**84 D**	**42**
SP1-1	09/05/95	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.66 J
	12/05/95	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	03/13/96	0.5 U	0.5 U	0.5 U	170 J	1.8	0.5 U	0.5 U	0.5 U	**420 J**
	07/02/96	0.5 U	0.5 U	0.5 U	7.4	0.76	0.5 U	0.5 U	0.5 U	**31 J**
	09/10/96	0.2 J	0.5 U	0.5 U	0.33 J	0.5 U	0.5 U	0.5 U	0.5 U	1.1
	06/11/99	3 U	3 U	3 U *	4	3 U	3 U	3 U	3 U	**32**
	10/20/99	0.5 U	0.5 U	0.5 U	0.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/25/00	0.5 U	0.5 U	0.5 U	32	2.5	0.5 U	0.5 U	1.7	**210 J**
	07/25/00	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	11/09/00	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1
	04/27/01	1 U	1 UJ	1 U	1.3	0.7 J	1 U	1 UJ	1 U	**8.4**
	07/31/01	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	10/30/01	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	05/01/02	0.5 U	0.5 U	0.5 U	5	1	0.5 U	0.5 U	0.5 U	**43**
	07/25/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/25/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/29/03	0.50 U	0.50 U	0.50 U	2.2	0.80	0.50 U	0.50 U	0.50 U	**31**
	10/23/03	0.50 U	0.50 U	0.50 U	0.17 J	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
	04/21/04	0.20 J	0.50 U	0.50 U	0.16 J	0.34 J	0.50 U	0.50 U	0.50 U	1.1
	10/14/04	0.26 J	0.12 U	0.12 U	0.14 J	0.18 J	0.11 U	0.12 U	0.12 U	0.22 U
	04/14/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	10/13/05	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
	07/12/06	0.13 J	0.5 U	0.2 U	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U	0.06 J
	10/17/06	0.14 J	0.5 U	0.3 U	0.16 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/15/07	0.11 J	0.5 U	0.5 U	0.14 J	0.5 U	0.5 U	0.5 U	0.5 U	0.05 J
	05/08/08	0.12 J	0.14 J	0.2 U	0.2 J	0.14 J	0.5 U	0.5 U	0.5 U	0.13 J
	06/24/09	0.5 U	0.08 J	0.2 U	0.32 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/16/10	0.09 J	0.09 J	0.5 U	0.40 J	0.14 J	0.5 U	0.5 U	0.14 J	0.31 J
	07/19/11	0.10 J	0.5 U	0.5 U	0.27 J	0.13 J	0.5 U	0.5 U	0.5 U	0.11 J
	06/25/14	0.5 U	0.5 U	0.5 U	0.34 J	0.12 J	0.5 UJ	0.5 U	0.5 U	0.24 J

Table B-4 (Continued)
Summary of Analytical Results for OU 1 Surface Water and Seep Sampling Through June 2014

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
Remediation Goal		**N/A**	**59**	**1.9**	**N/A**	**33,000**	**4.2**	**41,700**	**56**	**2.9**
TF19	09/05/95	1 U	1 U	1 U	4	1 U	1 U	1 U	1 U	0.92 J
	12/04/95	1 U	1 U	1 U	8.4	1 U	1 U	1 U	1 U	2.8
	03/12/96	0.39 J	0.5 U	0.5 UJ	18	0.5 U	0.5 U	0.5 U	1.3 J	**19**
	07/01/96	0.5 U	0.5 U	0.5 U	5.9	0.5 U	0.5 U	0.5 U	0.68	2.3
	06/06/00	0.4 J	0.5 U	0.5 U	12	0.2 J	0.5 U	0.5 U	2.3	**3.1**
	06/22/01	0.55	0.12 U	0.12 U	18	0.22 J	0.11 U	0.12 U	2.1	**3.2**
	06/19/02	0.22 J	0.5 U	0.5 U	8.5	0.5 U	0.5 U	0.5 U	1.3	1.9
	04/29/03	0.50 U	0.50 U	0.50 U	26	0.50 U	0.50 U	0.50 U	4.9	**6.1**
	04/23/04	0.13 J	0.50 U	0.50 U	9	0.17 J	0.50 U	0.50 U	1.6	1.1
	04/14/05	0.2 U	0.2 U	0.2 U	11	0.2 U	0.2 U	0.2 U	2.4	1.8
	07/12/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/15/07	0.5 U	0.5 U	0.5 U	6.5	0.5 U	0.5 U	0.5 U	0.98	1.0
	05/09/08	0.5 U	0.5 U	0.2 U	0.18 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/25/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/17/10	0.5 U	0.5 U	0.5 U	3.9	0.5 U	0.5 U	0.5 U	0.58	0.42 J
	07/19/11	0.5 U	0.5 U	0.5 U	0.27 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/18/14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:
Shaded row indicates data evaluated in this 5-year review period.
Bolded value exceeds or is equal to the remediation goal.
Data from 1995 to April 2004 are from U.S. Navy 2005a, from October 2004 through 2008 are from U.S. Navy 2008a and 2009g, from 2009 are from U.S. Navy 2009h, and from 2010 through 2014 are from U.S. Navy 2015a.
* - The reporting limit exceeds the remediation goal.
D - The reported result is from a dilution.
DCA - dichloroethane
DCE - dichloroethene
J - The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
MDL - method detection limit
µg/L - microgram per liter
MRL - method reporting limit
N/A - not applicable
PCE - tetrachloroethene
TCA - trichloroethane
TCE - trichloroethene
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table B-5
Summary of PCB Aroclor Analytical Results for OU 1 Seep Sampling Location

Location	Sampling Date	Total PCBs[a] (µg/L)
	Remediation Goal	**0.04**
SP1-1	Spring 1990	**1.8**
	Fall 1991	**1.5**
	09/05/95	**0.16**
	12/05/95	**0.15**
	03/13/96	**0.2**
	07/02/96	**0.24 J**
	10/10/96	**0.13**
	06/07/00	**0.42**
	06/17/02	**0.45**
	04/21/04	**0.42**
	07/12/06	**0.29**
	05/08/08	**0.3**
	06/16/10	**0.29**
	06/25/14	**0.696**

[a]Data are from U.S. Navy 2008 and 2015a.

Notes:
Shaded row indicates data evaluated in this 5-year review period.
Bolded value indicates it exceeds or is equal to the remediation goal.
J - The result is an estimated concentration that is less than the method reporting limit, but greater than or equal to the method detection limit.
µg/L - microgram per liter
PCBs - polychlorinated biphenyls

Table B-6
Summary of Analytical Results for PCBs and Metals in OU 1 Sediment
From April 1996 Through June 2014

Location	Sampling Date	TOC (%)[c]	PCBs (µg/kg or mg/kg OC)[d] Aroclor 1254	Aroclor 1260	Total PCBs	Metals (mg/kg) Arsenic	Beryllium	Chromium	Lead	Mercury	Nickel	Zinc
SQS Screening Level (mg/kg)[a]		**NA**	**NA**	**NA**	**12**	**57**	**NA**	**260**	**450**	**0.41**	**NA**	**410**
AET Screening Level (µg/kg dry weight)		**NA**	**NA**	**NA**	**130**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
DB05	April 1996	0.68	3 U	3 U	8 U	3.2	0.2 U	19	8	0.05 U	15	26
	June 2000	N/A	10 U	10 U	20 U *	4.3	0.16	25.9	8.58	0.06	21.1 J	33.4 J
	June 2004	0.79	10 U	10 U	20 U *	2.9	0.14	20.2	7.91	0.04	18.9	31.1
	June 2009	1.42	0.18 J [e]	0.63 U [e]	0.18 J[e]	3.71	0.146	48.5 J	10.8	0.058 J	24.8 J	43.7 J
	June 2014	N/A	N/A	N/A	N/A	3.23	0.145	22	7	0.054	20.1	36
DB07	April 1996	0.56	3 U	3 U	8 U	3	0.2 U	15	6	0.05 U	14	22
	June 2000	N/A	10 U	10 U	20 U *	9.6	0.12	27.7	129	0.08	18.8 J	216 J
	June 2004	1.12	0.41 J [e]	0.89 U [e]	0.41 J [e]	6.3	0.16	23.8	40.2	0.17	25.2	74.7
	June 2009	0.51	7.4 U	7.4 U	15 U *	2.78	0.085	15.8 J	5.85	0.034 J	16.2 J	25.4 J
	June 2014	N/A	N/A	N/A	N/A	3.1	0.089	12.8	4.19	0.033	14.3	23.1
DB08	April 1996	0.74	3 UJ	3 UJ	8 UJ	4	0.2 U	20	7	0.05 U	17	30
	June 2000	N/A	10 UJ	10 UJ	10 UJ	3.2	0.13	23	7.13	0.05	22.9 J	30.4 J
	June 2004	0.69	10 U	10 U	20 U *	4.1	0.17	25.6	8.71	0.04	26.8	37
	June 2009	1.43	0.20 J[e]	0.59 U [e]	0.20 J [e]	3.6	0.131	27.6 J	17.6	0.074 J	24.4 J	51.7 J
	June 2014	N/A	N/A	N/A	N/A	2.58	0.104	17	5.04	0.045	14.7	26
DB08 FD	June 2009	1.35	N/A	N/A	N/A	3.78	0.142	28.2 J	17.4	0.075 J	23.6 J	57.5 J
MA09	April 1996	0.48	56	6 J	**62**	3	0.2 U	21	6	0.05 U	25	27
	June 2000	N/A	200	10 U	**200**	5.5	0.21	43.4	13.9	0.07	37.4 J	58.5 J
	June 2002	0.55	3.7 J	12 U	3.7 J	2.6	0.18	29.7 J	3.21	0.03	43.9 J	25.5 J
	June 2004	3.14	2.68 [e]	0.32 U [e]	2.68 [e]	10.4	0.25	37.3	50.6	0.04	48.3	173
	June 2009	1.18	1.36 [e]	0.68 U [e]	1.36 [e]	5.73	0.138	29.2	6.93	0.026 J	26.9 J	42.2 J
	June 2014	N/A	N/A	N/A	N/A	10	0.182	38.9	12.6	0.052	36.3	86.1
MA09 FD	April 1996	0.53	141	14	**155**	6	0.2 U	32	6	0.05 U	24	27
MA10	April 1996	2.03	1.08 [e]	0.74 U [e]	1.08 [e]	5	0.2 U	146	11	0.06	33	69
MA11	April 1996	3.40	1.56 [e]	0.29 U [e]	1.56 [e]	21	0.2 U	104	12	0.05	39	80
	June 2000	N/A	0.5 [e]	0.29 U [e]	0.5 [e]	7	0.17	74.5	12.1	0.07	28.3 J	68.3 J
	June 2004	1.03	0.97 U [e]	0.97 U [e]	1.94 U [e]	5	0.21	28.4	5.04	0.03	27.8	29
	June 2009	1.91	2.88 U [e]	1.47 U [e]	2.88 U [e]	21.3	0.249	**269 J**	26.8 J	0.120 J	42.3 J	138 J
	June 2014	N/A	N/A	N/A	N/A	18	0.222	45.2	10	0.086	29.4	115
MA11 FD	June 2014	N/A	N/A	N/A	N/A	26.3	0.243	63.4	12.4	0.083	34.9	120
MA14	June 2000	N/A	140	10 U	**140**	6.2	0.16	34.1	20.8	0.09	33 J	81.8 J
	June 2002	0.59	9.7 J	13 U	9.7 J	2.5	0.16	20.9 J	10	0.03	32.4 J	63.7 J
	June 2004	2.16	0.6 [e]	0.46 U [e]	0.6 [e]	3.9	0.15	22.5	13.5	0.02	29.4	84.3
	June 2009	2.90	3.45 [e]	0.45 U [e]	3.45 [e]	6.94	0.169	45.7 J	29.8	0.114 J	30.0 J	71.5
	June 2014	N/A	N/A	N/A	N/A	4.45	0.144	21.7	9.35	0.037	28.8	53.3
MA14 FD	June 2002	1.16	0.83 J [e]	0.1 U [e]	0.83 J [e]	1.6	0.14	15.4 J	7.47	0.02	21.8 J	50.1 J
	June 2004	2.95	0.75 [e]	0.34 U [e]	0.75 [e]	4.9	0.22	29.1	15.7	0.03	31.2	74.5
TF18	April 1996	0.56	3 U	3 U	8 U	2	0.2 U	19	7	0.05 U	13	21
	June 2000	N/A	6 J	10 U	6 J	3.3	0.14	25.1	10.9	0.05	20.4 J	36 J
	June 2004	28.30	4.7 J	10 U	4.7	2.6	0.12	19.9	7.67	0.04	23.4	35.9
	June 2009	0.59	2.4 JP	6.9 U	14 U *	2.29	0.082	14.5 J	5.25 J	0.026 J	12.6 J	21.8 J
	June 2014	N/A	N/A	N/A	N/A	3.94	0.151	27.9	9.51	0.054	23.1	44.1
TF20	April 1996	0.46	3 U	3 U	8 U	3	0.2 U	14	6	0.05 U	15	34
	June 2000	N/A	10 U	10 U	20 U *	3.3	0.14	26.4	8.12	0.03	26.2 J	32.6 J
	June 2004	0.70	3.3 J	10 U	3.3	3.3	0.16	24.4	9.55	0.03	25.6	37.6
	June 2009	0.64	8.1 U	8.1 U	17 U *	2.91	0.106	19.2 J	7.12	0.030 J	20.8 J	29.3 J
	June 2014	N/A	N/A	N/A	N/A	3.71	0.15	26.4	9.61	0.051	23.8	40

Table B-6 (Continued)
Summary of Analytical Results for PCBs and Metals in OU 1 Sediment
From April 1996 Through June 2014

Location	Sampling Date	TOC (%)[c]	PCBs (µg/kg or mg/kg OC)[d]			Metals (mg/kg)						
			Aroclor 1254	Aroclor 1260	Total PCBs	Arsenic	Beryllium	Chromium	Lead	Mercury	Nickel	Zinc
SQS Screening Level (mg/kg)[a]		**NA**	**NA**	**NA**	**12**	**57**	**NA**	**260**	**450**	**0.41**	**NA**	**410**
AET Screening Level (µg/kg dry weight)		**NA**	**NA**	**NA**	**130**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
TF21	April 1996	0.92	42	4 J	**46**	4	0.2 U	23	9	0.05 U	19	30
	June 2000	N/A	32	10 U	**32**	5.5	0.16	34.5	14.1	0.06	27.7 J	51.2 J
	June 2004	2.42	1.16 [e]	0.41 U [e]	1.16 [e]	7	0.21	38.3	19.4	0.07	30.6	70.2
	June 2009	0.92	6.2 J	11 U	6.2 J	4.05	0.13	23.1 J	8.88	0.041 J	22.6	47.7
	June 2014	N/A	N/A	N/A	N/A	4.32	0.157	27	10.3	0.06	22.8	44.6
FLD-004[b]	June 2000	N/A	28	10 U	**28**	5.9	0.19	36.2	14.6	0.06	29.5 J	53 J

[a]Sediment quality standards (SQS) for PCBs based on TOC-normalized values and for metals based on dry weight values.

[b]PCB-contaminated sediment was removed in October 1999. FLD-004 is a field duplicate of TF21 in 2000.

[c]TOC was not measured in sediment samples collected in 2000. As a result, TOC values from the 1996 sampling event were used to normalize the 2000 data.

[d]If percent TOC is between 1 and 4.5, then PCB concentrations shown in these three columns are TOC-normalized (see footnote e) with units of mg/kg OC. To calculate TOC-normalized values, the concentration in µg/kg is divided by the decimal fraction TOC times 1,000 µg/kg per mg/kg. If the percent TOC is less than 4.5, the PCB concentrations are not normalized and are in units of µg/kg.

[e]TOC-normalized data

Notes:
Shaded row indicates data evaluated in this 5-year review period.
Bolded value exceeds or is equal to the screening level.
* - The reporting limit exceeds the screening level.
Data from 1996 to 2004 are from U.S. Navy 2005a, with the exception of the TOC and TOC-normalized data for PCBs, which are from U.S. Navy 1996d (vol. II), 2003c and 2005c; data from 2009 are from U.S. Navy 2009h and from 2010 to 2014 are from U.S. Navy 2014a.
AET - apparent effects threshold
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
MDL - method detection limit
µg/kg - microgram per kilogram
mg/kg - milligram per kilogram
mg/kg OC - milligram per kilogram of organic carbon
MRL - method reporting limit
NA - not applicable
N/A - not analyzed
PCBs - polychlorinated biphenyls
SQS - sediment quality standards
TOC - total organic carbon
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL

Table B-7
Summary of Analytical Results for OU 1 Shellfish Tissue Sampling From 1996 to 2009

Location	Sampling Date	PCBs	Metals (mg/kg wet weight)						
		Aroclor 1254 (µg/kg wet weight)	Arsenic	Beryllium	Chromium	Lead	Mercury	Nickel	Zinc
DB05	April 1996	5 J	3.1	0.004 U	0.74	0.128 J	0.03	0.92	9.6
	June 2000	10 U	2.23	0.003 U	0.38	0.12	0.02	0.64	13.86
	June 2004	10 U	2.11	0.003 U	0.15	0.1	0.02	0.63	12.09
	June 2009	9.8 U	1.740 J	0.0026 J	0.194	0.169 J	0.0147	0.324 J	11.9 J
DB07	April 1996	3 U	3.6	0.004 U	0.76	0.116 J	0.03	0.75	9.7
	June 2000	10 U	2.26	0.003 UJ	0.48	0.42	0.01	0.37 J	16.5
	June 2004	10 U	1.98	0.003 UJ	0.11	0.12	0.01 U	0.52	14.15
	June 2009	9.7 U	1.450 J	0.0003 J	0.093	0.0796 J	0.0103	0.207 J	11.3 J
DB07 FD	June 2000	10 U	2.22	0.003 UJ	1	0.33	0.01	0.59 J	19.50 J
DB08	April 1996	3 U	4.1	0.004 U	0.68	0.138 J	0.02	1.01	10.1
	June 2000	10 U	2.14	0.003 UJ	0.65	0.11	0.01	0.50 J	19.42
	June 2004	10 U	2.92	0.003 UJ	0.13	0.07	0.02	0.78	12.94
	June 2009	9.9 U	1.970 J	0.0010 J	0.214	0.184 J	0.0169	0.263 J	13.5 J
DB08 FD	June 2004	10 U	2.69	0.001 UJ	0.15	0.08	0.02	0.88	12.89
TF18	April 1996	3 U	2.65	0.004 U	0.52	0.114 J	0.02	0.63	9
	June 2000	10 U	1.88	0.003 UJ	1.05	0.09	0.02	1.05 J	15.66
	June 2004	10 U	2.59	0.003 UJ	0.12	0.12	0.02	0.77	15.01
	June 2009	9.7 U	1.660 J	0.0006 J	0.119 J	0.0811 J	0.0183	0.274 J	10.9 J
TF20	April 1996	3 U	3	0.004 U	0.83	0.109 J	0.02	0.81	9.4
	June 2000	10 U	1.88	0.003 UJ	0.72	0.09	0.02	0.93 J	15
	June 2004	10 U	2.04	0.003 UJ	0.08 U	0.1	0.02	0.72	14.21
	June 2009	10 U	1.760 J	0.0009 J	0.535	0.0802 J	0.024	0.270 J	8.490 J
TF20 FD	June 2009	9.8 U	1.930 J	0.0065	1.23	0.365 J	0.0212	1.140 J	9.740 J
TF21	April 1996	13	3.52	0.002 J	0.79	0.177 J	0.02	1.42	9.6
	June 2000	**23**	2.15	0.003 UJ	0.86	0.14	0.02	1.04 J	14.08
	June 2004	10 U	2.46	0.003 UJ	0.11	0.17	0.02	0.66	12.48
	June 2009	9.9 U	1.840 J	0.0023 J	0.13	0.127 J	0.0142	0.457 J	10.1 J
TF21 FD	April 1996	11	2.5	0.004 U	0.63	0.189 J	0.02	1.14	9.1

Notes:
The remediation goal for total PCBs is 15 µg/kg for the seafood ingestion pathway and 2,600 µg/kg for the ecological risk pathway. Field duplicate data from 1996 to 2004 are from U.S. Navy 1996d and 2005b. All other data from 1996 to 2004 are from U.S. Navy 2005a and from 2009 are from U.S. Navy 2009h.
Shaded row indicates data evaluated in this review period.
Bolded value exceeds or is equal to the remediation goal.
FD - field duplicate
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
MDL - method detection limit
µg/kg - microgram per kilogram
mg/kg - milligram per kilogram
MRL - method reporting limit
PCBs - polychlorinated biphenyls
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table B-8
Summary of Target Analytes Detected in Groundwater at OU 2 Area 2 From Fall 1995 to Spring 2014

Location	Sampling Date	cis,1,2-DCE (µg/L)	TCE (µg/L)	Vinyl Chloride (µg/L)
RG (Drinking Water)[a]		**16[e]**	**5[f]**	**0.023**
2MW-1	11/21/95	1 U	**41 J**	1 U *
	09/30/96	1 U	**28**	1 U *
	10/16/97	1 U	**29**	1 U *
	10/08/98	0.2 U	**29**	0.2 U *
	11/22/99	0.5 U	**17**	0.5 U *
	11/17/00	0.5 U	**22**	0.5 UJ *
	11/19/01	0.1 U	**16**	0.2 U *
	06/17/02	0.1 U	**11**	0.2 U *
	06/18/03	0.067 U	**12**	0.12 U *
	06/15/04	0.067 U	**9.7**	0.12 U *
	06/21/05	0.2 U	**10**	0.2 U *
	06/20/06	0.5 U	**8.1**	0.2 U *
	06/12/07	0.5 U	**5.8**	0.2 U *
	05/06/08	0.5 U	4.9	0.2 U *
	06/24/09	0.21 J	**5.8 J**	0.2 U *
	6/15/10	NS	NS	NS
	7/20/11	0.08 J	3.8	0.2 U *
	6/13/12	0.059	3.8	0.01 J
	6/24/14	0.089	1.2	0.018 J
2MW-3	11/20/95	**19**	1 J	**4**
2MW-4	11/20/95	1 U	1 U	1 U *
2MW-5	11/21/95	7	**11**	**1**
	09/30/96	1	2	**1**
	10/16/97	1	2	**1**
	10/08/98	0.26	2.1	0.2
	11/22/99	0.5	0.4 J	0.5
2MW-6[b]	11/20/95	10	1 U	**4**
	09/30/96	15	1 U	**5**
	10/16/97	11	1 U	**4**
	10/08/98	9.5	0.2 U	**2.7**
	11/22/99	12	0.5 U	**2.7**
	11/17/00	15	0.5 U	**2.9 J**
	11/19/01	7 J	0.2 UJ	**1.2 J**
	06/17/02	13	0.2 U	**2.1**
	06/18/03	9.9	0.081 U	**1.5**
	06/15/04	6.9	0.081 U	0.86
	6/21/05	4.5	0.2 U	0.68

Table B-8 (Continued)
Summary of Target Analytes Detected in Groundwater at
OU 2 Area 2 From Fall 1995 to Spring 2014

Location	Sampling Date	cis,1,2-DCE (µg/L)	TCE (µg/L)	Vinyl Chloride (µg/L)
RG (Drinking Water)[a]		**16[e]**	**5[f]**	**0.023**
2MW-6[b] (cont.)	6/21/06	9	0.5 U	**1.1**
	6/13/07	8.4	0.5 U	0.99
	5/7/08	2.7	0.5 U	0.34
	06/24/09	7.1	0.03 J	0.99
	6/15/10	3.5	0.5 U	0.34
	7/20/11	1.5	0.5 U	0.09 J
	6/13/12	1.7	0.018 J	0.099
	6/23/14	3.9	0.021 UJ	0.22
MW2-6[c]	11/17/00	0.5 U	0.5 U	0.5 U *
MW2-8[d]	11/19/01	0.72	0.2 U	0.2 U *
	06/17/02	0.97	0.2 U	0.2 U *
	06/18/03	1.4	0.081 U	0.12 U *
	06/15/04	1.9	0.081 U	0.2 J
	06/24/05	1.9	0.2 U	0.2 U *
	06/20/06	2	0.5 U	0.2 U *
	06/12/07	1.9	0.5 U	0.2
	05/06/08	1.4	0.5 U	0.07 J
	06/24/09	1.1	0.5 U	0.07 J
	6/15/10	1.1	0.5 U	0.2 UJ *
	7/20/11	1.2	0.5 U	0.2 U *
	6/13/12	0.92 J	0.0045 J	0.035
	6/23/14	0.43	0.02 U	0.016 J

[a]Protection of human health by ingestion
[b]The 11/17/00 and 11/19/01 results for 2MW-6 are the average concentrations of the 2MW-6 sample and its field duplicate.
[c]Prior to 2000, MW2-6 was last sampled in 1991 during the remedial investigation. TCE was detected at an estimated 0.6 µg/L.
[d]The 06/17/02 results for MW2-8 are the average concentrations of the MW2-8 sample and its field duplicate.
[e]No RG for cis-1,2-DCE was established in the Record of Decision. For comparison purposes, the current MTCA Method B value is shown here.
[f]Value listed accounts for adjustment when the maximum contaminant level or water quality standard is sufficiently protective to serve as the MTCA cleanup level for that individual chemical. Individual chemical cleanup levels may require downward adjustment for multiple chemical contaminants or multiple exposure pathways (WAC 173-340-720[7][b]). Value does not account for adjustments due to background levels or PQLs.

Notes:
Bolded value indicates it exceeds or is equal to the RG for drinking water. Shaded columns indicate the most current sampling period results.
Shaded rows indicate the last 5 years of sampling results.
* - The reporting limit exceeds the RG

Table B-8 (Continued)
Summary of Target Analytes Detected in Groundwater at
OU 2 Area 2 From Fall 1995 to Spring 2014

Data from 1995 to 2004 are from U.S. Navy 2005a, from 2005 to 2008 are from U.S. Navy 2008b, from 2009 are from U.S. Navy 2009f, and from 2010 through 2014 from U.S. Navy 2012b and 2014b.
DCE - dichloroethene
EPA - U.S. Environmental Protection Agency
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
MDL - method detection limit
µg/L - microgram per liter
MRL - method reporting limit
MTCA - Model Toxics Control Act
PQL - practical quantitation limits
TCE - trichloroethene
RG - remediation goal
U - The compound was analyzed for, but was not detected (“nondetect”) at or above the MRL/MDL.

Table B-9
Summary of 1,4-Dioxane Results in Groundwater at OU 2 Area 2 for June 2007

Location	Sampling Date	1,4-Dioxane (µg/L)
2MW-1	06/12/07	1.0 U *
2MW-6	06/13/07	0.3 J
MW2-8	06/12/07	1.0 U *

Notes:
No remediation goal is established for 1,4-dioxane. The Model Toxics Control Act Method B cleanup level is 0.44 µg/L.
Data are from U.S. Navy 2007b.
* - The reporting limit exceeds the MTCA Method B cleanup level.
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
MDL - method detection limit
µg/L - microgram per liter
MRL - method reporting limit
U - The compound was analyzed for, but was not detected (“nondetect”) at or above the MRL/MDL.

Table B-10
Summary of Selected Volatile Organic Compounds Detected in Groundwater and Seeps at OU 2 Area 8 (Fall 1995 to Spring 2014)

Location	Sampling Date	Analyte Concentration (µg/L)				
		1,1-DCE	**cis-1,2-DCE**	**PCE**	**1,1,1-TCA**	**TCE**
RG (Drinking Water)[a]		**7[b]**	**70**	**5[b]**	**200**	**5[b]**
RG (Surface Water)[a]		**3.2[b,c]**	**--**	**8.9[b,c]**	**42,000**	**81[b,c]**
MW8-8	11/95	1	2	**49**	23	**190**
	6/96	0.90 J	1	**34**	11	**110**
	9/96	1	2	**58**	19	**190**
	5/97	1 U	1	**15**	3	**68**
	10/97	0.60 U	1 U	**19**	9	**78**
	5/98	1 U	0.9 J	**12**	3	**63**
	10/98	1 U	1 U	**30**	9	**76**
	5/99	5 U *	5 U	5 U	5 U	**58**
	11/99	1	3.2	2	10	**150 H**
	6/00	1 J	4.5	**23**	6.6	**120**
	6/01	1.3	7.3	**20**	3.9	**84**
	6/02	1.1	7.3	**17**	3.9	**81**
	6/03	0.94	6.8	**12**	2.7	**81 D**
	6/04	1.1	8.5	**13**	2.9	**80 D**
	6/05	0.7	7.4	**11**	2	**64**
	6/06	0.68	7.6	**9.2**	2.2	**68 D**
	6/07	0.55	7.5	**7.7**	1.7	**53 D**
	5/08	0.41 J	6.6	**8.4**	1.6	**59**
	06/09	0.69	9.1	**5.6**	1.6	**66**
	06/10	0.55	8.4	**5.1**	1.5	**58**
	07/11	0.37 J	5.9	**6**	1.5	**59**
	06/12	0.14 J	2.1	**9.7**	1.1	**38**
	06/13	0.5 U	0.46 J	**9**	0.6	**24 J**
	06/14	0.5 U	0.83	**9.8**	0.83	**32**
MW8-9	11/95	50 U *	27 J	50 U *	50 U	**1600**
	6/96	1 U	28	1 U	2	**800**
	9/96	1 U	28	0.40 J	2	**1000**
	5/97	1 U	34	0.30 J	2	**1600**
	10/97	1 U	1 U	1 U	1	**720**
	5/98	1 U	12	1 U	0.70 J	**370**
	10/98	1 U	34	1 U	3	**610**
	5/99	1 U	6	1 U	1 U	**84**
	11/99	0.50 U	30	0.60	1.4	**500**
	6/00	2.5 U	15	2.5 U	1 J	**170**
	6/01	0.24 U	18	0.26 J	0.44 J	**330**
	6/02	0.50 U	7.5	0.23 J	0.69	**60**
	6/03	0.50 U	1.3 U	0.50 U	0.23 J	**21**
	6/04	0.50 U	1.7	0.18 J	0.44 J	**25**
	6/05	0.2 U	0.2	0.2 U	0.2 U	4.1
	6/06	0.50 U	0.42 J	0.20 J	0.28 J	3.9
	6/07	0.5 U	0.27 J	0.5 U	0.15 J	1.9
	5/08	0.5 U	0.23 J	0.16 J	0.14 J	1.7

Table B-10 (Continued)
Summary of Selected Volatile Organic Compounds Detected in Groundwater and Seeps at OU 2 Area 8 (Fall 1995 to Spring 2014)

Location	Sampling Date	Analyte Concentration (µg/L)				
		1,1-DCE	**cis-1,2-DCE**	**PCE**	**1,1,1-TCA**	**TCE**
RG (Drinking Water)[a]		**7**[b]	**70**	**5**[b]	**200**	**5**[b]
RG (Surface Water)[a]		**3.2**[b,c]	**--**	**8.9**[b,c]	**42,000**	**81**[b,c]
MW8-9 (cont.)	06/09	0.2 U	1.3	0.18 J	0.14 J	**20**
	06/10	0.5 U	0.69	0.11 J	0.12 J	**9.4**
	07/11	0.5 U	0.8	0.12 J	0.11 J	**12**
	06/12	0.5 UJ	1.2	0.49 J	0.16 J	**14**
	06/13	0.5 U	2.7	0.18 J	0.13 J	**43 J**
	06/14	0.5 U	1.5	0.29 J	0.12 J	**24**
MW8-10	6/00	0.54	1.8	1.2	4.2	**22**
	6/02	0.24 J	2.4	0.84	0.74	**31**
MW8-11	11/95	**44**	1 U	1 U	**520**	**84**
	6/96	**47**	1 U	1 U	**460**	**84**
	9/96	**27**	0.30 J	1 U	**420**	**80**
	5/97	**42**	1 U	1 U	**500**	**63**
	10/97	**30**	2	1 U	**300**	**62**
	5/98	**33**	1 U	1 U	**200**	**61**
	10/98	**35**	1 U	1 U	**220**	**62**
	5/99	**8**	2 U	2 U	45	**27**
	11/99	**12**	0.50 U	0.50 U	64 H	**54 H**
	6/00	**12**	0.40 J	0.50 U	82 J	**41 J**
	6/01	**15**	0.38 J	0.27 J	91	**62**
	6/02	1.1	0.46 J	0.79	84	**92**
	6/03	**20**	0.47 J	0.6	80 D	**99 D**
	6/04	**25**	0.37 J	0.66	80	**110 D**
	6/05	**10**	0.2	0.5	33	**61**
	6/06	**10**	0.27 J	0.68	39	**99 D**
	6/07	3.3	0.29 J	0.81	21	**46 D**
	5/08	2.4	0.37 J	1.1	31	**53**
	06/09	1.6	0.38 J	1.2	22	**67**
	06/10	1.6	0.83	1.5	14	**80 J**
	07/11	0.35 J	0.82	0.79	10	**75**
	06/12	0.77 J	0.81	1.1	9.7	**56**
	06/13	0.56	0.61	1	6.9	**67**
	06/14	0.21 J	0.45 J	0.9	5	**55**
MW8-12	11/95	**10**	1	**13**	140	**85**
	6/96	**14**	1 U	**5**	180	**63**
	9/96	**20**	2	**23**	**250**	**120**
	5/97	6	1	**12**	67	**120**
	10/97	4	1 U	**7**	41	**44**
	5/98	2	2	**10**	20	**46**
	10/98	1 U	1 U	**15**	22	**46**
	5/99	1 U	1 U	4 U	8	**25**
	11/99	0.9	2.1	**9.7**	14	**50 H**

Table B-10 (Continued)
Summary of Selected Volatile Organic Compounds Detected in Groundwater and Seeps at OU 2 Area 8 (Fall 1995 to Spring 2014)

Location	Sampling Date	Analyte Concentration (µg/L)				
		1,1-DCE	**cis-1,2-DCE**	**PCE**	**1,1,1-TCA**	**TCE**
RG (Drinking Water)[a]		**7[b]**	**70**	**5[b]**	**200**	**5[b]**
RG (Surface Water)[a]		**3.2[b,c]**	**--**	**8.9[b,c]**	**42,000**	**81[b,c]**
MW8-12 (cont.)	6/00	0.50 J	3	**16**	6.8	**54**
	6/01	0.67	4.8	**14**	6.5	**76**
	6/02	0.50 U	4.5	**14**	5	**47**
	6/03	0.31 J	3.2	**9.8**	3.2	**36**
	6/04	0.34 J	3.1	**8.5**	4.1	**40**
	6/05	0.3	3.3	**8.8**	2.8	**34**
	6/06	0.28 J	2.5	**7.9**	2.5	**31**
	6/07	0.22 J	3.5	**6.8**	2	**37**
	5/08	0.15 J	2.4	**7.7**	1.8	**28**
	06/09	0.18 J	3.4	**11**	2.5	**52**
	06/10	0.2 J	3.9	**6.2**	1.5	**31**
	07/11	0.11 J	3	**6**	2.1	**31**
	06/12	0.5 UJ	1.8	**6.3**	1.6	**31**
	06/13	0.5 U	0.5	**5.6**	1.2	**23**
	06/14	0.5 U	0.39 J	**5.7**	1.1	**22**
MW8-14	11/95	1 U	1 U	1 U	1 U	1 U
	6/96	1 U	1 U	1 U	1 U	1 U
	9/96	1 U	1 U	1 U	1 U	1 U
	5/97	1 U	1 U	1 U	1 U	1 U
	10/97	1 U	1 U	1 U	1 U	1 U
	5/98	1 U	1 U	1 U	1 U	1 U
	10/98	1 U	1 U	1 U	1 U	1 U
	5/99	1 U	1 U	1 U	1 U	1 U
	11/99	0.50 U	3.2	0.50 U	0.50 U	0.50 U
	6/00	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
	6/01	0.12 U	0.12 U	0.11 U	0.84	0.12 U
	6/02	0.50 U	0.50 U	0.50 U	0.18 J	0.50 U
	6/03	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
	6/04	0.50 U	0.50 U	0.50 U	0.12 J	0.50 U
	6/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	6/06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	6/07	0.5 U	0.5 U	0.5 U	0.5 U	0.23 J
	5/08	0.5 U	0.5 U	0.5 U	0.11 J	0.5 U
	06/09	0.2 U	0.5 U	0.5 U	0.1 J	0.5 U
	06/10	0.5 U	0.5 U	0.5 U	0.18 J	0.5 U
	07/11	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/12	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U
	06/13	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ
	06/14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Table B-10 (Continued)
Summary of Selected Volatile Organic Compounds Detected in Groundwater and Seeps at OU 2 Area 8 (Fall 1995 to Spring 2014)

Location	Sampling Date	Analyte Concentration (μg/L)				
		1,1-DCE	**cis-1,2-DCE**	**PCE**	**1,1,1-TCA**	**TCE**
RG (Drinking Water)[a]		**7[b]**	**70**	**5[b]**	**200**	**5[b]**
RG (Surface Water)[a]		**3.2[b,c]**	**--**	**8.9[b,c]**	**42,000**	**81[b,c]**
MW8-16	11/95	1 U	2	0.60 J	2	**58**
	6/96	1 U	2	0.80 J	2	**72**
	9/96	1 U	3	0.80 J	2	**69**
	5/97	1 U	2	0.80 J	2	**57**
	10/97	1 U	1 U	0.60 J	2	**47**
	5/98	1 U	2	0.80 J	1	**61**
	10/98	1 U	3	1 U	1 U	**47**
	5/99	1 U	6	1 U	2	**40**
	11/99	0.50 U	5.3	0.80	1.7	**63**
	6/00	0.59	16	0.70	1.1	**51**
	6/01	0.77	21	0.84	1.2	**74**
	6/02	0.67	30 U	0.99	0.83	**130**
	6/03	0.57	28	1.5	0.94	**190 D**
	6/04	0.61	**130 D**	0.75	0.59 J	**120 D**
	6/05	0.9	34	2.2	0.7	**350**
	6/06	0.64	**93 D**	1.1	0.33 J	**200 D**
	6/07	0.68	38	1.5	0.42 J	**430 D**
	5/08	0.65	67 D	1	0.18 J	**380 D**
	06/09	0.21	14	0.64	0.13 J	**140 D**
	06/10	0.13 J	9.2	0.64	0.16 J	**79 J**
	06/11	0.1 J	3.6	0.76	0.22 J	**90**
	06/12	0.08	2.7	0.8	0.18 J	**56**
	06/13	0.5 U	0.93	0.79	0.21 J	**50**
	06/14	0.5 U	1	0.97	0.19 J	**50**
Seep A	6/96	16	7	3	88	68
	6/00	3.1	3.7	0.30 J	19	7.4
	6/01	1.4	1.3	0.31 J	11	3
	6/02	1.0	0.68	0.50 U	9.5	1.2
	6/03	0.50 U	0.50 U	0.24 J	1.6	0.36 J
	6/04	13	9.9	0.92	77	49
	6/05	0.2 U	0.2 U	0.3	2.2	0.3
	6/06	1.5 J	2 J	0.3 J	12 J	3.6 J
	6/07	0.42	0.85	0.31 J	2.8	2.4
	5/08	1.1	1.7	0.55	5.5	7.7
	06/09	1.5	1.9	0.39 J	5.7	6.4
	06/10	0.36 J	1.6	0.29 J	1.8	4.4
	07/11	0.5 U	0.09 J	0.1 J	0.5 U	1.4
	06/12	11 J	1.9	1	53 J	13
	06/13	0.5 U	1.3	0.26 J	1	3.3 J
	06/14	2.9	1	0.73	21	7.4

Table B-10 (Continued)
Summary of Selected Volatile Organic Compounds Detected in Groundwater and Seeps at OU 2 Area 8 (Fall 1995 to Spring 2014)

Location	Sampling Date	Analyte Concentration (µg/L)				
		1,1-DCE	cis-1,2-DCE	PCE	1,1,1-TCA	TCE
RG (Drinking Water)[a]		**7[b]**	**70**	**5[b]**	**200**	**5[b]**
RG (Surface Water)[a]		**3.2[b,c]**	**--**	**8.9[b,c]**	**42,000**	**81[b,c]**
Seep B	6/96	1 U	0.70 J	1 U	1	14
	6/00	0.50 U	0.50 U	0.50 U	0.30 J	2.2
	6/01	0.12 U	0.44 J	0.13 J	0.26 J	3.1
	6/02	0.50 U	0.52	0.12 J	0.15 J	5.4
	6/03	0.50 U	0.20 J	0.14 J	0.50 U	1.9
	6/04	0.50 U	0.23 J	0.39 J	0.80	0.61
	6/05	0.2 U	0.2 U	0.4	0.3	0.3
	6/06	0.5 U	0.18 J	0.22 J	0.12 J	0.48 J
	6/07	0.5 U	0.5 U	0.5 U	0.5 U	0.14 J
	5/08	0.5 U	0.12 J	0.17 J	0.1 J	0.41 J
	06/09	0.2 U	0.5 U	0.18 J	0.16 J	0.4 J
	06/10	0.5 U	0.51	0.18 J	0.09 J	5.7
	07/11	0.5 U	0.09 J	0.12 J	0.5 U	1.3

[a]Protection of human health for ingestion
[b]Value listed accounts for adjustment when the maximum contaminant level or water quality standard is sufficiently protective to serve as the RG for that individual chemical. Individual cleanup levels may require downward adjustment for multiple chemical contaminants or multiple exposure pathways. Value does not account for adjustments due to background levels or practical laboratory quantitation limits.
[c]Protection of human health for fish ingestion

Notes:
Bolded value indicates concentration in the monitoring well exceeds or is equal to the RG for drinking water, or in the seep exceeds or is equal to the RG for surface water.
Shaded row indicates data evaluated in this review period.
Yellow highlighted value exceeds or is equal to the surface water RG.
* - The reporting limit exceeds the RG
Data from 1995 to 2004 are from U.S. Navy 2005a, from 2005 to 2008 are from U.S. Navy 2008c, from 2009 are from U.S. Navy 2009d, and from 2010 through 2014 in U.S. Navy 2015c.
D - The reported result is from a dilution.
DCE - dichloroethene
H - Analytical result is from an analysis reported past the holding time.
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
MDL - method detection limit
µg/L - microgram per liter
MRL - method reporting limit
PCE - tetrachloroethene
RG - remediation goal
TCA - trichloroethane
TCE - trichloroethene
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table B-11
Summary of 1,4-Dioxane Results in Groundwater and Seeps at OU 2 Area 8 for June 2007 through 2014

Location	Sampling Date	1,4-Dioxane (µg/L)
MW8-8	06-07	**0.70 J**
	07-11	1.0 U *
	06-12	**0.76 J**
	06-13	1.0 U *
	06-14	1.0 U *
MW8-9	06-07	1.0 U *
	07-11	1.0 U *
	06-12	1.0 U *
	06-13	1.0 U *
	06-14	1.0 U *
MW8-11	06-07	**39**
	07-11	**29**
	06-12	**19**
	06-13	**11**
	06-14	**11**
MW8-12	06-07	**1.1**
	07-11	0.18 J
	06-12	**0.53 J**
	06-13	1.0 U *
	06-14	0.31 J
MW8-14	06-07	1.0 U *
	07-11	1.0 U *
	06-12	1.0 J
	06-13	1.0 U *
	06-14	1.0 U *
MW8-16	06-07	1.0 U *
	07-11	1.0 U *
	06-12	1.0 U *
	06-13	1.0 U *
	06-14	1.0 U *
Seep A	07-11	1.0 U *
Seep B	07-11	1.0 U *

Notes:
No remediation goal is established for 1,4-dioxane.
Bold value is equal to or exceeds the Model Toxics Control Act Method B cleanup level (0.44 µg/L).
Data are from U.S. Navy 2015c.
* - Reporting limit exceeds the MTCA Method B cleanup level.
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
MDL - method detection limit
µg/L - microgram per liter
MRL - method reporting limit
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table B-12
Summary of Inorganics Detected in Groundwater and Seeps at OU 2 Area 8 Exceeding One-Half of the MTCA Method B Cleanup Levels (Fall 1995 to Spring 2014)

		Analyte Concentration (µg/L)																									
		Arsenic				Cadmium		Total Chromium		Chromium VI		Copper		Lead		Mercury		Nickel		Silver		Thallium		Zinc		Cyanide	
Location	Sampling Date	Total	Total (ICP)	Dissolved	Dissolved (ICP)	Total	Dissolved	Total	Dissolved[b]	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
	RG Drinking Water	**0.05[e]**				**5**		**50[c]**		**80**		**590**		**15**		**2**		**100**		**48**		**1.1**		**4,800**		**320**	
	RG Surface Water	**0.14[a,e]**				**8**		**50[d]**		**50**		**2.5**		**5.8**		**0.025**		**7.9**		**1.2**		**1.6**		**77**		**1**	
MW8-6	6/96	NA	NA	NA	**1.1 B**	NA	(-)	NA	NA	(-)	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	54.8	(-)	NA
MW8-7	11/95	**3.3 +**	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	(-)	NA	0.11	NA	(-)	NA	(-)	NA	NS	**2.4 +**	(-)	NA	(-)	NA
MW8-8	11/95	(-)	NA	NA	NA	(-)	NA	NA	NA	**390**	NA	4.8 +	NA	(-)	NA	(-)	NA	12.8 +	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA
	6/96	NA	NA	NA	**1.4 B**	NA	(-)	NA	NA	**380**	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	NA	NA	**1.2 BN**	NA	(-)	(-)	NA
	9/96	NA	NA	(-)	NA	NA	(-)	**330**	NA	**320**	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	NA
	5/97	NA	NA	2.0 UN *	NA	NA	(-)	NA	**319**	NA	**350**	NA	2.0 U	NA	(-)	NA	0.20 U *	NA	5.0 U	NA	4.0 U *	NA	1.0 UN	NA	(-)	(-)	NA
	10/97	NA	NA	0.50 UN *	NA	NA	(-)	NA	**372**	NA	NA	NA	2.3 B	NA	(-)	NA	0.10 U *	NA	11.0 U *	NA	1.8 B	NA	1.8 UN *	NA	(-)	(-)	NA
	5/98	NA	NA	0.50 U *	NA	NA	(-)	NA	**344**	NA	NA	NA	(-)	NA	(-)	NA	0.10 U *	NA	4.0 U	NA	1.0 UN	NA	1.2 U *	NA	(-)	(-)	NA
	10/98	NA	NA	1.8 U *	NA	NA	(-)	NA	**322**	NA	NA	NA	(-)	NA	(-)	NA	0.10 U *	NA	(-)	NA	1.0 UN	NA	1.2 U *	NA	(-)	10 U *	NA
	5/99	NA	NA	1.7 U *	NA	NA	(-)	NA	**184 N**	NA	NA	NA	(-)	NA	(-)	NA	0.10 U *	NA	3.5 BN	NA	2.2 U *	NA	1.0 UN	NA	(-)	(-)	NA
	11/99	NA	NA	5 U *	NA	NA	2.5	NA	**154**	NA	NA	NA	10 U *	NA	2 U	NA	0.2 U *	NA	20 U *	NA	10 U *	NA	5 U *	NA	10 U	NA	0.01 U
	6/00	NA	NA	**0.20 J**	NA	NA	1.33	NA	**95.7**	NA	**102 J**	NA	0.46 J	NA	0.03	NA	0.10 U *	NA	3.21 J	NA	0.907	NA	0.01 U	NA	3.1	NA	10 U *
	6/01	NA	NA	0.3 UJ *	NA	NA	0.58	NA	**71.4**	NA	NS	NA	0.29 J	NA	0.04 U	0.0022	NA	NA	1.5	NA	0.62	NA	0.005 U	NA	2 U	NA	NA
	6/02	NA	NA	**0.13 J**	NA	NA	0.83 J	NA	**191**	NA	NA	NA	0.40	NA	0.15 UJ	NA	0.10 U *	NA	1.45	NA	0.47 J	NA	0.006 J	NA	0.8	NA	NA
	6/03	NA	NA	**0.43 J**	NA	NA	0.15	NA	**84.1 J**	NA	NA	NA	0.49	NA	0.04	NA	0.10 U *	NA	0.76 J	NA	0.17	NA	0.005 B	NA	0.7	NA	NA
	6/04	NA	NA	**0.32 B**	NA	NA	0.2	NA	**111**	NA	NA	NA	0.45	NA	0.009 B	NA	0.04 U *	NA	0.79	NA	0.489	NA	0.003 U	NA	1.45	NA	NA
	06/05	NA	NA	**0.44**	NA	NA	1.23	NA	**88.3**	NA	NA	NA	0.42	NA	0.1 U	NA	0.1 U *	NA	2.8	NA	0.265	NA	0.01 U	NA	0.99	NA	NA
	06/06	NA	NA	**0.27 B**	NA	NA	0.334	NA	**88.6**	NA	NA	NA	0.369	NA	0.021 U	NA	0.2 U *	NA	0.61 J	NA	0.284	NA	0.02 U	NA	1.02	NA	NA
	06/07	NA	NA	**0.26 J**	NA	NA	0.12	NA	**81.9**	NA	NA	NA	5.1	NA	0.24	NA	0.2 U *	NA	0.69	NA	0.19	NA	0.02 U	NA	1	NA	NA
	05/08	NA	NA	**0.21 B**	NA	NA	0.124	NA	**96**	NA	NA	NA	0.496	NA	0.054 U	NA	0.2 U *	NA	1.08	NA	0.182	NA	0.005 B	NA	0.77	NA	NA
	06/09	NA	NA	**0.21 J**	NA	NA	0.432	NA	43.8	NA	NA	NA	0.437	NA	0.020 U	NA	0.2 U *	NA	1.05	NA	0.746 J	NA	0.009 J	NA	1.43	NA	NA
	06/10	NA	NA	**0.85**	NA	NA	0.114	NA	**55.6**	NA	NA	NA	0.77	NA	0.02 UJ	NA	0.02 J	NA	0.72	NA	0.292	NA	0.02 U	NA	0.87	NA	NA
	07/11	NA	NA	**0.91**	NA	NA	0.036 UJ	NA	**118**	NA	NA	NA	0.55	NA	0.02 UJ	NA	0.2 U *	NA	0.4	NA	0.198	NA	0.02 U	NA	0.48 J	NA	NA
	06/12	NA	NA	**0.7**	NA	NA	0.022	NA	**59.6**	NA	NA	NA	0.51	NA	0.107	NA	0.2 U *	NA	0.68	NA	0.2	NA	0.013 J	NA	0.5	NA	NA
	05/13	NA	NA	**0.648**	NA	NA	0.008	NA	**52.3**	NA	NA	NA	0.33	NA	0.02 U	NA	0.2 U *	NA	0.34	NA	0.211	NA	0.02 U	NA	0.37 J	NA	NA
	06/14	NA	NA	**0.56**	NA	NA	0.015 J	NA	**66.7**	NA	NA	NA	0.39 J	NA	0.05	NA	0.0023	NA	0.33	NA	0.336	NA	0.02 U	NA	0.38 J	NA	NA
MW8-9	11/95	**3.0 NW**	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	3.6 W+	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA
	6/96	NA	NA	NA	**2.6 B**	NA	(-)	NA	NA	**380**	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	(-)	(-)	NA
	9/96	NA	NA	**3.4 BW**	NA	NA	3.5 B	(-)	NA	(-)	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	NA
	5/97	NA	NA	**3.2 NW**	NA	NA	(-)	NA	(-)	NA	(-)	NA	2.0 U	NA	(-)	NA	0.20 UN *	NA	5.0 U	NA	4.0 U *	NA	**134 N**	NA	(-)	(-)	NA
	10/97	NA	NA	**1.4 BNW**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.35	NA	11.0 U	NA	1.0 U	NA	1.8 UNW *	NA	(-)	(-)	NA
	5/98	NA	NA	**1.1 BW**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.10 U *	NA	7.0 B	NA	1.0 UN	NA	6.0 U *	NA	(-)	(-)	NA
	10/98	NA	NA	**5.4 B**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.13 B	NA	38.2 B	NA	2.0 B	NA	6.0 UW *	NA	(-)	10 U *	NA
	5/99	NA	NA	**2.0 B**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.10 U *	NA	16.3 BN	NA	2.7 B	NA	10.0 UNW *	NA	(-)	(-)	NA
	11/99	NA	NA	5 U *	NA	NA	**14**	NA	8	NA	NA	NA	10 U *	NA	2 U	NA	0.2 U *	NA	20 U *	NA	10	NA	5 U	NA	10 U	NA	0.01 U
	6/00	NA	NA	**0.80 J**	NA	NA	1.05	NA	9.8	NA	16 J	NA	0.95 J	NA	0.97	NA	0.10 U *	NA	8.57 J	NA	3.7	NA	0.01 U	NA	8.6	NA	10 U *
	6/01	NA	NA	**0.5 J**	NA	NA	1.13	NA	9.7	NA	NS	NA	0.78 J	NA	0.04 U	0.0036		NA	4.2	NA	1.61	NA	0.005 B	NA	3 U	NA	NA
	6/02	NA	NA	**0.43 J**	NA	NA	0.65 J	NA	6.43	NA	NA	NA	0.90	NA	0.049 UJ	NA	0.10 U *	NA	4.97	NA	1.44 J	NA	0.003 J	NA	3.2	NA	NA
	6/03	NA	NA	**0.58 J**	NA	NA	0.98	NA	6.9 J	NA	NA	NA	1.38	NA	0.23	NA	0.10 B	NA	4.85 J	NA	1.66	NA	0.015 B	NA	4.9	NA	NA
	6/04	NA	NA	**0.42 B**	NA	NA	0.51	NA	7.09	NA	NA	NA	0.73	NA	0.52	NA	0.05 U *	NA	3.91	NA	1.3	NA	0.003 U	NA	1.57	NA	NA
	06/05	NA	NA	**0.43**	NA	NA	0.904	NA	6.8	NA	NA	NA	0.75	NA	0.1 U	NA	0.1 U *	NA	3.5	NA	0.68	NA	0.01 U	NA	2.17	NA	NA
	06/06	NA	NA	**0.49 B**	NA	NA	0.454	NA	6.87	NA	NA	NA	0.652	NA	0.02 U	NA	0.2 U *	NA	2.57 J	NA	0.863	NA	0.02 U	NA	1.01	NA	NA
	06/07	NA	NA	**0.52 J**	NA	NA	0.3	NA	6.1	NA	NA	NA	8.1	NA	0.35	NA	0.2 U *	NA	2.3	NA	0.48	NA	0.02 U	NA	1.3	NA	NA
	05/08	NA	NA	**0.69**	NA	NA	0.363	NA	6.38	NA	NA	NA	0.654	NA	0.026 U	NA	0.2 U *	NA	2.25	NA	0.421	NA	0.004 B	NA	0.82	NA	NA
	06/09	NA	NA	**0.63 J**	NA	NA	0.59	NA	4.85	NA	NA	NA	0.659	NA	0.020 U	NA	0.2 U *	NA	1.55	NA	0.263 J	NA	0.020 U	NA	0.59	NA	NA
	06/10	NA	NA	**0.73**	NA	NA	0.174	NA	4.28	NA	NA	NA	0.739	NA	0.02 UJ	NA	0.2 U *	NA	1.2	NA	0.312	NA	0.02 UJ	NA	4.57	NA	NA
	07/11	NA	NA	**0.63**	NA	NA	0.343	NA	7.46	NA	NA	NA	0.739	NA	0.014 J	NA	0.2 U *	NA	1.74	NA	0.497	NA	0.02 UJ	NA	0.65	NA	NA
	06/12	NA	NA	**0.61**	NA	NA	0.286	NA	6.09	NA	NA	NA	0.581	NA	0.015 J	NA	0.2 U *	NA	1.48	NA	0.43	NA	0.02 UJ	NA	0.6	NA	NA
	05/13	NA	NA	**0.67**	NA	NA	0.238	NA	5.41	NA	NA	NA	0.561	NA	0.009 J	NA	0.2 U *	NA	1.28	NA	0.245	NA	0.02 UJ	NA	0.48 J	NA	NA
	06/14	NA	NA	**0.66**	NA	NA	0.231	NA	6.3	NA	NA	NA	0.564	NA	0.18	NA	0.00439	NA	1.38	NA	0.36	NA	0.02 UJ	NA	0.7	NA	NA

Table B-12 (Continued)
Summary of Inorganics Detected in Groundwater and Seeps at OU 2 Area 8 Exceeding One-Half of the MTCA Method B Cleanup Levels (Fall 1995 to Spring 2014)

		Analyte Concentration (µg/L)																									
		Arsenic				Cadmium		Total Chromium		Chromium VI		Copper		Lead		Mercury		Nickel		Silver		Thallium		Zinc		Cyanide	
Location	Sampling Date	Total	Total (ICP)	Dissolved	Dissolved (ICP)	Total	Dissolved	Total	Dissolved[b]	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
RG Drinking Water		0.05[e]				5		50[c]		80		590		15		2		100		48		1.1		4,800		320	
RG Surface Water		0.14[a,e]				8		50[d]		50		2.5		5.8		0.025		7.9		1.2		1.6		77		1	
MW8-11	11/95	2.0 W+	NA	NA	NA	251	NA	NA	NA	950	NA	13.4 S	NA	(-)	NA	0.22	NA	51.3	NA	4.2	NA	(-)	NA	207	NA	24	NA
	6/96	NA	NA	NA	1.0 U *	NA	444	NA	NA	800	NA	NA	18.9 B	NA	NA	NA	NA	NA	39.5 B	NA	NA	NA	(-)	NA	248	20	NA
	9/96	NA	NA	2.4 BW	NA	NA	262	626	NA	720	NA	NA	14.3 B	NA	NA	NA	NA	NA	42.3	NA	(-)	NA	NA	NA	166	NA	NA
	5/97	NA	NA	2.1 NW	NA	NA	210	NA	441	NA	610	NA	12.4	NA	(-)	NA	0.20 UN *	NA	30.5	NA	7.0 N	NA	10.0 UW *	NA	161	(-)	NA
	10/97	NA	NA	0.66 BNW	NA	NA	278	NA	377	NA	NA	NA	11.7 B	NA	(-)	NA	0.32	NA	40.0	NA	4.4 B	NA	9.0 UNW *	NA	178	(-)	NA
	5/98	NA	NA	0.50 UW *	NA	NA	320	NA	303	NA	NA	NA	12.5 B	NA	(-)	NA	0.10 U *	NA	36.9 B	NA	5.2 BN	NA	6.0 U *	NA	193	(-)	NA
	10/98	NA	NA	2.1 B	NA	NA	126 E	NA	459	NA	NA	NA	9.0 B	NA	(-)	NA	0.17 B	NA	16.2 B	NA	2.2 B	NA	1.2 UW *	NA	50.9	11	NA
	5/99	NA	NA	2.6 B	NA	NA	33.5 N	NA	198	NA	NA	NA	5.3 B	NA	(-)	NA	0.10 B	NA	4.6 BN	NA	2.2 U *	NA	10.0 UNW *	NA	(-)	(-)	NA
	11/99	NA	NA	5 U *	NA	NA	205	NA	201	NA	NA	NA	10 U *	NA	2U	NA	0.2 U *	NA	20 U *	NA	10	NA	5 U *	NA	89	NA	0.03 U
	6/00	NA	NA	0.80 J	NA	NA	106	NA	221	NA	227 J	NA	4.44 J	NA	0.16	NA	0.10 U *	NA	10.2 J	NA	2.09	NA	0.04	NA	109	NA	10 U *
	6/01	NA	NA	0.7 J	NA	NA	129	NA	429	NA	NS	NA	4.95 J	NA	0.062	0.0071		NA	13	NA	2.29	NA	0.038	NA	110	NA	NA
	6/02	NA	NA	0.52 J	NA	NA	420 J	NA	608	NA	NA	NA	4.90	NA	0.047 UJ	NA	0.10 U *	NA	9.46	NA	3.87 J	NA	0.040 J	NA	221	NA	NA
	6/03	NA	NA	0.61 J	NA	NA	353	NA	302 J	NA	NA	NA	5.15	NA	0.02 U	NA	0.10 U *	NA	9.10 J	NA	5.87	NA	0.041	NA	134	NA	NA
	6/04	NA	NA	0.57	NA	NA	357	NA	290	NA	NA	NA	5.29	NA	0.036	NA	0.08 U *	NA	31.9	NA	6.45	NA	0.053	NA	157	NA	NA
	06/05	NA	NA	1.9	NA	NA	266	NA	230	NA	NA	NA	4.63	NA	0.1 U	NA	0.1 U *	NA	24.4	NA	6	NA	0.05	NA	91	NA	NA
	06/06	NA	NA	0.61	NA	NA	338	NA	157	NA	NA	NA	3.48	NA	0.066 U	NA	0.2 U *	NA	25.8 J	NA	6.17	NA	0.0405	NA	135	NA	NA
	06/07	NA	NA	0.53 J	NA	NA	231	NA	150	NA	NA	NA	3.60	NA	0.094	NA	0.2 U *	NA	19.3	NA	4.70	NA	0.038	NA	81.0	NA	NA
	05/08	NA	NA	0.82	NA	NA	154	NA	191	NA	NA	NA	3.44	NA	0.055 U	NA	0.2 U *	NA	15.1	NA	3.5	NA	0.025	NA	58.1	NA	NA
	06/09	NA	NA	0.94 J	NA	NA	115	NA	163	NA	NA	NA	3.1	NA	0.020 U	NA	0.2 U *	NA	11.1	NA	2.45 J	NA	0.024	NA	49.1	NA	NA
	06/10	NA	NA	0.87	NA	NA	214	NA	157	NA	NA	NA	3.09	NA	0.02 UJ	NA	0.02 J	NA	19.8	NA	5.86	NA	0.034 UJ	NA	85.7	NA	NA
	07/11	NA	NA	0.68	NA	NA	166	NA	165	NA	NA	NA	3	NA	0.023	NA	0.2 U *	NA	16	NA	3.55	NA	0.025	NA	68	NA	NA
	06/12	NA	NA	0.7	NA	NA	152	NA	153	NA	NA	NA	2.81	NA	0.02 U	NA	0.2 U *	NA	11.4	NA	3.22	NA	0.026 UJ	NA	68.4	NA	NA
	05/13	NA	NA	0.86	NA	NA	85.1	NA	187	NA	NA	NA	2.61	NA	0.014 J	NA	0.2 U *	NA	9.77	NA	2.77	NA	0.022 UJ	NA	44	NA	NA
	06/14	NA	NA	0.93	NA	NA	106	NA	164	NA	NA	NA	2.76	NA	0.05	NA	0.00973	NA	12.1	NA	2.6	NA	0.033 UJ	NA	43	NA	NA
MW8-12	11/95	5.1 N	NA	NA	NA	28.6	NA	NA	NA	1500	NA	329 S+	NA	11.7	NA	0.19	NA	34.6 +	NA	(-)	NA	(-)	NA	(-)	NA	47	NA
	6/96	NA	NA	NA	3.6 B	NA	46.1	NA	NA	380	NA	NA	(-)	NA	NA	NA	NA	NA	17.9 B	NA	NA	NA	(-)	NA	29.7	31	NA
	9/96	NA	NA	1.9 B	NA	NA	53.8	1740	NA	1800	NA	NA	(-)	NA	NA	NA	NA	NA	49.3	NA	(-)	NA	NA	NA	(-)	NA	NA
	5/97	NA	NA	2.0 UN *	NA	NA	565	NA	1280	NA	1400	NA	64.4	NA	20 UN *	NA	0.20 UN *	NA	673	NA	40 UN *	NA	1.0 UNW	NA	727	(-)	NA
	10/97	NA	NA	1.8 BN	NA	NA	154	NA	961	NA	NA	NA	150	NA	(-)	NA	0.10 U *	NA	423	NA	1.8 B	NA	1.8 UNW *	NA	325	(-)	NA
	5/98	NA	NA	2.4 BW	NA	NA	7.3	NA	728	NA	NA	NA	5.2 B	NA	(-)	NA	0.10 U *	NA	7.5 B	NA	1.0 BN	NA	1.2 U *	NA	(-)	(-)	NA
	10/98	NA	NA	1.8 U *	NA	NA	6.5 E	NA	1090	NA	NA	NA	4.0 B	NA	(-)	NA	0.15 B	NA	8.9 B	NA	1.2 B	NA	1.2 U *	NA	(-)	58	NA
	5/99	NA	NA	1.7 U *	NA	NA	45.7 N	NA	815 N	NA	NA	NA	19.9 B	NA	3.2 N	NA	0.10 U *	NA	70.0 N	NA	2.2 U *	NA	1.0 UNW	NA	48.9	(-)	NA
	11/99	NA	NA	NA	NA	NA	(-)	NA	(-)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6/00	NA	NA	0.20 J	NA	NA	20	NA	163	NA	216 J	NA	5.65 J	NA	0.75	NA	0.10 U *	NA	26.8 J	NA	0.88	NA	0.01 U	NA	24.9	NA	10 U *
	6/01	NA	NA	0.3 J	NA	NA	20.7	NA	193	NA	NA	NA	6.14 J	NA	1.2	0.0022	NA	NA	22	NA	1.24	NA	0.013 B	NA	25.3	NA	NA
	6/02	NA	NA	0.37 J	NA	NA	4.42 J	NA	238	NA	NA	NA	4.10	NA	0.17 UJ	NA	0.10 U *	NA	2.77	NA	0.27 K	NA	0.006 J	NA	1.8	NA	0.06
	6/03	NA	NA	0.32 J	NA	NA	7.84	NA	107 J	NA	NA	NA	2.78	NA	0.15	NA	0.10 U *	NA	4.36 J	NA	0.47	NA	0.013 B	NA	2.3	NA	NA
	6/04	NA	NA	0.43 B	NA	NA	3.23	NA	146	NA	NA	NA	5.15	NA	0.096	NA	0.05 U *	NA	2.55	NA	-0.197	NA	0.007 B	NA	0.92	NA	NA
	06/05	NA	NA	1.3	NA	NA	2.04	NA	114	NA	NA	NA	3.7	NA	0.219	NA	0.1 U *	NA	3	NA	0.22	NA	0.01 U	NA	5.97	NA	NA
	06/06	NA	NA	0.28 B	NA	NA	2.71	NA	113	NA	NA	NA	2.67	NA	0.048 U	NA	0.2 U *	NA	1.99 J	NA	0.279	NA	0.02 U	NA	4.17	NA	NA
	06/07	NA	NA	0.47 J	NA	NA	0.31	NA	101	NA	NA	NA	2.6	NA	0.054	NA	0.2 U *	NA	0.92	NA	0.037	NA	0.02 U	NA	0.67	NA	NA
	05/08	NA	NA	0.53	NA	NA	0.431	NA	100	NA	NA	NA	2.18	NA	0.036 U	NA	0.2 U *	NA	1.07	NA	0.057	NA	0.004 B	NA	0.25 B	NA	NA
	06/09	NA	NA	0.68 J	NA	NA	0.109	NA	80.8	NA	NA	NA	1.65	NA	0.018 J	NA	0.2 U *	NA	0.57	NA	0.016 J	NA	0.006 J	NA	0.15 J	NA	NA
	06/10	NA	NA	0.35 J	NA	NA	0.433	NA	74.8	NA	NA	NA	2.48	NA	0.264 J	NA	0.02 J	NA	0.93	NA	0.05	NA	0.02 UJ	NA	0.39 J	NA	NA
	07/11	NA	NA	0.46 J	NA	NA	0.194	NA	137	NA	NA	NA	2.22	NA	0.048	NA	0.2 U *	NA	0.66	NA	0.027 UJ	NA	0.02 UJ	NA	0.2 J	NA	NA
	06/12	NA	NA	0.5	NA	NA	0.128	NA	106	NA	NA	NA	1.78	NA	0.028	NA	0.2 U *	NA	0.57	NA	0.019 J	NA	0.034 J	NA	0.5 UJ	NA	NA
	05/13	NA	NA	4.63	NA	NA	0.063	NA	89.4	NA	NA	NA	1.53	NA	0.032	NA	0.2 U *	NA	0.42	NA	0.008 J	NA	0.02 U	NA	0.43 J	NA	NA
	06/14	NA	NA	2.2	NA	NA	0.096	NA	97.2	NA	NA	NA	2.7 J	NA	0.064	NA	0.00142	NA	0.33	NA	0.02 UJ	NA	0.02 U	NA	0.35 J	NA	NA
MW8-14	11/95	5.1 W+	NA	NA	NA	22.4	NA	NA	NA	90	NA	152 S	NA	203 N	NA	0.52	NA	100	NA	(-)	NA	(-)	NA	241	NA	(-)	NA
	6/96	NA	NA	NA	3.3 B	NA	10.9	NA	NA	(-)	NA	NA	6.7 B	NA	NA	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	29.9	(-)	NA

Table B-12 (Continued)
Summary of Inorganics Detected in Groundwater and Seeps at OU 2 Area 8 Exceeding One-Half of the MTCA Method B Cleanup Levels (Fall 1995 to Spring 2014)

Location	Sampling Date	Arsenic Total	Arsenic Total (ICP)	Arsenic Dissolved	Arsenic Dissolved (ICP)	Cadmium Total	Cadmium Dissolved	Total Chromium Total	Total Chromium Dissolved[b]	Chromium VI Total	Chromium VI Dissolved	Copper Total	Copper Dissolved	Lead Total	Lead Dissolved	Mercury Total	Mercury Dissolved	Nickel Total	Nickel Dissolved	Silver Total	Silver Dissolved	Thallium Total	Thallium Dissolved	Zinc Total	Zinc Dissolved	Cyanide Total	Cyanide Dissolved
		Analyte Concentration (µg/L)																									
RG Drinking Water		0.05[e]				5		50[c]		80		590		15		2		100		48		1.1		4,800		320	
RG Surface Water		0.14[a,e]				8		50[d]		50		2.5		5.8		0.025		7.9		1.2		1.6		77		1	
	9/96	NA	NA	**3.1 BW**	NA	NA	**19.9**	(-)	NA	(-)	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	8.6 B	NA	NA	NA	(-)	NA	NA
	5/97	NA	NA	**2.8 NW**	NA	NA	**9.8**	NA	(-)	NA	(-)	NA	2.0 U	NA	(-)	NA	0.20 UN *	NA	5.0 U	NA	7.3 N	NA	10.0 UN *	NA	(-)	(-)	NA
	10/97	NA	NA	**1.0 BNW**	NA	NA	3.2	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.48	NA	11.0 U *	NA	2.0 B	NA	1.8 UBN *	NA	(-)	(-)	NA
	5/98	NA	NA	**0.86 BW**	NA	NA	**12.6**	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.10 U *	NA	4.8 B	NA	1.2 BN	NA	6.0 U *	NA	(-)	(-)	NA
	10/98	NA	NA	**10.8**	NA	NA	**16.9 E**	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.15 B	NA	4 B	NA	1.0 U	NA	6.0 UW *	NA	(-)	10 U *	NA
	5/99	NA	NA	**2.2 B**	NA	NA	**10.5 N**	NA	(-)	NA	NA	NA	13.2	NA	(-)	NA	0.10 U *	NA	(-)	NA	2.2 U *	NA	10.0 UNW *	NA	(-)	(-)	NA
	11/99	NA	NA	5 U *	NA	NA	**13**	NA	7	NA	NA	NA	10 U *	NA	2U	NA	0.2U *	NA	20 U *	NA	10 U *	NA	5 U	NA	10 U	NA	0.01 U
	6/00	NA	NA	**2**	NA	NA	**13.8**	NA	14.4	NA	58.8 J	NA	1.22 J	NA	0.61	NA	0.10 U *	NA	3.71 J	NA	0.564	NA	0.01 U	NA	3.2	NA	10 U *
	6/01	NA	NA	**1.3 J**	NA	NA	**13.2**	NA	29.7	NA	NA	NA	1.16 J	NA	0.959	.0009 B		NA	2.4	NA	0.31	NA	0.007 B	NA	3 U	NA	NA
	6/02	NA	NA	**1.53 J**	NA	NA	**14.9 J**	NA	15.8	NA	NA	NA	1.70	NA	0.74 UJ	NA	0.10 U *	NA	4.63	NA	0.44 J	NA	0.007 J	NA	4	NA	NA
	6/03	NA	NA	**2.08 J**	NA	NA	**14.6**	NA	16.2 J	NA	NA	NA	1.53	NA	0.74	NA	0.10 U *	NA	4.71 J	NA	0.38	NA	0.006 B	NA	2.6	NA	NA
	6/04	NA	NA	**1.63**	NA	NA	**13.5**	NA	22.2	NA	NA	NA	1.37	NA	0.89	NA	0.06 U *	NA	5.61	NA	0.351	NA	0.007 B	NA	2.6	NA	NA
	06/05	NA	NA	**2**	NA	NA	**12.5**	NA	17.8	NA	NA	NA	1.65	NA	1.1	NA	0.1 U *	NA	6.9	NA	0.46	NA	0.01 U	NA	2.92	NA	NA
	06/06	NA	NA	**1.66**	NA	NA	**11.1**	NA	14.9	NA	NA	NA	1.13	NA	0.682	NA	0.2 U *	NA	5.17 J	NA	0.358	NA	0.02 U	NA	2.25	NA	NA
	06/07	NA	NA	**1.5 J**	NA	NA	**9.8**	NA	15.4	NA	NA	NA	2.9	NA	0.99	NA	0.2 U *	NA	5.5	NA	0.33	NA	0.02 U	NA	2.6	NA	NA
	05/08	NA	NA	**1.91**	NA	NA	**8.33**	NA	21	NA	NA	NA	1.38	NA	0.817	NA	0.2 U *	NA	5.21	NA	0.24	NA	0.012 B	NA	2.2	NA	NA
	06/09	NA	NA	**1.78 J**	NA	NA	**8.91**	NA	18.2	NA	NA	NA	1.76	NA	1.18	NA	0.2 U *	NA	5.08	NA	0.259 J	NA	0.005 J	NA	2.58	NA	NA
	06/10	NA	NA	**1.91**	NA	NA	**10.4**	NA	28.3	NA	NA	NA	1.42	NA	1.57 J	NA	0.2 U *	NA	4.89	NA	0.383	NA	0.02 UJ	NA	2.23	NA	NA
	07/11	NA	NA	**1.75**	NA	NA	**8.65**	NA	15.1	NA	NA	NA	1.87	NA	1.06	NA	0.2 U *	NA	5.42	NA	0.285	NA	0.02 UJ	NA	2.38	NA	NA
	06/12	NA	NA	**1.67**	NA	NA	**7.9**	NA	19.8	NA	NA	NA	1.29	NA	0.88	NA	0.2 U *	NA	4.42	NA	0.223	NA	0.039 J	NA	2.1	NA	NA
	05/13	NA	NA	**1.56**	NA	NA	**8.52**	NA	23.9	NA	NA	NA	1.29	NA	1.07	NA	0.2 U *	NA	4.25	NA	0.237	NA	0.02 UJ	NA	2.01	NA	NA
	06/14	NA	NA	**1.6**	NA	NA	**7.6**	NA	15.76	NA	NA	NA	1.91	NA	1.17	NA	0.00202	NA	4.35	NA	0.25	NA	0.02 UJ	NA	2.6	NA	NA
MW8-15	11/95	(-)	NA	1.0 UN *	NA	(-)	(-)	NA	NA	(-)	NA	2.5 +	(-)	(-)	(-)	(-)	NA	(-)	9.3 +	(-)	3.0 UNW *	NS	(-)	(-)	35.6	(-)	NA
MW8-16	11/95	**2.3 +**	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	(-)	NA	0.16	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA
	6/96	NA	NA	NA	**2.8 B**	NA	(-)	NA	NA	(-)	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	NA	NA	**1.1 BNW**	NA	(-)	(-)	NA
	9/96	NA	NA	**2.9 B**	NA	NA	(-)	(-)	NA	(-)	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	NA
	5/97	NA	NA	**2.3 N**	NA	NA	(-)	NA	(-)	NA	(-)	NA	2.0 U	NA	(-)	NA	0.20 UN *	NA	5.0 U	NA	4.0 UN *	NA	1.0 UNW	NA	(-)	(-)	NA
	10/97	NA	NA	**1.4 BN**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.10 U *	NA	11.0 U *	NA	1.0 U	NA	1.8 UN *	NA	(-)	(-)	NA
	5/98	NA	NA	**1.2 B**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.10 U *	NA	5.7 B	NA	1.0 UN	NA	1.2 U *	NA	(-)	(-)	NA
	10/98	NA	NA	1.8 U *	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.10 U *	NA	(-)	NA	1.0 U	NA	1.2 U *	NA	(-)	10 U *	NA
	5/99	NA	NA	1.7 U *	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	3.4 N	NA	0.11 B	NA	4,1 BN	NA	2.2 U *	NA	1.0 UNW	NA	(-)	(-)	NA
	11/99	NA	NA	5 U *	NA	NA	4 U	NA	5U	NA	NA	NA	10 U *	NA	2 U	NA	0.2 U *	NA	20 U *	NA	10 U *	NA	5 U *	NA	10 U	NA	0.01 U
	6/00	NA	NA	**1.14 J**	NA	NA	0.16	NA	.17 U	NA	4.0 U	NA	0.20 J	NA	7 U *	NA	0.10 U *	NA	1.02 J	NA	0.020 B	NA	0.03 U	NA	4	NA	10 UJ *
	6/01	NA	NA	**1.5 J**	NA	NA	0.21	NA	0.45	NA	NA	NA	0.2 R	NA	0.04 U	.0003 B	NA	NA	1.4	NA	0.07 U	NA	0.005 U	NA	36.5	NA	NA
	6/02	NA	NA	**1.82 J**	NA	NA	0.065 J	NA	0.04 U	NA	NA	NA	0.20	NA	0.011 UJ	NA	0.10 U *	NA	2.59	NA	0.001 J	NA	0.002 J	NA	1.7	NA	NA
	6/03	NA	NA	**2.37 J**	NA	NA	0.42	NA	1.0 UJ	NA	NA	NA	0.10 U	NA	0.10 U	NA	0.10 U *	NA	9.34 J	NA	0.04 U	NA	0.02 U	NA	2.3 B	NA	NA
	6/04	NA	NA	**2.75**	NA	NA	0.055	NA	0.04 U	NA	NA	NA	0.38	NA	0.011 B	NA	0.04 U *	NA	3.76	NA	0.005 U	NA	0.001 U	NA	1.07	NA	NA
	06/05	NA	NA	**3**	NA	NA	2 U	NA	5 U	NA	NA	NA	2	NA	2 U	NA	0.1 U *	NA	10 U *	NA	3 U *	NA	1 U	NA	6 U	NA	NA
	06/06	NA	NA	**2.44**	NA	NA	0.186	NA	0.2 U	NA	NA	NA	0.043 B	NA	0.02 U	NA	0.2 U *	NA	3.61 J	NA	0.028	NA	0.02 U	NA	1.15	NA	NA
	06/07	NA	NA	**2.3 J**	NA	NA	0.098	NA	1	NA	NA	NA	0.77	NA	0.075	NA	0.2 U *	NA	2.7	NA	0.02 U	NA	0.02 U	NA	1	NA	NA
	05/08	NA	NA	**3.61**	NA	NA	0.125	NA	0.41	NA	NA	NA	0.043 B	NA	0.044 U	NA	0.2 U *	NA	0.64	NA	0.01 B	NA	0.002 U	NA	0.36 B	NA	NA
	06/09	NA	NA	**3.50 J**	NA	NA	0.013 J	NA	0.10 J	NA	NA	NA	0.156	NA	0.020 U	NA	0.2 U *	NA	0.42	NA	0.004 J	NA	0.02 U	NA	0.10 J	NA	NA
	06/10	NA	NA	**1.52**	NA	NA	0.022 UJ	NA	0.06 J	NA	NA	NA	0.1 UJ	NA	0.02 UJ	NA	0.2 U *	NA	1	NA	0.005 J	NA	0.02 UJ	NA	0.21 J	NA	NA
	07/11	NA	NA	**4.1**	NA	NA	0.059	NA	0.29	NA	NA	NA	0.72	NA	0.02 UJ	NA	0.2 U *	NA	0.65	NA	0.02 UJ	NA	0.02 U	NA	0.46 J	NA	NA
	06/12	NA	NA	**2.04**	NA	NA	0.027	NA	0.33	NA	NA	NA	0.295	NA	0.009 J	NA	0.2 U *	NA	0.35	NA	0.015 J	NA	0.02 UJ	NA	0.5 UJ	NA	NA
	05/13	NA	NA	**4.19**	NA	NA	0.037	NA	2.49	NA	NA	NA	0.5	NA	0.042	NA	0.2 U *	NA	0.68	NA	0.053	NA	0.02 U	NA	1.25	NA	NA
	06/14	NA	NA	**3.9**	NA	NA	0.013 J	NA	1.11	NA	NA	NA	1.06 J	NA	0.054	NA	0.00289	NA	0.31	NA	0.022 UJ	NA	0.02 U	NA	0.84	NA	NA
MW8-17	11/95	**3.0 N**	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	26.7 S+	NA	(-)	NA	0.11	NA	35.2 +	NA	(-)	NA	NA	(-)	(-)	NA	(-)	NA
MW8-18	11/95	**1.8 N**	NA	**1.2 N**	NA	(-)	(-)	NA	NA	(-)	NA	3.8 +	(-)	(-)	(-)	(-)	NA	16.0 +	9.0 +	(-)	3.0 UNW *	NA	(-)	(-)	(-)	(-)	NA
MW8-19	11/95	**3.3 NW**	NA	**1.9 N**	NA	(-)	(-)	NA	NA	(-)	NA	22.9 S+	1.3 +	3.2	NA	(-)	NA	25.7 +	9.0 U + *	(-)	3.0 UNW *	NA	(-)	(-)	(-)	(-)	NA

Table B-12 (Continued)

Summary of Inorganics Detected in Groundwater and Seeps at OU 2 Area 8 Exceeding One-Half of the MTCA Method B Cleanup Levels (Fall 1995 to Spring 2014)

		Analyte Concentration (µg/L)																									
		Arsenic				Cadmium		Total Chromium		Chromium VI		Copper		Lead		Mercury		Nickel		Silver		Thallium		Zinc		Cyanide	
Location	Sampling Date	Total	Total (ICP)	Dissolved	Dissolved (ICP)	Total	Dissolved	Total	Dissolved[b]	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
RG Drinking Water		**0.05[e]**				**5**		**50[c]**		**80**		**590**		**15**		**2**		**100**		**48**		**1.1**		**4,800**		**320**	
RG Surface Water		**0.14[a,e]**				**8**		**50[d]**		**50**		**2.5**		**5.8**		**0.025**		**7.9**		**1.2**		**1.6**		**77**		**1**	
MW8-20	11/95	(-)	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	7.9 +	NA	(-)	NA	(-)	NA	18.6 +	NA	(-)	NA	NA	(-)	(-)	NA	(-)	NA
Seep A[f]	6/96	NA	NA	NA	1.3 B	46.7	33.9	183	159	240	NA	7.8 B	5.1 B	NA	NA	NA	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	(-)	NA
	5/97	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	(-)	NA	NA	NA	NA
	6/00	NA	NA	2.4 J	NA	NA	0.14	NA	0.6	NA	NA	NA	0.27	NA	1.3 J	NA	NA	NA	5.59 J	NA	1.14 J	NA	0.02	NA	0.8	NA	10 U *
	6/01	NA	NA	0.9 J	NA	NA	23.2	NA	5.6	NA	NA	NA	1 J	NA	0.06	0.0034	NA	NA	1	NA	0.1	NA	0.022	NA	7.6 B	NA	NA
	6/02	NA	NA	1.95 J	NA	NA	2.57 J	NA	0.44 U	NA	NA	NA	0.80	NA	0.054 UJ	NA	0.10 U *	NA	0.95	NA	0.011 UJ	NA	0.003 J	NA	1.3	NA	NA
	6/03	NA	NA	1.29 J	NA	NA	38.3	NA	7.6 J	NA	NA	NA	0.89	NA	0.03	NA	0.10 U *	NA	1.22 J	NA	0.02	NA	0.012 B	NA	4.5 B	NA	NA
	6/04	NA	NA	0.66	NA	NA	88.9	NA	45.5	NA	NA	NA	1.08	NA	0.032	NA	0.06 U *	NA	4.29	NA	0.031	NA	0.015 B	NA	0.83	NA	NA
	06/05	NA	NA	1.7	NA	NA	50.3	NA	11	NA	NA	NA	1.13	NA	0.1 U	NA	0.1 U *	NA	2	NA	0.032 U	NA	0.014	NA	1.83	NA	NA
	06/06	NA	NA	1.21	NA	NA	14.4	NA	3.58	NA	NA	NA	0.814	NA	0.08 U	NA	0.2 U *	NA	1.74 J	NA	0.162	NA	0.02 U	NA	1.4	NA	NA
	06/07	NA	NA	1 J	NA	NA	19.4	NA	7.2	NA	NA	NA	1.2	NA	0.063	NA	0.2 U *	NA	1.5	NA	0.02 U	NA	0.02 U	NA	1.5	NA	NA
	05/08	NA	NA	2.48	NA	NA	7.96	NA	10.6	NA	NA	NA	0.867	NA	0.092 U	NA	0.2 U *	NA	1.77	NA	0.037	NA	0.01 B	NA	1.44	NA	NA
	06/09	NA	NA	1.50 J	NA	NA	2.57	NA	5.0	NA	NA	NA	0.383	NA	0.028	NA	0.2 U *	NA	1.18	NA	0.013 J	NA	0.003 J	NA	1.00	NA	NA
	06/10	NA	NA	1.66	NA	NA	6.6	NA	4.87	NA	NA	NA	0.517	NA	0.042 UJ	NA	0.2 U *	NA	1.94	NA	0.03	NA	0.02 UJ	NA	2.58	NA	NA
	07/11	NA	NA	1.19	NA	NA	1.08	NA	3.59	NA	NA	NA	0.651	NA	0.036	NA	0.2 U *	NA	1.58	NA	0.02 UJ	NA	0.02 UJ	NA	0.6	NA	NA
	06/12	NA	NA	0.98	NA	NA	15.4	NA	7.52	NA	NA	NA	0.468	NA	0.047	NA	0.2 U *	NA	2.99	NA	0.107	NA	0.026 UJ	NA	1.21	NA	NA
	05/13	NA	NA	1.27	NA	NA	0.848	NA	4.32	NA	NA	NA	0.435	NA	0.016 J	NA	0.2 U *	NA	1.03 UJ	NA	0.009 J	NA	0.02 UJ	NA	0.68	NA	NA
	06/14	NA	NA	1.1	NA	NA	2.9	NA	7.3	NA	NA	NA	0.511	NA	0.03	NA	0.00162	NA	1.97	NA	0.02 UJ	NA	0.02 UJ	NA	0.8	NA	NA
Seep B[f]	6/96	NA	3.0 B	NA	4.6 B	(-)	(-)	NA	NA	(-)	NA	24.5 B	8.5 B	NA	NA	NA	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	(-)	NA
	5/97	NA	NA	NA	NA	NA	NS	NA	NS	NA	NA	NA	NS	NA	NA	NA	NA	NA	NS	NA	NA	NA	(-)	NA	NA	NA	NA
	6/00	NA	NA	2.5 J	NA	NA	0.82	NA	6.4	NA	NA	NA	0.76	NA	.22 J	NA	NA	NA	.83 J	NA	0.297 J	NA	0.01 U	NA	1.4	NA	10 U *
	6/01	NA	NA	1.4 J	NA	NA	1.52	NA	4.4	NA	NA	NA	0.8 J	NA	0.04 U	.0009 B	NA	NA	1	NA	0.1 U	NA	0.011 B	NA	3.4 U	NA	NA
	6/02	NA	NA	1.29 J	NA	NA	2.23 J	NA	3.54	NA	NA	NA	0.90	NA	0.024 UJ	NA	0.10 U *	NA	1.95	NA	0.049 J	NA	0.011 J	NA	1.9	NA	NA
	6/03	NA	NA	1.33 J	NA	NA	4.18	NA	2.9 J	NA	NA	NA	0.76	NA	0.02 U	NA	0.10 U *	NA	1.26 J	NA	0.09	NA	0.013 B	NA	9.0 B	NA	NA
	6/04	NA	NA	1.02	NA	NA	8.33	NA	15.9	NA	NA	NA	0.71	NA	0.27	NA	0.06 U *	NA	4.31	NA	0.097	NA	0.017 B	NA	0.97	NA	NA
	06/05	NA	NA	1.43	NA	NA	2.06	NA	6.52	NA	NA	NA	0.89	NA	0.1 U	NA	0.1 U *	NA	2.77	NA	0.035	NA	0.01 U	NA	1.12	NA	NA
	06/06	NA	NA	1.32	NA	NA	2.1	NA	3.33	NA	NA	NA	0.602	NA	0.022	NA	0.2 U *	NA	2.64 J	NA	0.085	NA	0.02 U	NA	1.01	NA	NA
	06/07	NA	NA	1.1 J	NA	NA	1.1	NA	2.7	NA	NA	NA	0.6	NA	0.058	NA	0.2 U *	NA	1.8	NA	0.02 U	NA	0.02 U	NA	0.96	NA	NA
	05/08	NA	NA	2.27	NA	NA	1.26	NA	3.28	NA	NA	NA	0.668	NA	0.18 U	NA	0.2 U *	NA	2.11	NA	0.051	NA	0.019 B	NA	1.39	NA	NA
	06/09	NA	NA	1.26 J	NA	NA	0.616	NA	3.19	NA	NA	NA	0.618	NA	0.058	NA	0.2 U *	NA	1.10	NA	0.009 J	NA	0.004 J	NA	0.73	NA	NA
	06/10	NA	NA	1.4	NA	NA	0.928	NA	3.7	NA	NA	NA	0.646	NA	0.02 UJ	NA	0.2 U *	NA	1.46	NA	0.202	NA	0.02 UJ	NA	2.31	NA	NA
	07/11	NA	NA	1.17	NA	NA	1.05	NA	3.53	NA	NA	NA	0.69	NA	0.025	NA	0.2 U *	NA	1.61	NA	0.024 UJ	NA	0.018 J	NA	0.68	NA	NA

[a]Value listed is the lower of the cancer or noncancer value.
[b]Results are less than the results reported for chromium (VI) because of variation in analytical methods. Variance in results for these analytes is common.
[c]Value is for total chromium. Chromium (VI) is 80 µg/L.
[d]50 µg/L is for chromium (VI). There is no goal for total chromium.
[e]The background concentration of arsenic in groundwater at the site is 12 µg/L.
[f]Seeps are only compared to surface water RGs.

Notes:
Data from 1995 to 2004 are from U.S. Navy 2005a, from 2005 to 2008 are from U.S. Navy 2008e, from 2009 are from U.S. Navy 2009d, and from 2010 through 2014 are from U.S. Navy 2014b (updated some values based on Naval Installation Restoration Information Solution download).
Shaded row indicates data evaluated in this 5-year review period.
Bolded value indicates it exceeds or is equal to the RG for drinking water.
Yellow highlighted value exceeds or is equal to the surface water RG.
* - The reporting limit exceeds the RG.
(-) - undetected above one-half of the MTCA Method B cleanup levels
\+ - Duplicate analysis is not within control limits.
B - between instrument detection limit and contract required detection limit
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
MDL - method detection limit
µg/L - microgram per liter
MRL - method reporting limit
MTCA - Model Toxics Control Act
N - Spiked sample is outside of control limits.
NA - not analyzed
RG - remediation goal
S - determined by method of standard additions
W - Post-digestion spike for furnace atomic absorption spectrophotometric analysis is out of control limits (85 to 115%), and sample is less than 50% of spike absorbance.
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table B-13
SVOC Concentrations in OU 2 Area 8 Sediments (1996 Through 2008)

Location	Sampling Date	Fluoranthene (µg/kg)	Phenanthrene (µg/kg)	Phenol (µg/kg)
Sediment Quality Standard		**160**	**100**	**420**
Cleanup Screening Level		**1,200**	**480**	**1,200**
Background Screening Value[a]		**NA**	**NA**	**NA**
Remedial Investigation[b]				
LB17	-	110 J	**110**	210
LB18	-	ND	ND	**650**
Seep Sediments				
S.STATION1	04-MAY-1996	110	14	**3,000 J**
	01-JUN-2000	17	7 J	140
	03-JUN-2004	15	4.3 J	400
	29-JUL-2008	9.8 U	2.5 J	**670**
S.STATION2	04-MAY-1996	13	4.5 J	**1,900**
	01-JUN-2000	28	5 J	20 J
	03-JUN-2004	7.8 J	1.6 U	30 U
	29-JUL-2008	11 U	3.5 J	18 J
S.STATION3	04-MAY-1996	19	12	110 J
	02-JUN-2000	82	53	62
	03-JUN-2004	56	**100**	410
	29-JUL-2008	14 U	2.2 J	160
Midzone Sediments				
S.STATION4	04-MAY-1996	9.1	3.5	240 J
	01-JUN-2000	65 J	9 J	300
	03-JUN-2004	5.4 J	7.5 J	75
	29-JUL-2008	9.8 U	3.4 J	**500**
S.STATION5	04-MAY-1996	44	12	**530**
	02-JUN-2000	15	7 J	20 J
	03-JUN-2004	19	2.1 J	30 U
	29-JUL-2008	27	1.3 U	16 J
S.STATION6	04-MAY-1996	11	6 U	390 U
	02-JUN-2000	8 J	4 J	30 J
	03-JUN-2004	14	2.8 J	69
	29-JUL-2008	10 U	8.7	**710**
Deeper Sediments				
S.STATION7	04-MAY-1996	11	13	460 U *
	01-JUN-2000	16	4 J	79
	03-JUN-2004	13	2.8 J	**2,000**
	29-JUL-2008	9.9 U	1.3 U	360
S.STATION8	04-MAY-1996	49	22	**5,200**
	02-JUN-2000	6 J	10 U	**1,500**
	03-JUN-2004	5.8 J	2 J	**1,000**
	29-JUL-2008	10 U	2.5 J	**620**
S.STATION9	04-MAY-1996	59	22	240 J
	02-JUN-2000	48	23	**2,000**
	03-JUN-2004	89	65	30 U
	29-JUL-2008	10	3.3 J	16 J

Table B-13 (Continued)
SVOC Concentrations in OU 2 Area 8 Sediments (1996 Through 2008)

Location	Sampling Date	Fluoranthene (μg/kg)	Phenanthrene (μg/kg)	Phenol (μg/kg)
Sediment Quality Standard		**160**	**100**	**420**
Cleanup Screening Level		**1,200**	**480**	**1,200**
Background Screening Value[a]		**NA**	**NA**	**NA**
Mean[c,d]				
All Stations	1996	36	12	**1,294**
	2000	32	13	**461**
	2004	25	21	**444**
	2008	8.3	3.0	341

[a]Background screening value: 95th percentile, maximum value, or minimum detection limit value of samples from reference locations (U.S. Navy 1993a)
[b]Locations LB17 and LB18 from the remedial investigation (U.S. Navy 1993a) were immediately offshore of Area 8 and are considered subtidal, whereas Area 8 sediment locations (i.e., 1 through 9) are intertidal. LB18 was located close to Pier 2, and sediments might be affected by pier-related activities. Thus, results of sediment sampling at these remedial investigation locations and the 1996 monitoring locations are likely not directly comparable.
[c]One-half detection limit was used to calculate the mean for all nondetects.
[d]Mean of sampling locations (1 through 9) for each year

Notes:
Shaded row indicates data evaluated in this 5-year review period.
Bolded value exceeds the sediment quality standard.
* - The reporting limit exceeds the sediment quality standard.
Data presented in this table were downloaded from the Naval Installation Restoration Information Solution (NIRIS) database, when available in NIRIS. If not available in NIRIS, data were entered directly from the second 5-year review report (U.S. Navy 2005a).
Results are reported on a dry-weight basis.
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
MDL - method detection limit
μg/kg - microgram per kilogram
MRL - method reporting limit
NA - not available
ND - not detected
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table B-14
Metal Concentrations in OU 2 Area 8 Sediment (1996 Through 2012)

Location	Sampling Date	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Tin (mg/kg)	Zinc (mg/kg)
Cleanup Screening Level		**6.7**	**270**	**390**	**530**	**0.59**	**NA**	**6.1**	**NA**	**960**
RI Sediment Background Value[a]		**0.68**	**88**	**35**	**36**	**0.109**	**57**	**<0.23**	**15**	**96**
EIM Reference Area Range[b]		**0.03 - 2.3**	**9.9 - 84.5**	**3.1 - 61**	**2.1 - 36.9**	**0.0081 J - 0.224**	**8.3 - 60.4**	**0.02 B - 0.56**	**0.34 - 3.4**	**13.1 - 110**
Remedial Investigation[c]										
LB17	-	0.45 J	120	18	12	0.018	NA	ND	NA	55
LB18	-	ND	92	15	ND	0.02	NA	0.38 J	NA	63
Seep Sediments										
S.STATION1	5/4/1996	0.6	14.1 J	6.4 J	6.6 J	0.07	10.2	0.3 J	NA	29.5 J
	6/1/2000	0.79 J	26.9	10.3	5.15	0.03	19.3 J	0.23	NA	34.7 J
	6/3/2004	0.252 J	22	14.6 J	7.4	0.03	30.3	0.332	NA	42.2
	7/29/2008	0.82 J	21.8	16	31.6 J	0.033 U	29.9	0.545 J	4.3 U	44.1 J
	11/14/2012	1.14 J	3.9 J	4 J	1.2	0.027 U	5.5	0.102 J	19	11 J
S.STATION2	5/4/1996	2	34.9 J	16.5	3.1 J	1.9 J	15.8	0.8 J	NA	39.1 J
	6/1/2000	3.96 J	45.4	10	4.64	0.89	20.2 J	0.33	NA	38.4 J
	6/3/2004	4.49 J	38.3	20.8 J	8.88	0.09	31.3	0.301	NA	94.8
	7/29/2008	2.2 J	22.9	12.5	5.9 J	0.037 U	21.1	0.189 J	3.9 U	47 J
	11/14/2012	1.02 J	14.9 J	8 J	2.9	0.015 J	16.3	0.116 J	12	28 J
S.STATION3	5/4/1996	8.1	166 J	12.5	5.5 J	0.2 J	28 J	0.8 J	NA	42.7 J
	6/2/2000	4.87 J	97.7	12.9	7.33	0.26	25 J	0.26	NA	44.5 J
	6/3/2004	8.32 J	62.1	13.9 J	5.44	1.58	30.9	0.732	NA	45.8
	7/29/2008	13.8 J	34.8	13.7	5.22 J	0.197	23.8	0.395 J	4.3 U	47.1 J
	11/14/2012	7	36.9 J	7 J	3.1	0.04	17.8	0.204 J	10	23J
	11/14/2012 FD	7	18.6 J	14 J	2.3	0.07	18.6	0.3	7	40J
Midzone Sediments										
S.STATION4	5/4/1996	4.8	46.4 J	10.6	6.5 J	0.06	29.5	0.6 J	NA	47 J
	6/1/2000	1.38 J	36.3	9.37	5.93	0.06	20.4 J	0.72	NA	30.5
	6/3/2004	1.9 J	26	13.6 J	6.32	0.02	31.6	0.251	NA	39
	7/29/2008	0.946 J	18.3	12.1	4.78 J	0.04 U	20.5	0.316 J	4.6 U	39.2 J
	11/14/2012	1.3	20.0 J	10.5 J	3.3	0.0165 J	17.7	0.189 J	6	39 J

Table B-14 (Continued)
Metal Concentrations in OU 2 Area 8 Sediment (1996 Through 2012)

Location	Sampling Date	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Tin (mg/kg)	Zinc (mg/kg)
Cleanup Screening Level		**6.7**	**270**	**390**	**530**	**0.59**	**NA**	**6.1**	**NA**	**960**
RI Sediment Background Value[a]		**0.68**	**88**	**35**	**36**	**0.109**	**57**	**<0.23**	**15**	**96**
EIM Reference Area Range[b]		**0.03 - 2.3**	**9.9 - 84.5**	**3.1 - 61**	**2.1 - 36.9**	**0.0081 J - 0.224**	**8.3 - 60.4**	**0.02 B - 0.56**	**0.34 - 3.4**	**13.1 - 110**
S.STATION5	5/4/1996	2	65.4 J	8.7	5.5 J	0.06	19.8	0.3 J	NA	35.1 J
	6/2/2000	6.23 J	26.9	12.6	6.24	0.06	26.4 J	0.59	NA	39.7 J
	6/3/2004	2.85 J	31.5	10.7 J	4.49	0.46	26.9	0.317	NA	37.3
	7/29/2008	10.2 J	52.9	13.8	13.7 J	0.059	23.9	0.682	4.2 U	37.6 J
	11/14/2012	7.9	27.6 J	9.5 J	3.9	0.04	21.1	0.5	7	37 J
S.STATION6	5/4/1996	3.4	194 J	10.4	10.5 J	0.05	21.7	0.4 J	NA	41.8 J
	6/2/2000	1.98 J	75.4	10.6	6.22	0.16	21.2 J	0.23	NA	35.5 J
	6/3/2004	9.13 J	64.5	13.1 J	4.93	0.72	24.1	1.25	NA	39.3
	7/29/2008	7.27 J	56.9	13	5.62 J	0.191	24.3	0.32 J	4.1 U	44.8 J
	11/14/2012	7	19.3 J	9 J	3.5	0.11	16.3	0.205 J	9	32 J
Deeper Sediments										
S.STATION7	5/4/1996	0.07	54 J	10.5	7.8 J	0.07	24.8	0.07	NA	46.8 J
	6/1/2000	0.22 J	19.5	7.74	5.59	0.04	17 J	0.09	NA	27 J
	6/3/2004	2.66 J	34.6	10.5 J	6.31	0.04	24.4	1.54	NA	33.1
	7/29/2008	0.515 J	23.6	11	19.2 J	0.038 U	21.4	0.154 J	4.5 U	33.7 J
	11/14/2012	1.4	30.6 J	11.3 J	4.9	0.03	22.1	0.3	12	40 J
S.STATION8	5/4/1996	0.2 J	48 J	7.4	4.4 J	0.06	14	0.2 J	NA	27.3 J
	6/2/2000	0.97 J	67.1	8.05	4.83	0.04	17.9 J	0.22	NA	30.1 J
	6/3/2004	5.64 J	43.9	11.5 J	4.88	0.07	21.9	0.42	NA	31.8
	7/29/2008	15 J	36.8	15.4	3.92 J	0.038 U	25.4	0.456 J	4.3 U	38.4 J
	11/14/2012	4.2	41.1 J	11.9 J	4.7	0.03	25.8	0.4	5	40 J

Table B-14 (Continued)
Metal Concentrations in OU 2 Area 8 Sediment (1996 Through 2012)

Location	Sampling Date	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Tin (mg/kg)	Zinc (mg/kg)
Cleanup Screening Level		**6.7**	**270**	**390**	**530**	**0.59**	**NA**	**6.1**	**NA**	**960**
RI Sediment Background Value[a]		**0.68**	**88**	**35**	**36**	**0.109**	**57**	**<0.23**	**15**	**96**
EIM Reference Area Range[b]		**0.03 - 2.3**	**9.9 - 84.5**	**3.1 - 61**	**2.1 - 36.9**	**0.0081 J - 0.224**	**8.3 - 60.4**	**0.02 B - 0.56**	**0.34 - 3.4**	**13.1 - 110**
S.STATION9	5/4/1996	0.5	83.7 J	11.3	7.4 J	0.05	20.7	0.3 J	NA	38.3 J
	6/2/2000	1.46 J	86.9	10.2	37.6	0.07	21 J	0.23	NA	45 J
	6/3/2004	6.44 J	59.5	13 J	8.35	0.21	27.7	0.364	NA	40.6
	7/29/2008	21.9 J	73.3	15	26.6 J	0.329	29.3	0.484 J	4.3 U	43.1 J
	11/14/2012	12	28 J	6 J	3.3	0.12	18.6	0.3	11	21 J
Deeper Stations Established in 2012										
S.STATION10	11/14/2012	0.513 J	24.8 J	9.6 J	5.3	0.04	21.7	0.101 J	1.83 J	37 J
S.STATION11	11/14/2012	4.3	49.4 J	12.1 J	6.8	0.04	25.8	1.0	2	42 J
S.STATION12	11/14/2012	3.3	65.9 J	12.7 J	5.7	0.06	22.3	0.4	4	45 J
Subtidal Stations Established in 2012										
S.STATION21	12/11/2012	1.1	27.2	18	9.5	0.12	27	0.178 J	2	56
S.STATION22	12/11/2012	0.9	20.6	15.9	9.2	0.09	19.4	0.155 J	15	42
	12/11/2012 FD	0.88 J	16.4	54	7.8	0.10	16.7	0.146 J	12	50
S.STATION23	12/11/2012	0.9	16.7	22.6	16	0.07	17.4	0.092 J	12	44
S.STATION24	12/11/2012	0.7	28	19.6	7.4	0.07	31.9	0.161 J	6	42
S.STATION25	12/11/2012	1.0	29.7	20.2	10.8	0.10	29.4	0.225 J	2.0 U	61
S.STATION26	12/11/2012	0.8	12.4	20.2	6.7	0.07	14.1	0.113 J	27	33
S.STATION27	12/11/2012	1.0	18.1	23.7	10.4	0.09	18.4	0.159 J	18	48
S.STATION28	12/11/2012	0.7	17.4	15.7	5.3	0.06	22.2	0.104 J	5	50
Mean[d]										
All Intertidal Stations[e]	1996	2.4	79	10	6.4	0.28	21	0.42	NA	38.62
	2000	2.4	54	10	9.3	0.18	21	0.32	NA	36.16
	2004	4.6	42	14	6.3	0.36	28	0.61	NA	44.88
	2008	8.1	38	14	12.9	0.097	24	0.39	4.3 U	41.67
	2012	4.3	30	9.9	4.1	0.049	19	0.33	8.2	34

Table B-14 (Continued)
Metal Concentrations in OU 2 Area 8 Sediment (1996 Through 2012)

Location	Sampling Date	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Tin (mg/kg)	Zinc (mg/kg)
Cleanup Screening Level		**6.7**	**270**	**390**	**530**	**0.59**	**NA**	**6.1**	**NA**	**960**
RI Sediment Background Value[a]		**0.68**	**88**	**35**	**36**	**0.109**	**57**	**<0.23**	**15**	**96**
EIM Reference Area Range[b]		**0.03 - 2.3**	**9.9 - 84.5**	**3.1 - 61**	**2.1 - 36.9**	**0.0081 J - 0.224**	**8.3 - 60.4**	**0.02 B - 0.56**	**0.34 - 3.4**	**13.1 - 110**
All subtidal stations	2012	0.89	21	24	9.4	0.085	22	0.15	11	47

[a]Value is the 95th percentile of the maximum value, or the minimum detection limit value of sediment samples collected at reference locations (U.S. Navy 1993a.)
[b]Values were downloaded from Ecology's EIM database for Carr Inlet, Holmes Harbor, and Useless Bay.
[c]Locations LB17 and LB18 from the RI (U.S. Navy 1993a) were immediately offshore of Area 8 and are considered subtidal, whereas Area 8 sediment locations (i.e., 1 through 12) are intertidal. LB18 was located close to Pier 2, and sediments might be affected by pier-related activities. Thus, results of sediment sampling at these RI locations and the 1996 monitoring locations are likely not directly comparable.
[d]One-half detection limit was used to calculate the mean for all nondetections.
[e]The mean of sampling locations 1 through 9 for years 1996, 2000, 2004, and 2008 and locations 1 through 12 for 2012. The mean of sampling locations 1 through 9 for 2012 is 4.6 mg/kg.

Notes:
Shaded row indicates data evaluated in this 5-year review period.
Data presented in this table were downloaded from the Naval Installation Restoration Information Solution (NIRIS) database, when available in NIRIS. If not available in NIRIS, data were entered directly from the second 5-year review report (U.S. Navy 2005a).
Results are reported on a dry-weight basis.
EIM - Environmental Information Management
FD - field duplicate
J - The result is an estimated concentration.
mg/kg - milligram per kilogram
NA - not available or not analyzed
RI - remedial investigation
U - The compound was analyzed for, but was not detected ("nondetect") at or above the method reporting limit/method detection limit.

Table B-15
Chemical Concentrations in OU 2 Area 8 Clam Tissue (1996 Through 2008)

Location	Sampling Date	Fluoranthene (µg/kg)	Pyrene (µg/kg)	Phenol (µg/kg)	Benzoic Acid (µg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
Background Screening Value[a]		**NA**	**NA**	**NA**	**NA**	**0.26**	**< 0.95**	**0.76**	**NA**	**0.01**	**< 0.58**	**0.35**	**NA**
Remedial Investigation[b]													
LB17	-	660 U	660 UJ	660 U	1600 UJ	0.09	0.49	1	0.14 U	0.01	0.440	0.070	10.9 U
Seep Tissue													
STATION 1	04-MAY-1996	NA	NA	240	2600	1.5	2.84	1.82	0.21	0.03	1.2	2.2	14.1
	01-JUN-2000	8 J	6 J	50 U	4300	0.60 J	0.74	1.03 J	0.05 J	0.02	0.62 J	0.31	14.6
	03-JUN-2004	6.7 U	8.2 U	54 U	1300 J	0.57	0.43	1.1	0.057	0.02	0.86	0.9	12
	30-JUL-2008	1.9 J	4.8 U	87 U	1600 J	1.1	0.64	0.87	0.054	0.021	0.53	0.59	9.6
S.STATION2	07-MAY-1996	NA	NA	NA	2000	5.4	1.86	1.71	NA	0.18	0.5	0.73	16.5
	01-JUN-2000	8 J	10	20 J	6900	1.94 J	1.53	1.15 J	0.07 J	0.04	0.57 J	0.29	14.7
	03-JUN-2004	6.7 U	8.2 U	54 U	2100 J	1.2	0.63	1.2	0.065	0.022	0.87	0.58	16
	30-JUL-2008	1.9 J	4.8 U	96 U	1300 J	3.5	0.33	0.67	0.052	0.029	0.38	0.14	11
S.STATION3	07-MAY-1996	12 J	NA	NA	2400	5.75	8.78	1.73	0.12 J	0.02	0.6	0.31	17.5
	02-JUN-2000	7 J	25	50 U	6700	0.80 J	1.52	1.12	0.05 J	0.05	0.73 J	0.28	16.1
	03-JUN-2004	6.7 U	8.2 U	54 U	3700 J	1.8	1.1	1.17	0.074	0.039	0.81	0.57	15
	30-JUL-2008	1.6 J	4.8 U	91 U	1300 J	3.5	0.30	0.57	0.044 U	0.026	0.32	0.13	9.7
Midzone Tissue													
S.STATION4	07-MAY-1996	10	15 J	NA	1600	2.2	2.41	1.50	NA	0.02	0.6	0.81	13.6
	01-JUN-2000	10	6 J	20 J	6400	0.93 J	0.50	1.02 J	0.05 J	0.01	0.52 J	0.4	16.1
	03-JUN-2004	6.7 U	8.2 U	54 U	4500 J	1.3	0.77	1.01	0.063	0.02	0.82	0.83	13
	30-JUL-2008	2.1 J	1.2 J	92 U	1600 J	1.6	0.40	0.80	0.048	0.033	0.46	0.41	12
S.STATION5	04-MAY-1996	11	13 J	NA	2000 J	1.01	2.75	1.38	0.14 J	0.02	1.3	0.28	13.2
	02-JUN-2000	8 J	7 J	30 J	7300	1.21 J	0.67	0.96 J	0.05	0.02	0.43 J	0.17	14.2
	03-JUN-2004	6.7 U	8.2 U	54 U	5300 J	4.5	1.1	1.2	0.053	0.16	0.42	0.48	12
	30-JUL-2008	1.8 J	4.7 U	88 U	4000 J	0.97	0.22	0.72	0.069	0.021	0.41	0.13	11
S.STATION6	07-MAY-1996	NA	NA	NA	NA	1.5	2.57	1.11	NA	0.01	0.4	0.11	13.7
	02-JUN-2000	6 J	19	20 J	8500	0.54 J	0.44	1.09 J	0.04 J	0.02	0.41 J	0.13	18.5
	03-JUN-2004	6.7 U	8.2 U	54 U	5400 J	2.5	0.64	1.2	0.071	0.028	0.53	0.48	14
	30-JUL-2008	2 J	1.2 J	89 U	3000 J	0.87	0.19	0.92	0.072	0.023	0.38	0.18	11

Table B-15 (Continued)
Chemical Concentrations in OU 2 Area 8 Clam Tissue (1996 Through 2008)

Location	Sampling Date	Fluoranthene (µg/kg)	Pyrene (µg/kg)	Phenol (µg/kg)	Benzoic Acid (µg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
Background Screening Value[a]		**NA**	**NA**	**NA**	**NA**	**0.26**	**< 0.95**	**0.76**	**NA**	**0.01**	**< 0.58**	**0.35**	**NA**
Remedial Investigation[b]													
Deeper Tissue													
S.STATION7	07-MAY-1996	20	18 J	NA	1900 J	0.25	0.39	1.66	NA	0.01	0.4	0.43	15
	01-JUN-2000	11	29	30 J	10000	0.19 J	0.6	1.50 J	0.06 J	0.01	0.47 J	0.14	14.4
	03-JUN-2004	6.7 U	8.2 U	54 U	6500 J	1.3	0.28	1.3	0.075	0.017	0.43	0.63	14
	30-JUL-2008	8.4	4.6 J	92 U	3200 J	0.66	0.28	0.74	0.060	0.027	0.39	0.19	11
S.STATION8	07-MAY-1996	12	NA	NA	1800 J	0.22	2.2	1.53	0.21	0.01	1.3	0.49	11.1
	02-JUN-2000	10 U	10 U	240	10000	0.3 UJ	0.49	1.35 J	0.06 J	0.01	0.41 J	0.12	13.7
	03-JUN-2004	6.7 U	8.2 U	54 U	1700 J	1.6	0.51	1.2	0.076	0.016	0.48	0.33	14
	30-JUL-2008	2.2 J	1.3 J	96 U	3800 J	0.6	0.24	0.95	0.070	0.016	0.35	0.18	10
S.STATION9	07-MAY-1996	21 J	NA	NA	2700 J	0.22	3.24	1.64	NA	0.01	1.9	0.37	14
	02-JUN-2000	10 J	10 J	230	11000	0.24 J	0.71	1.34 J	0.06 J	0.02	0.54 J	0.2	13.9
	03-JUN-2004	6.7 U	8.2 U	54 U	4200 J	0.7	0.20	1.0	0.072	0.02	0.59	0.48	14
	30-JUL-2008	3 J	1.9 J	90 U	3600 J	1.2	0.21	0.95	0.071	0.022	0.4	0.14	12
Mean[c,d]													
All Stations	1996	14	15	240	2125	2.0	3.0	1.6	0.170	0.034	0.911	0.637	14.300
	2000	8.1	13	71	7900	0.73	0.80	1.2	0.054	0.022	0.522	0.227	15.141
	2004	3.4	4.1	27	3856	1.72	0.622	1.15	0.067	0.038	0.645	0.587	13.919
	2008	2.8	2.2	46	2600	1.56	0.313	0.80	0.057	0.024	0.402	0.231	10.841

[a]Value is 95th percentile, maximum value, or minimum detection limit value of samples from reference locations (U.S. Navy 1993a).
[b]Location LB17 from the remedial investigation (U.S. Navy 1993a) was immediately offshore of Area 8 and is considered subtidal, whereas Area 8 sediment locations (i.e., 1 through 9) are intertidal. Results of sediment sampling at the remedial investigation location and the 1996 monitoring locations are likely not directly comparable.
[c]One-half detection limit was used to calculate the mean for all nondetects.
[d]Mean of sampling locations (1 through 9) for each year.

Notes:
Data presented in this table were obtained from the Naval Installation Restoration Information Solution (NIRIS) database, where available. If not available in NIRIS, data were from the second 5-year review report (U.S. Navy 2005a).
Results are reported in wet-weight concentrations. The June 2000 metals data obtained from NIRIS were reported on a dry-weight basis. Since percent solids data were not available, the results could not be converted to wet-weight concentrations. Therefore, wet-weight metals concentrations are included from the second 5-year review report (U.S.

Table B-15 (Continued)
Chemical Concentrations in OU 2 Area 8 Clam Tissue (1996 Through 2008)

Navy 2005a). The June 2004 and the July 2008 metals data were obtained from NIRIS in dry-weight concentrations. Since percent solids data were available for these two sampling events, the results were converted to wet-weight concentrations.
Chemicals selected were metals that were elevated above background screening values at any location in Liberty Bay (U.S. Navy 1993a). Organic chemicals were not detected in clam tissues from location LB17 during the remedial investigation.
Shaded row indicates data evaluated in this 5-year review period.
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
MDL - method detection limit
µg/kg - microgram per kilogram
mg/kg - milligram per kilogram
MRL - method reporting limit
NA - not available or not analyzed
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL

APPENDIX C

Groundwater Concentrations at OU 1 (Area 1) and OU 2 (Areas 2 and 8)

CONTENTS

FIGURES

OU 1 – North Plantation

OU 1 – South Plantation

CONTENTS (Continued)

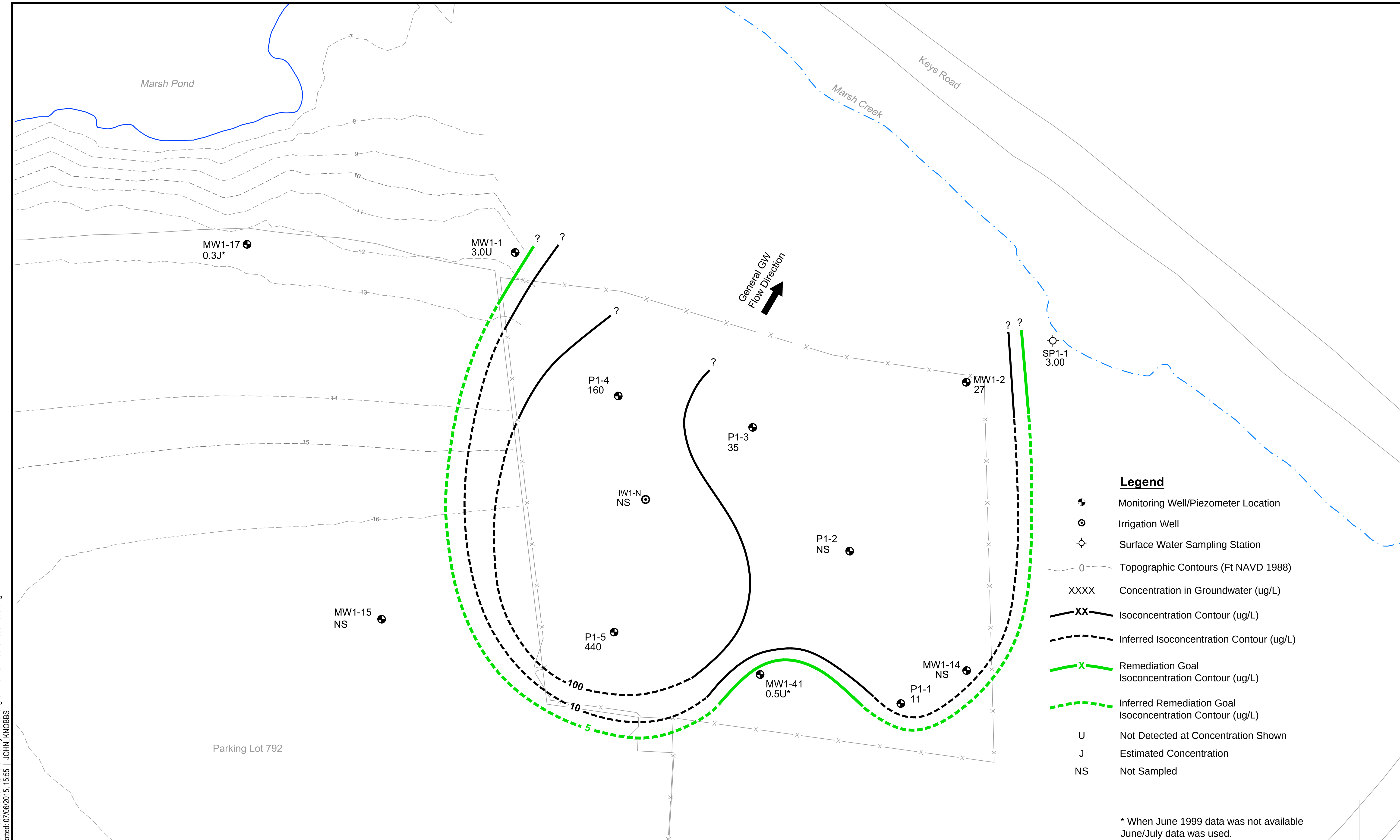

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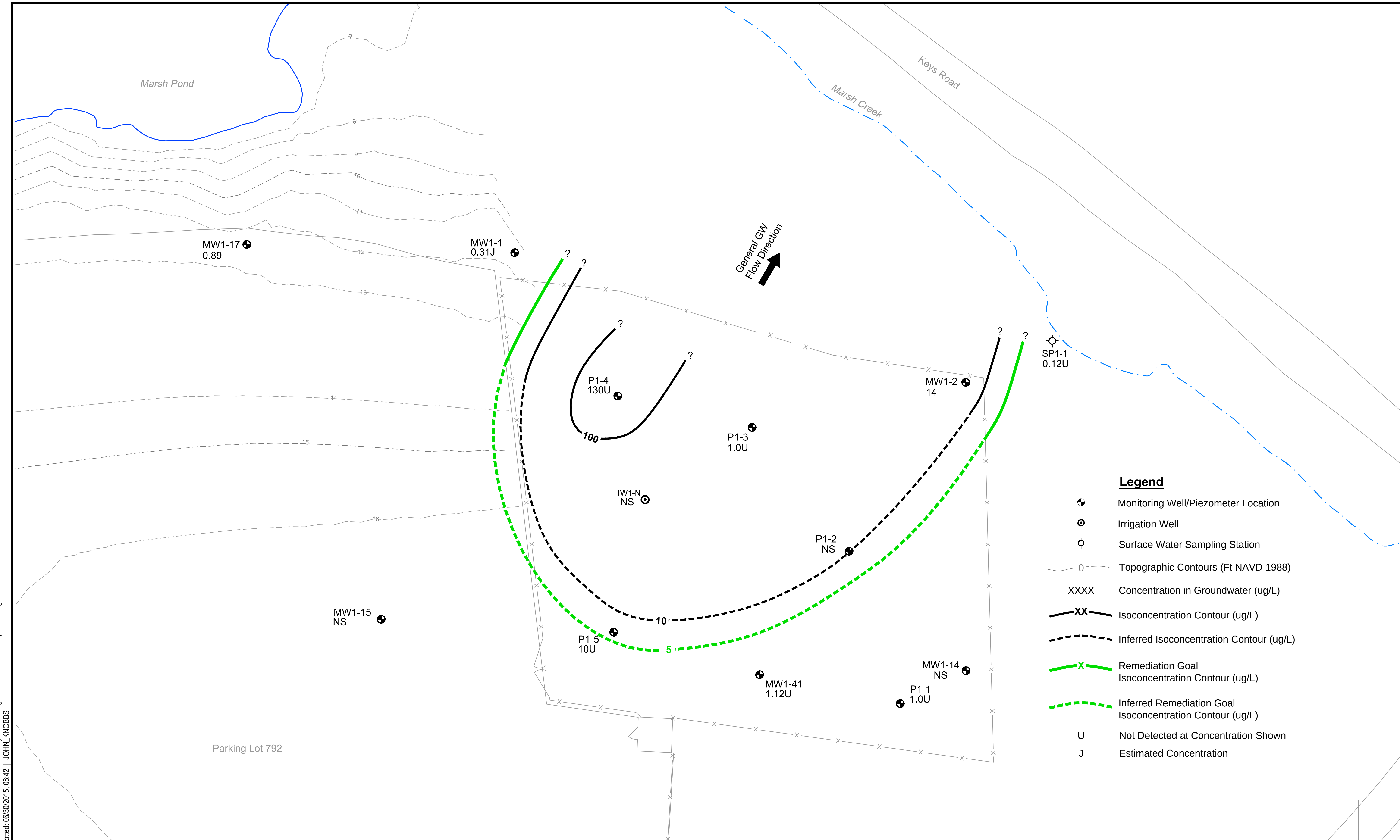
Figure C-1
OU 1, TCE Groundwater Concentrations, North Plantation Upper Aquifer, 1999/2000



U.S. NAVY	NBK Keyport FOURTH FIVE-YEAR REVIEW	0 20 40 SCALE IN FEET	Figure C-2 OU 1, TCE Groundwater Concentrations, North Plantation Upper Aquifer, 2004

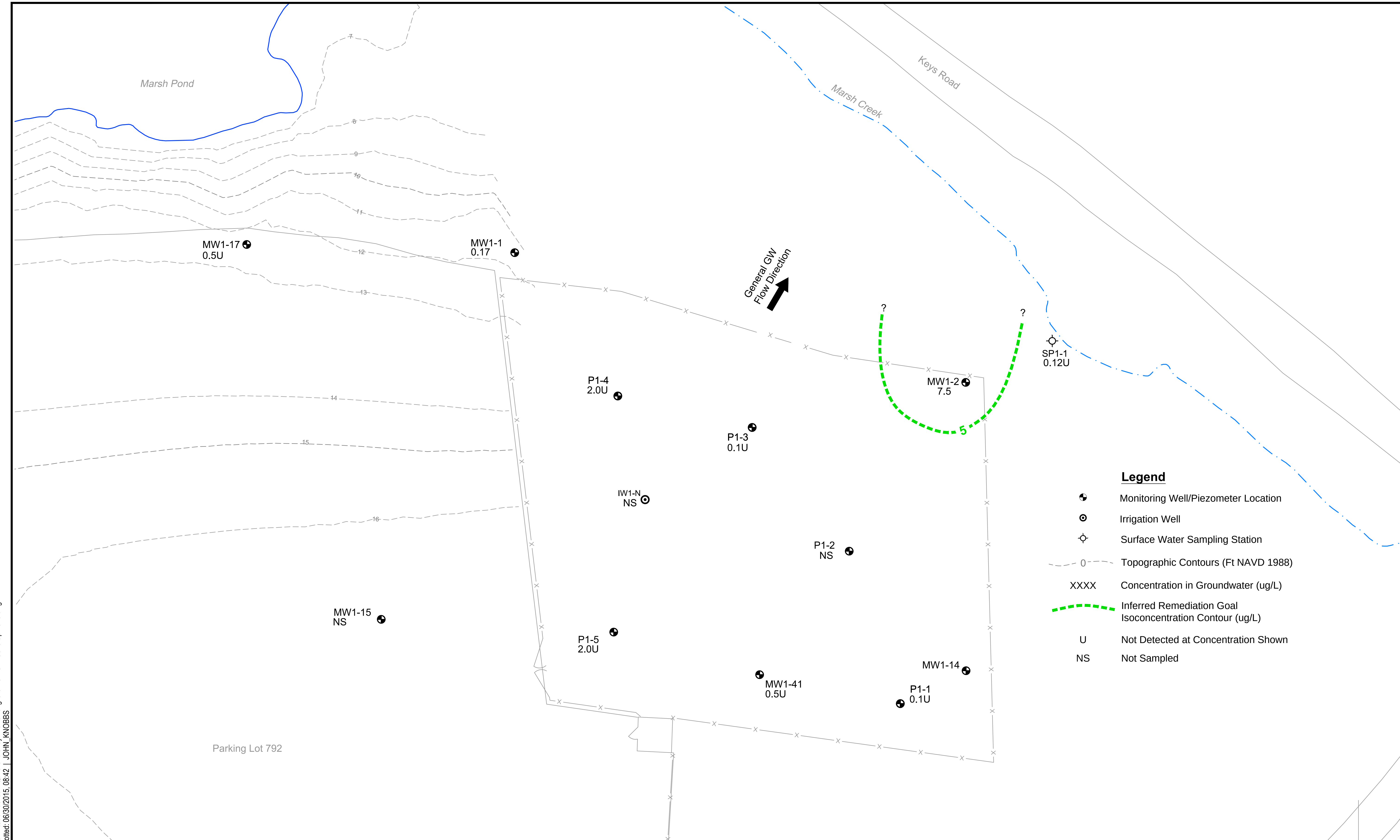


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Figure C-3
OU 1, TCE Groundwater Concentrations, North Plantation Upper Aquifer, 2010

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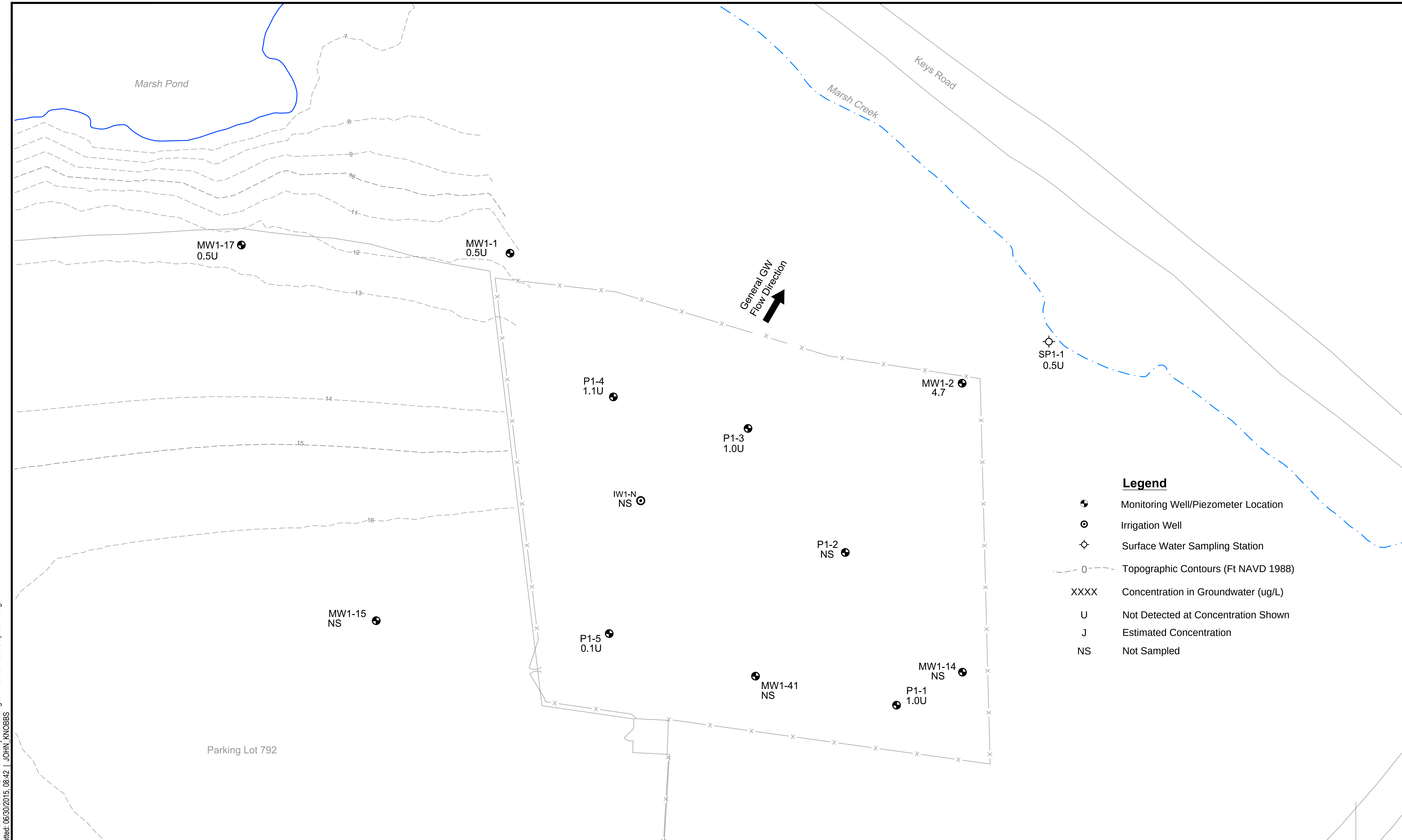

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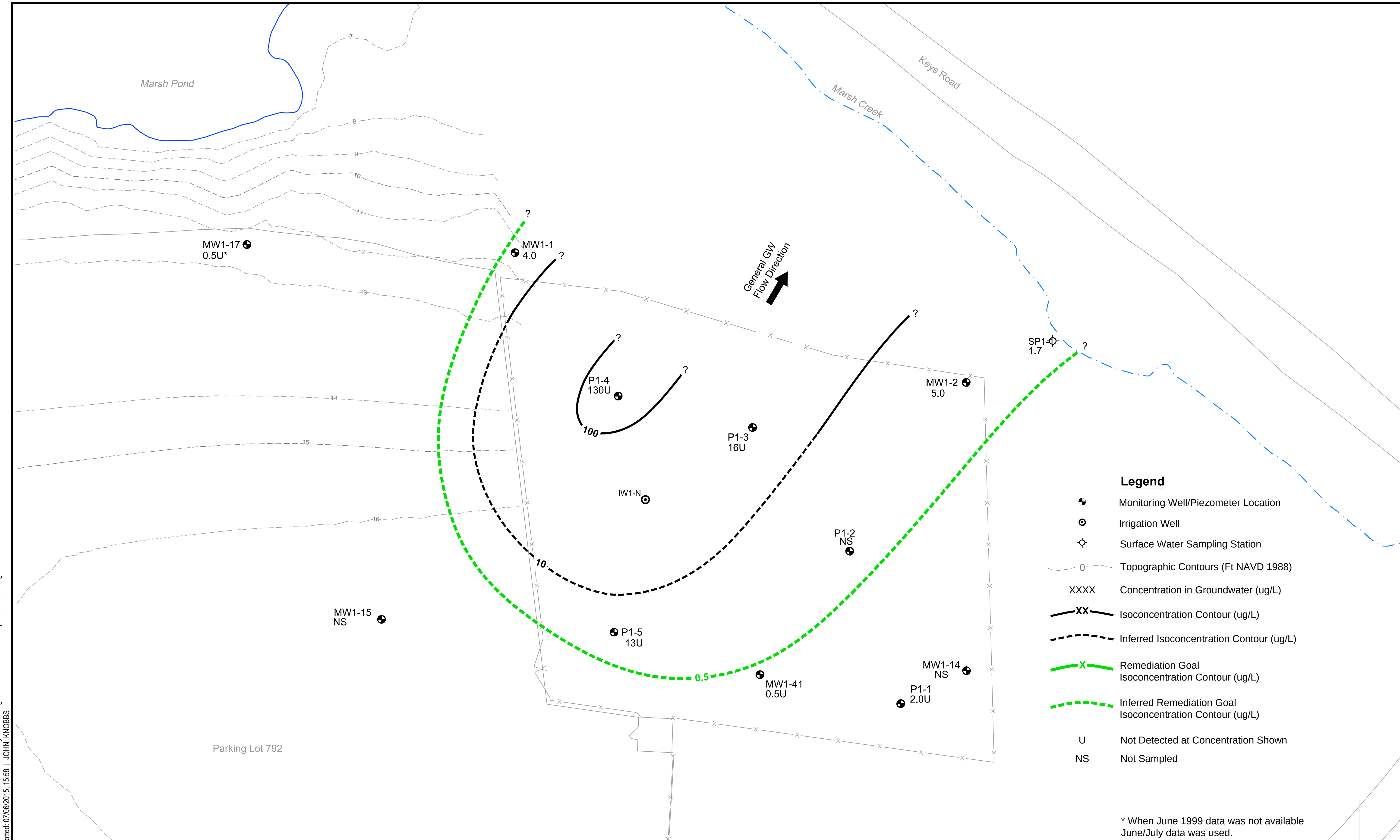
Figure C-4
OU 1, TCE Groundwater Concentrations, North Plantation Upper Aquifer, 2014



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SCALE IN FEET

Figure C-5
OU 1, 1,1-DCE
Groundwater Concentrations,
North Plantation Upper Aquifer, 1999/2000

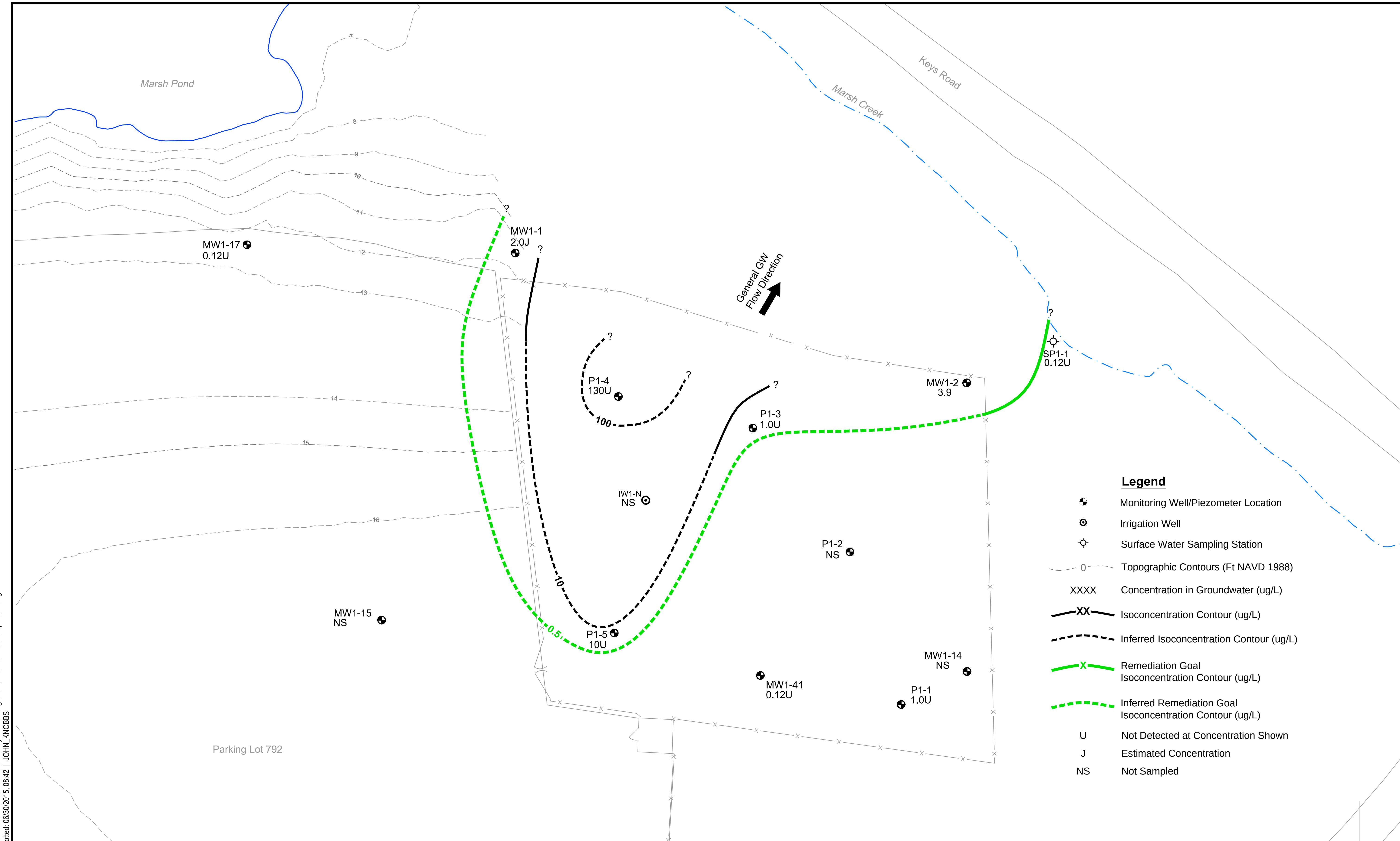

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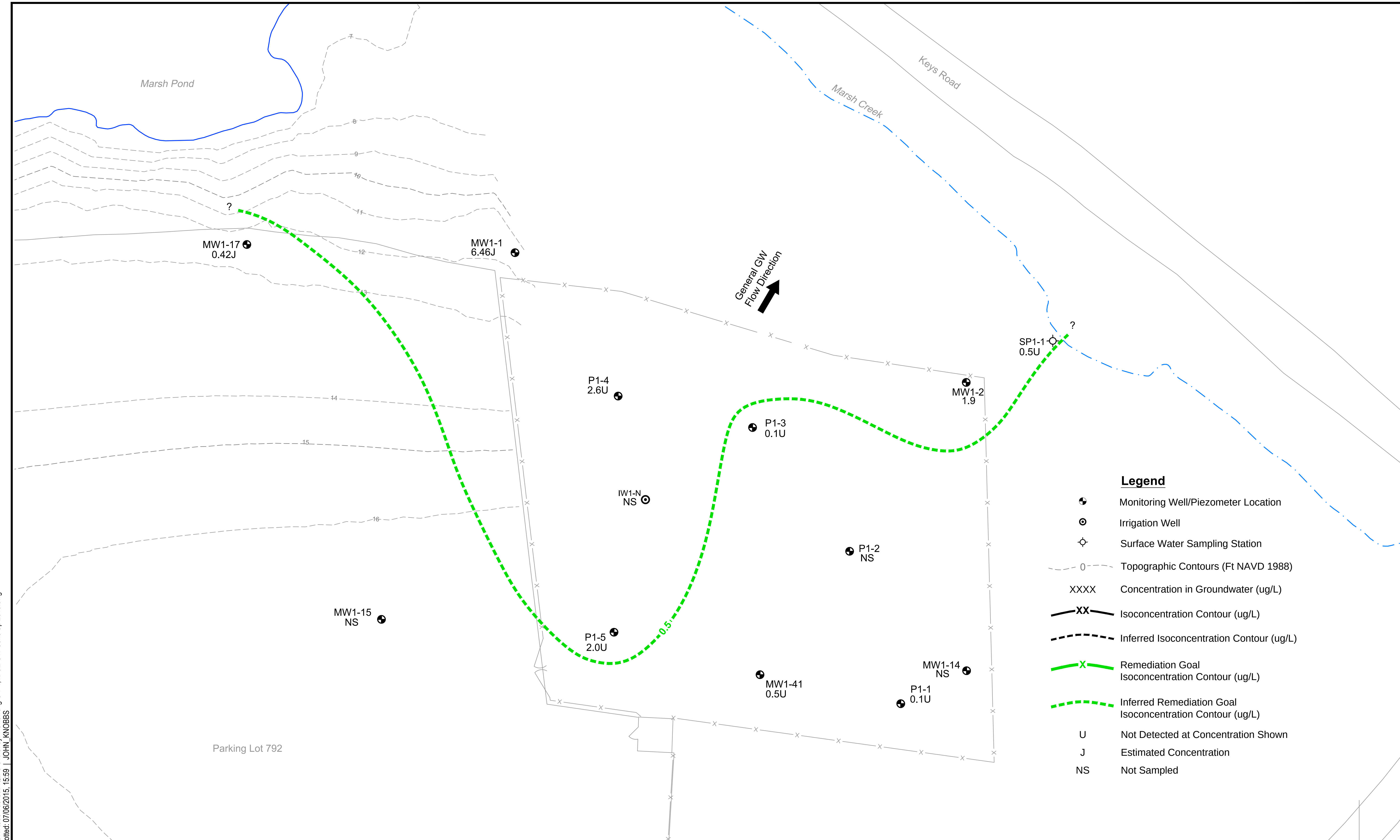
Figure C-6
OU 1, 1,1-DCE
Groundwater Concentrations,
North Plantation Upper Aquifer, 2004



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U.S. NAVY	NBK Keyport FOURTH FIVE-YEAR REVIEW		**Figure C-7 OU 1, 1,1-DCE Groundwater Concentrations, North Plantation Upper Aquifer, 2010**

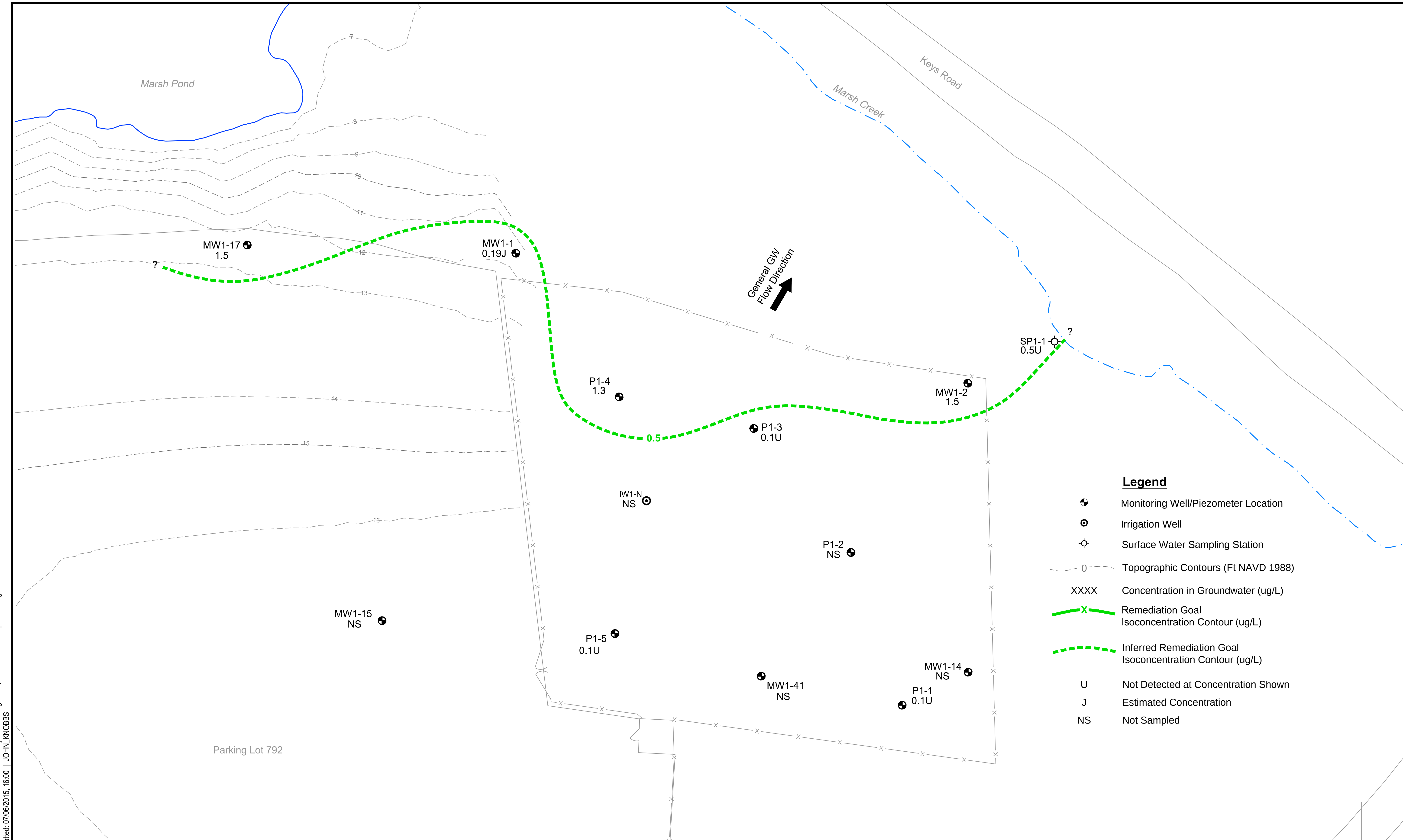

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Figure C-8
OU 1, 1,1-DCE
Groundwater Concentrations,
North Plantation Upper Aquifer, 2014

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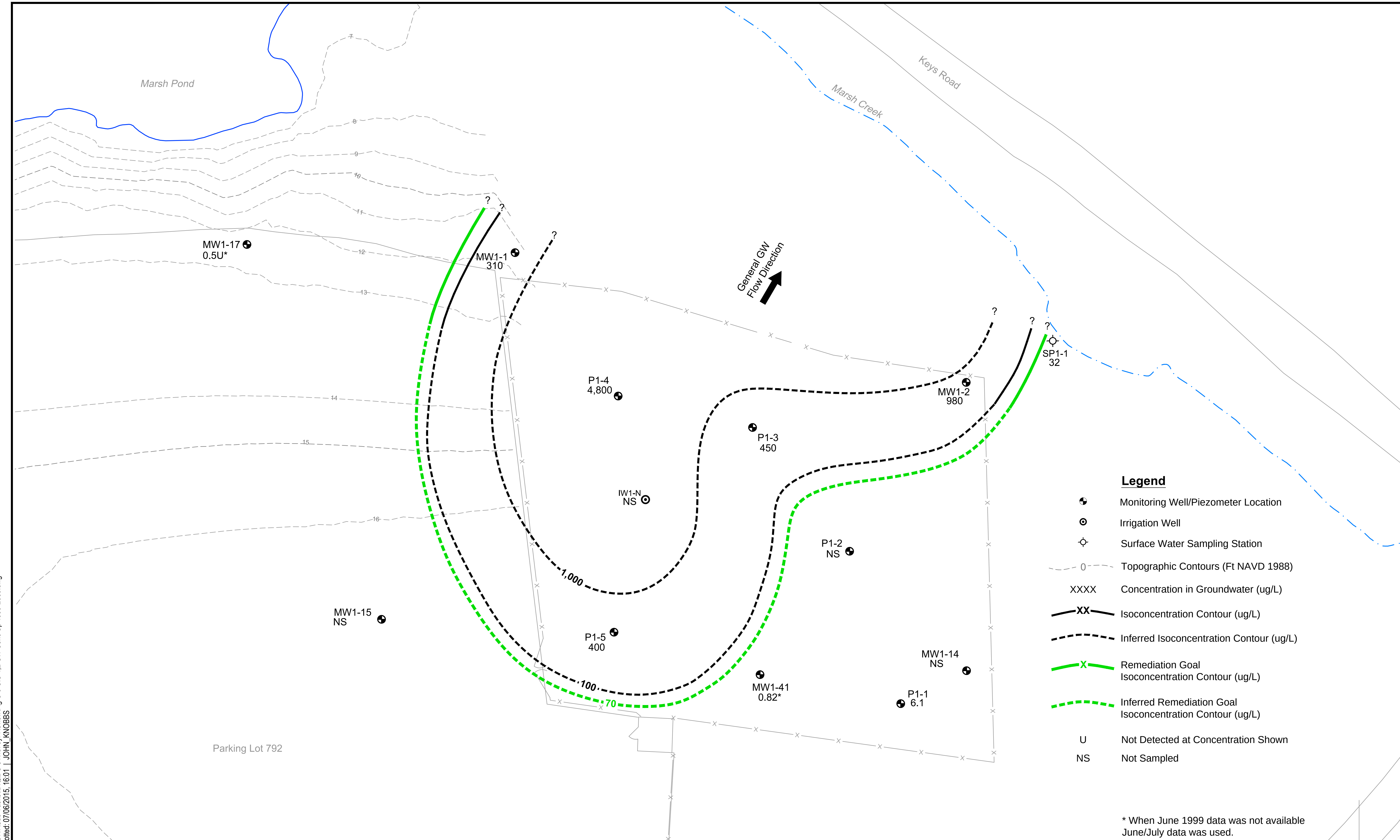

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Figure C-9
OU 1, cis-1,2-DCE
Groundwater Concentrations,
North Plantation Upper Aquifer, 1999/2000

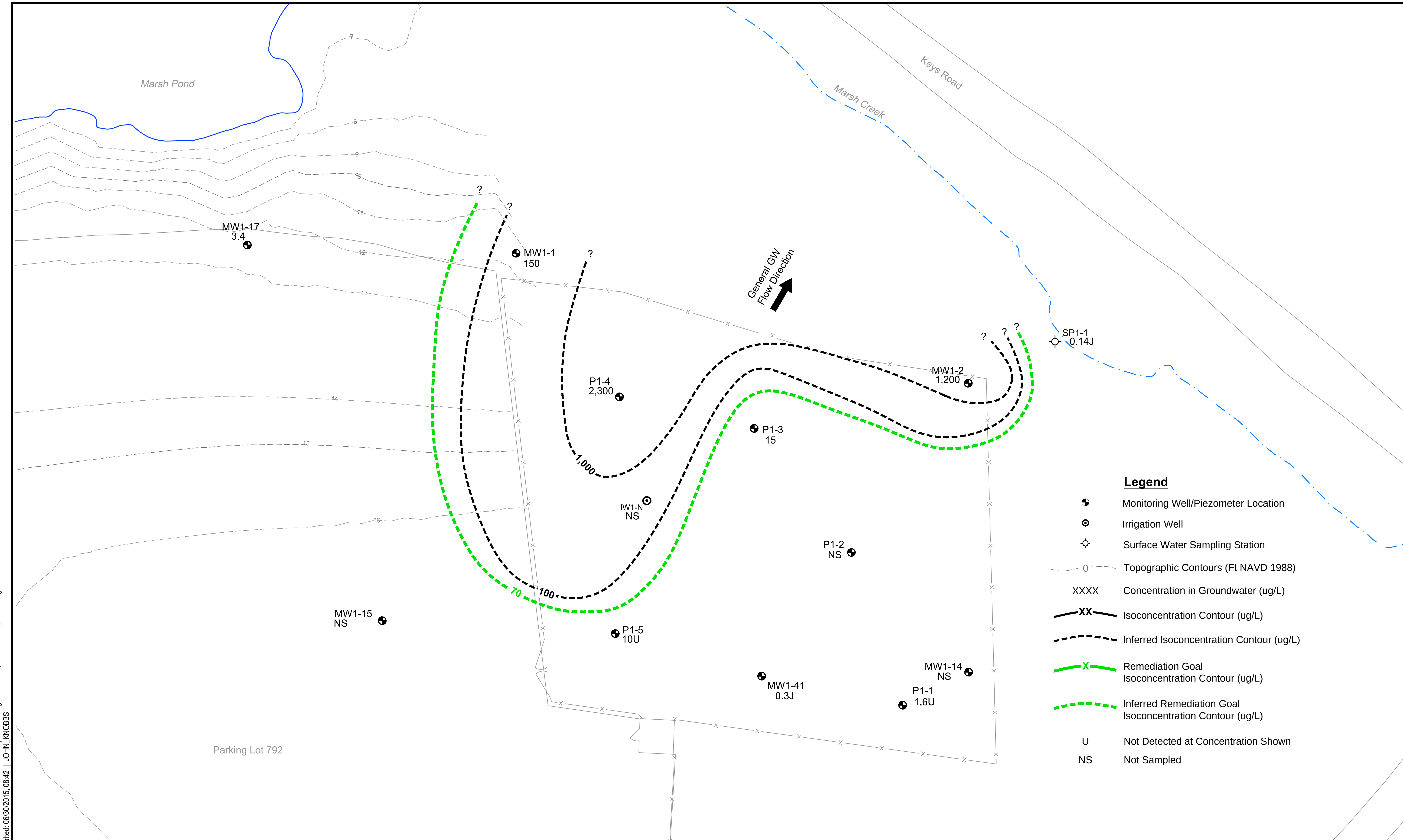

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Figure C-10
OU 1, cis-1,2-DCE
Groundwater Concentrations,
North Plantation Upper Aquifer, 2004

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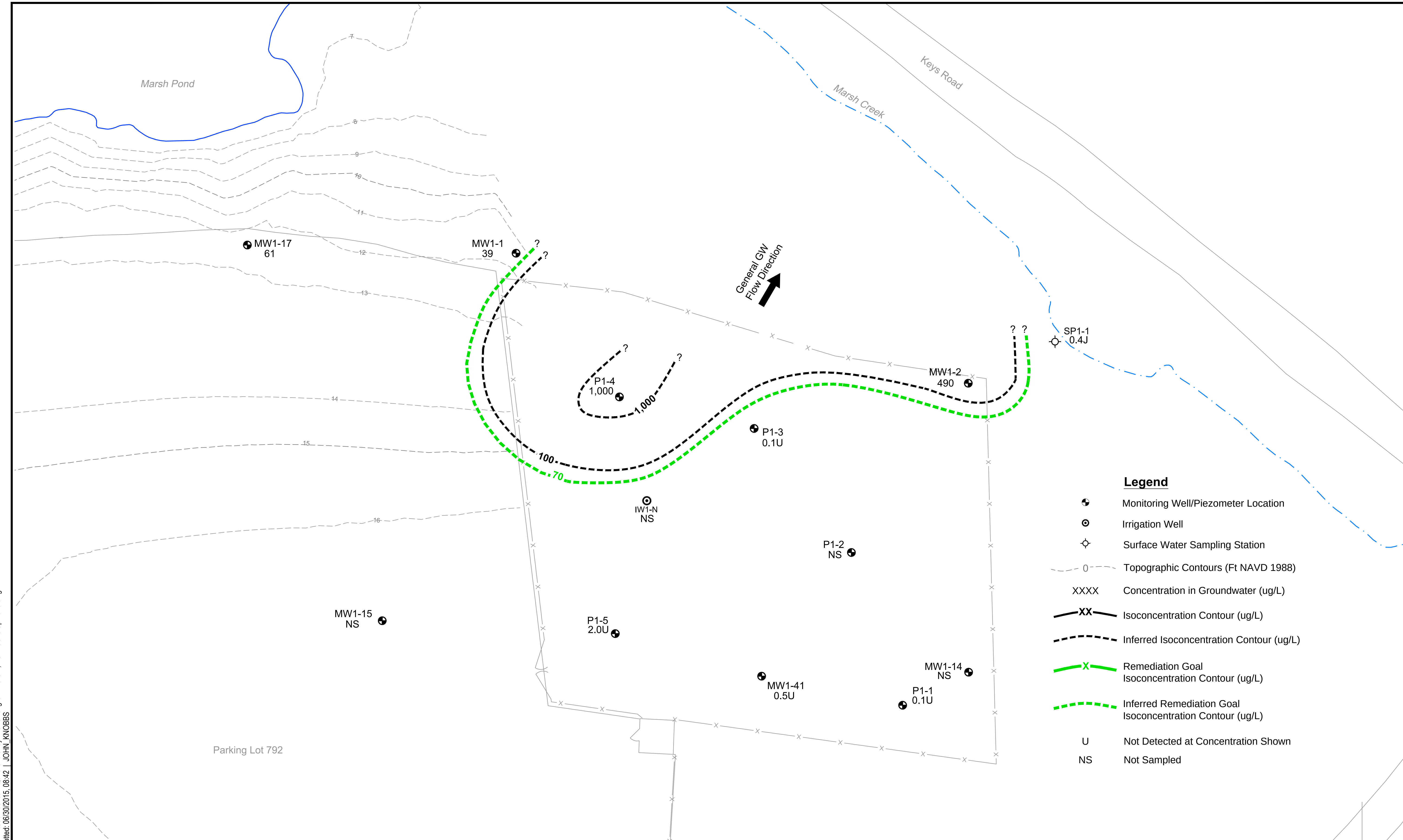

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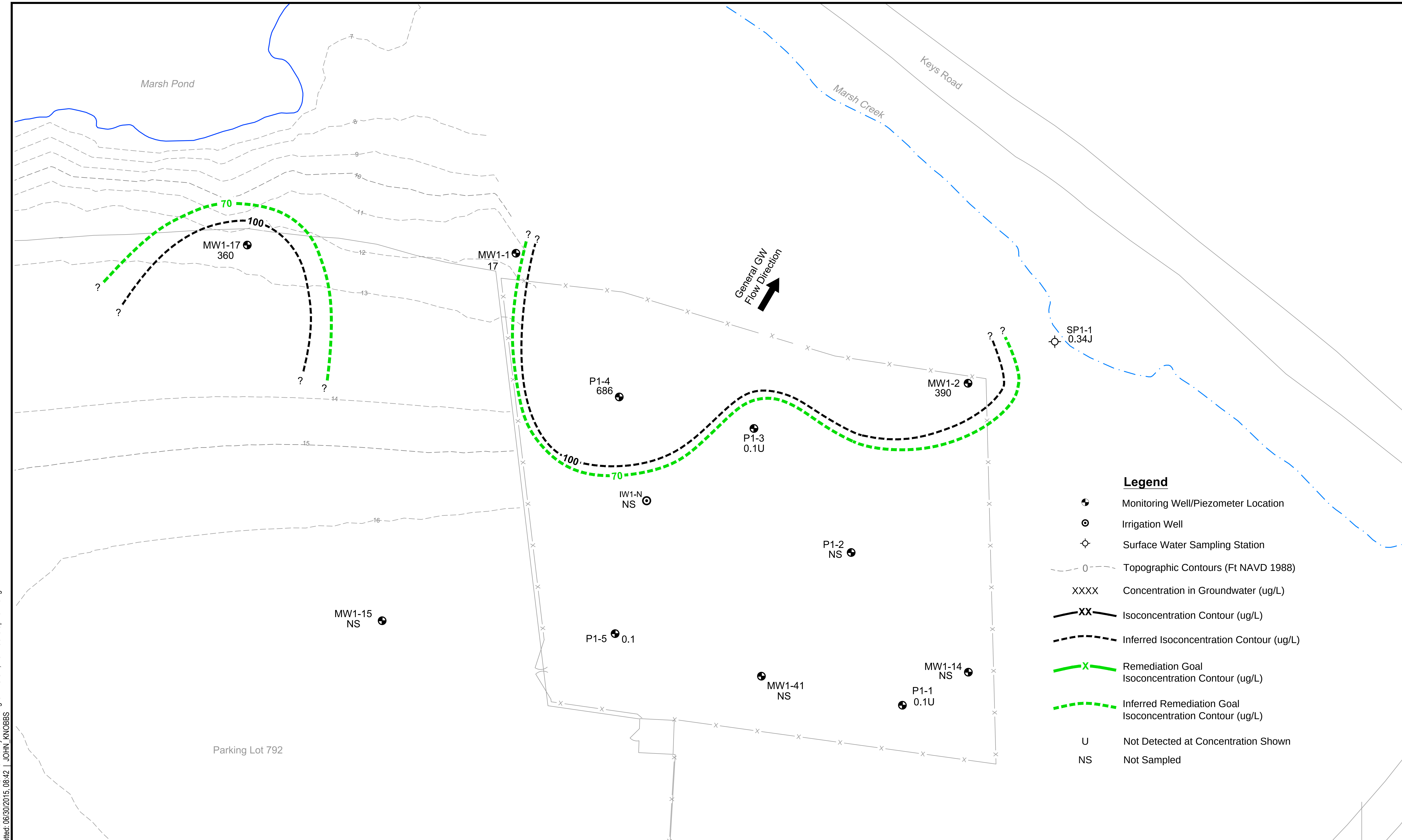
Figure C-11
OU 1, cis-1,2-DCE Groundwater Concentrations, North Plantation Upper Aquifer, 2010



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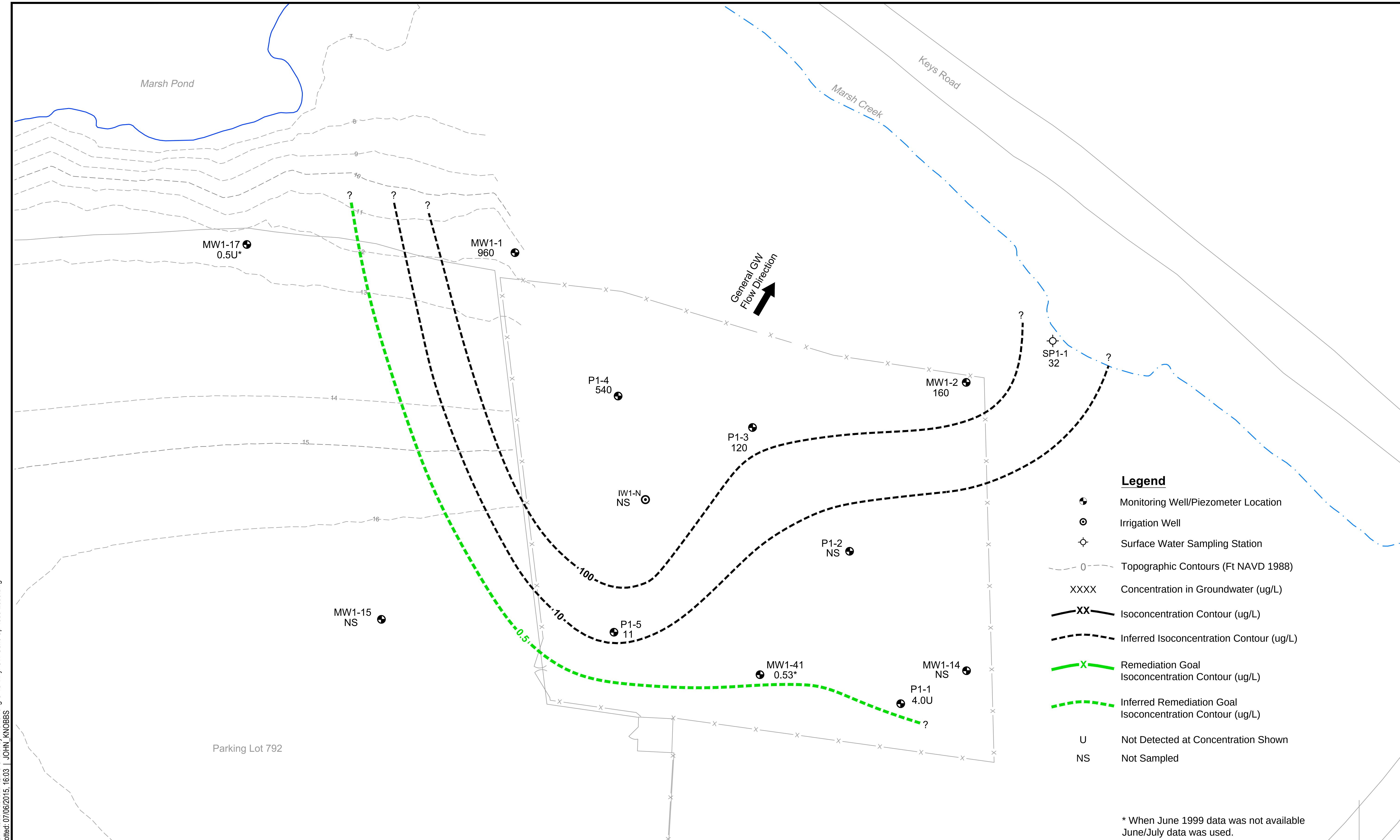
REVIEW

Figure C-12
OU 1, cis-1,2-DCE
Groundwater Concentrations,
North Plantation Upper Aquifer, 2014



J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\DIQ\DO 81\4th 5yr Review\Fig C-13 Vinyl GW Conc Up 1999-2000.dwg
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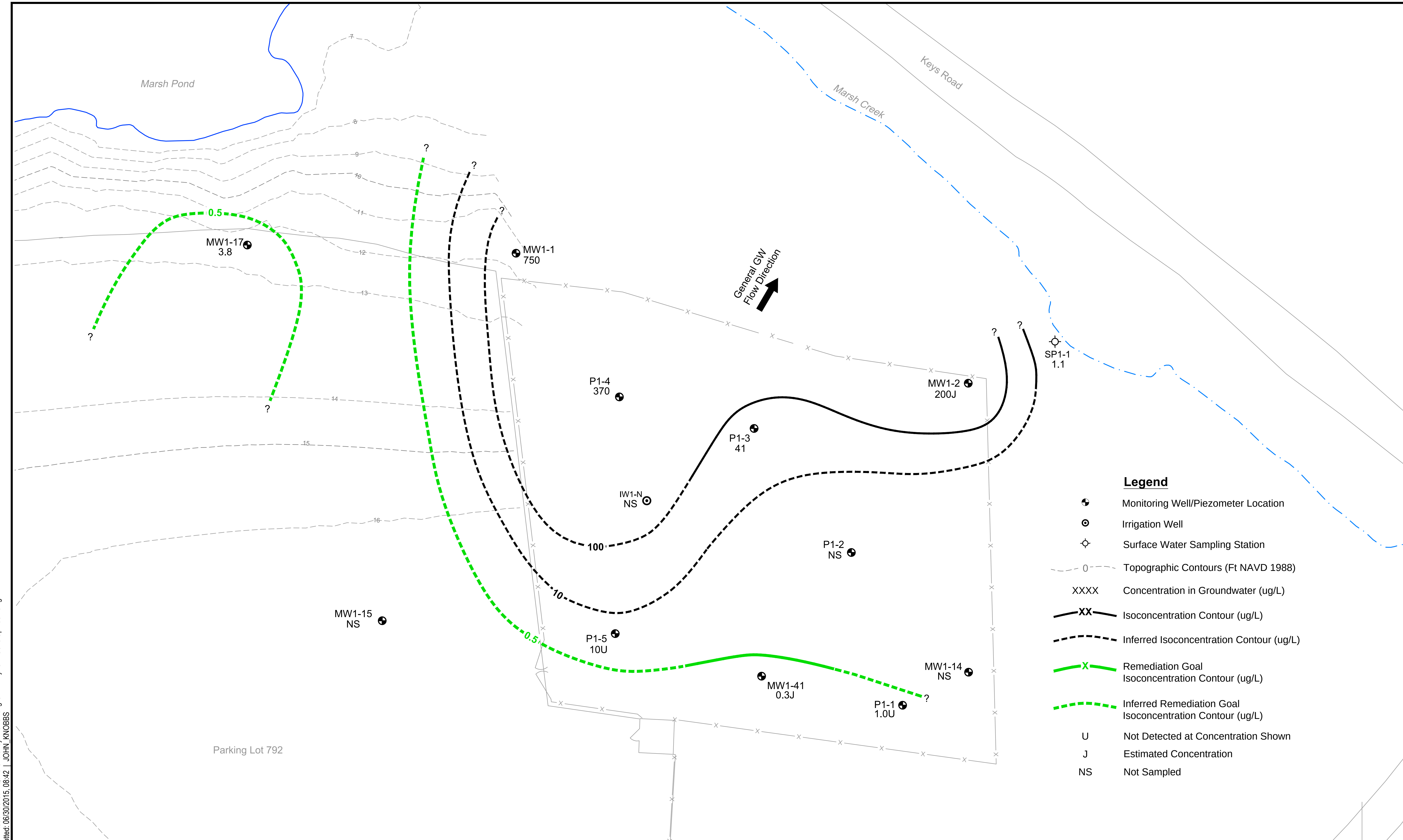
Figure C-13
OU 1, Vinyl Chloride Groundwater Concentrations, North Plantation Upper Aquifer, 1999/2000



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REVIEW

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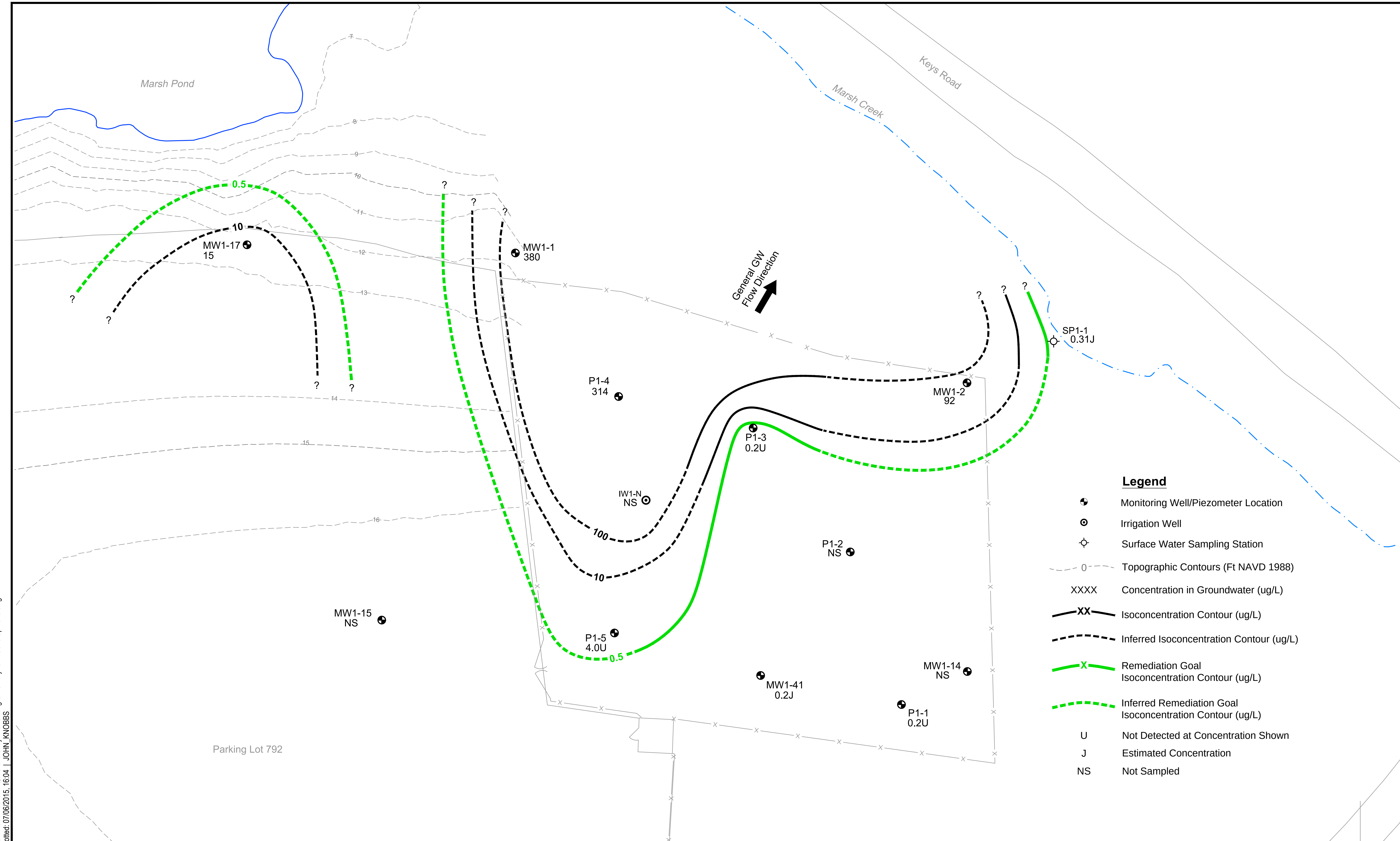
Figure C-14
OU 1, Vinyl Chloride Groundwater Concentrations, North Plantation Upper Aquifer, 2004



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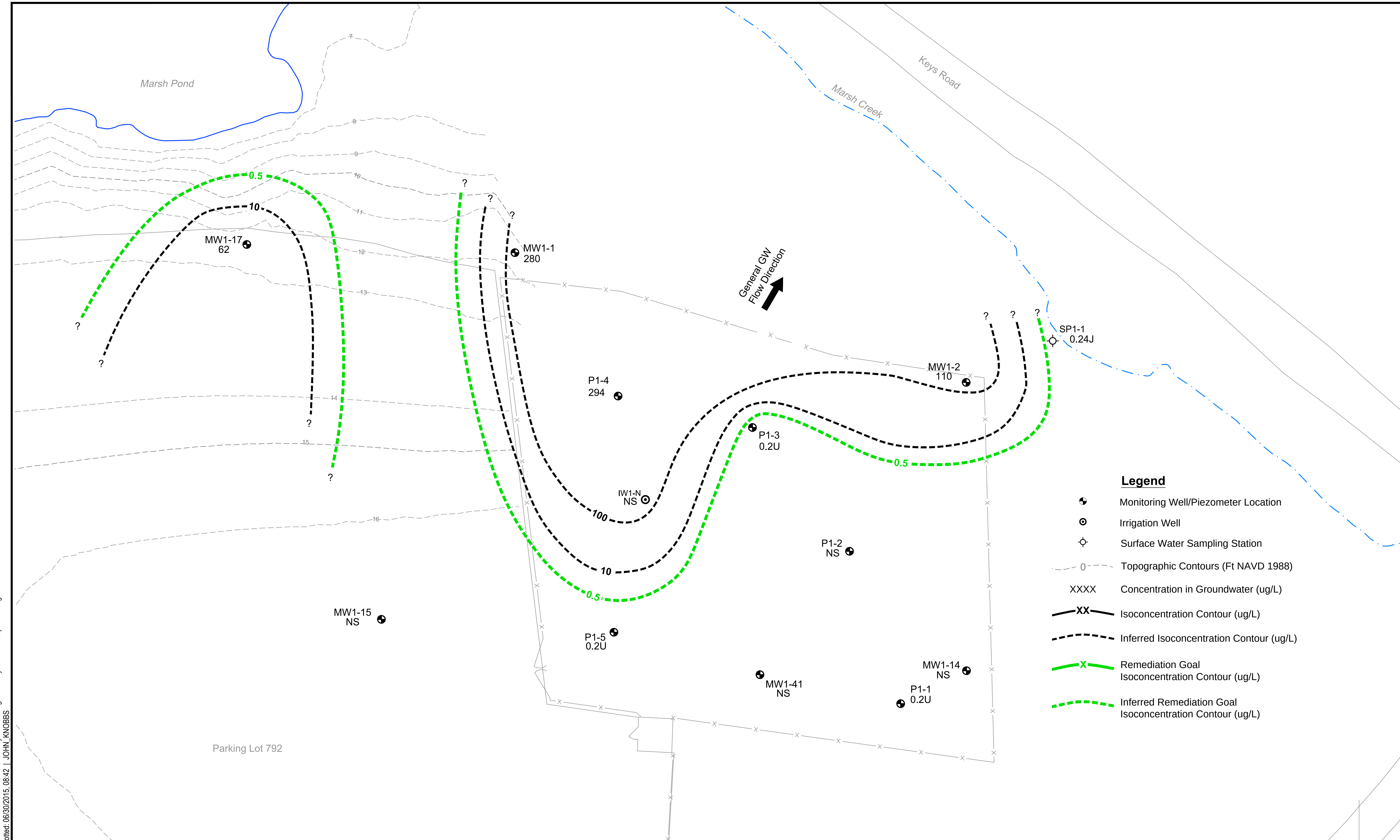
REVIEW

Figure C-15
OU 1, Vinyl Chloride Groundwater Concentrations, North Plantation Upper Aquifer, 2010



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Mod: 06/29/2015, 11:05 | Plotted: 06/30/2015, 08:42 | JOHN_KNOBBS

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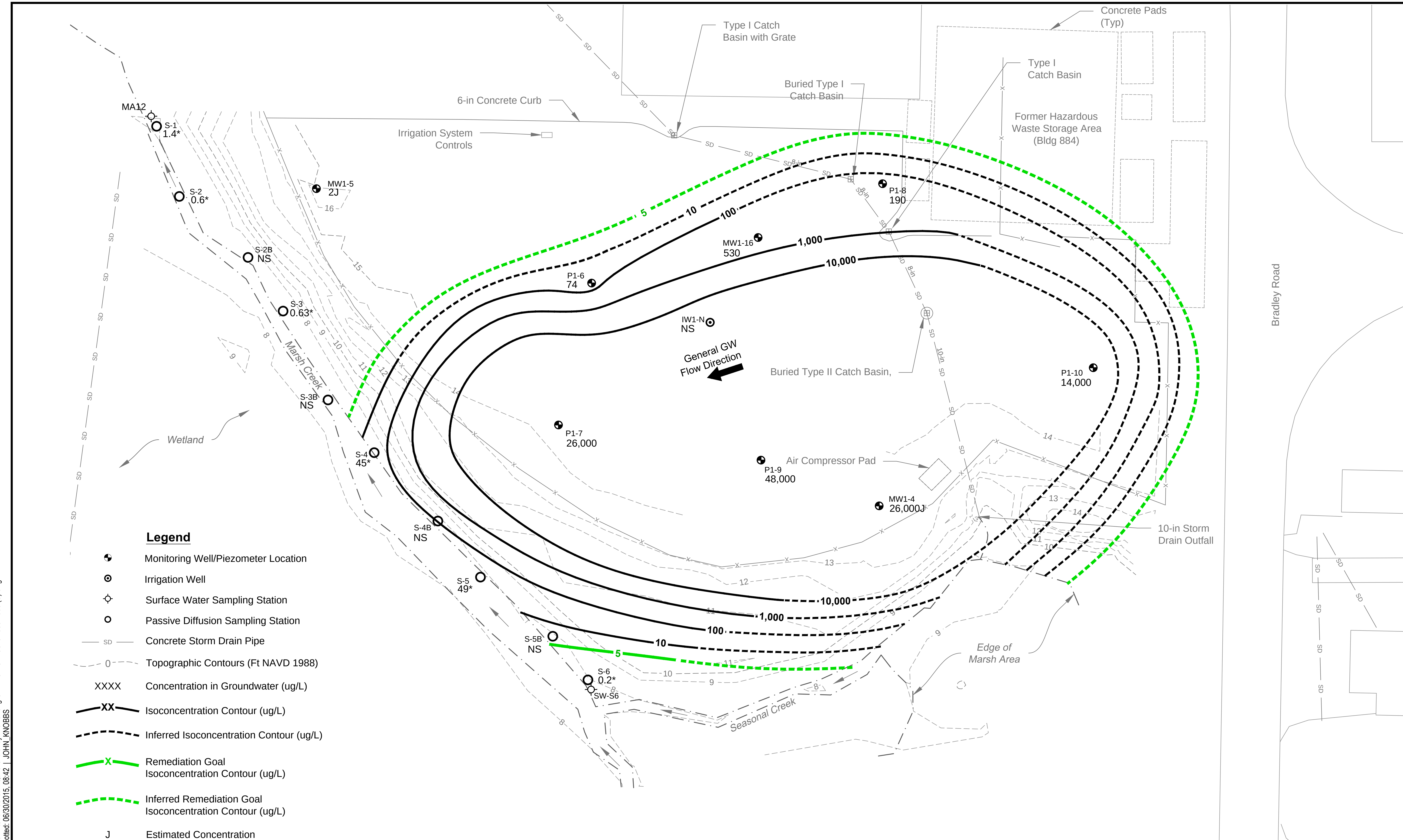
REVIEW

Figure C-16
OU 1, Vinyl Chloride
Groundwater Concentrations,
North Plantation Upper Aquifer, 2014



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REVIEW

Figure C-17
OU 1, TCE Groundwater Concentrations, South Plantation Upper Aquifer, 1999/2000

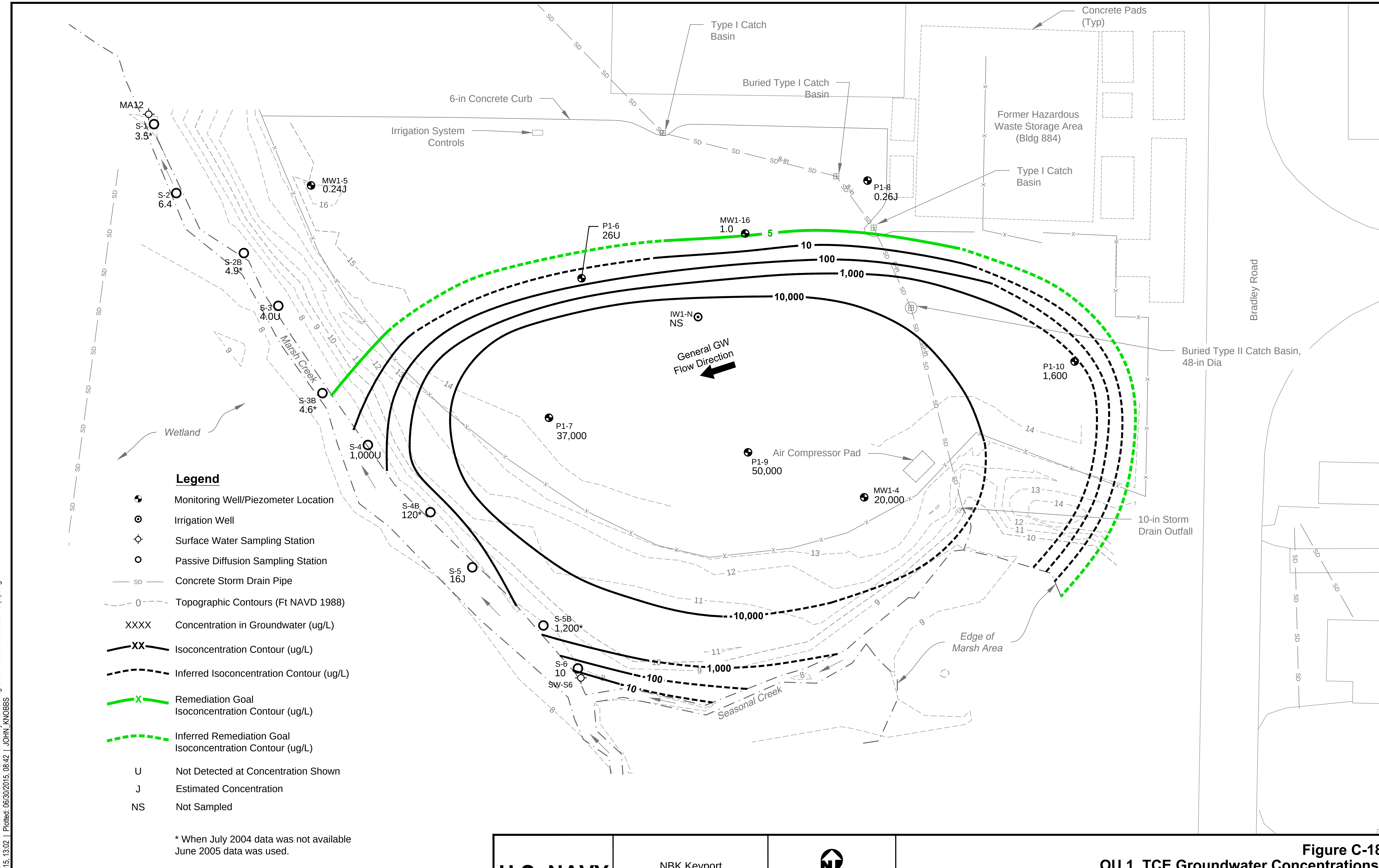

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Figure C-18
OU 1, TCE Groundwater Concentrations, South Plantation Upper Aquifer, 2004/2005

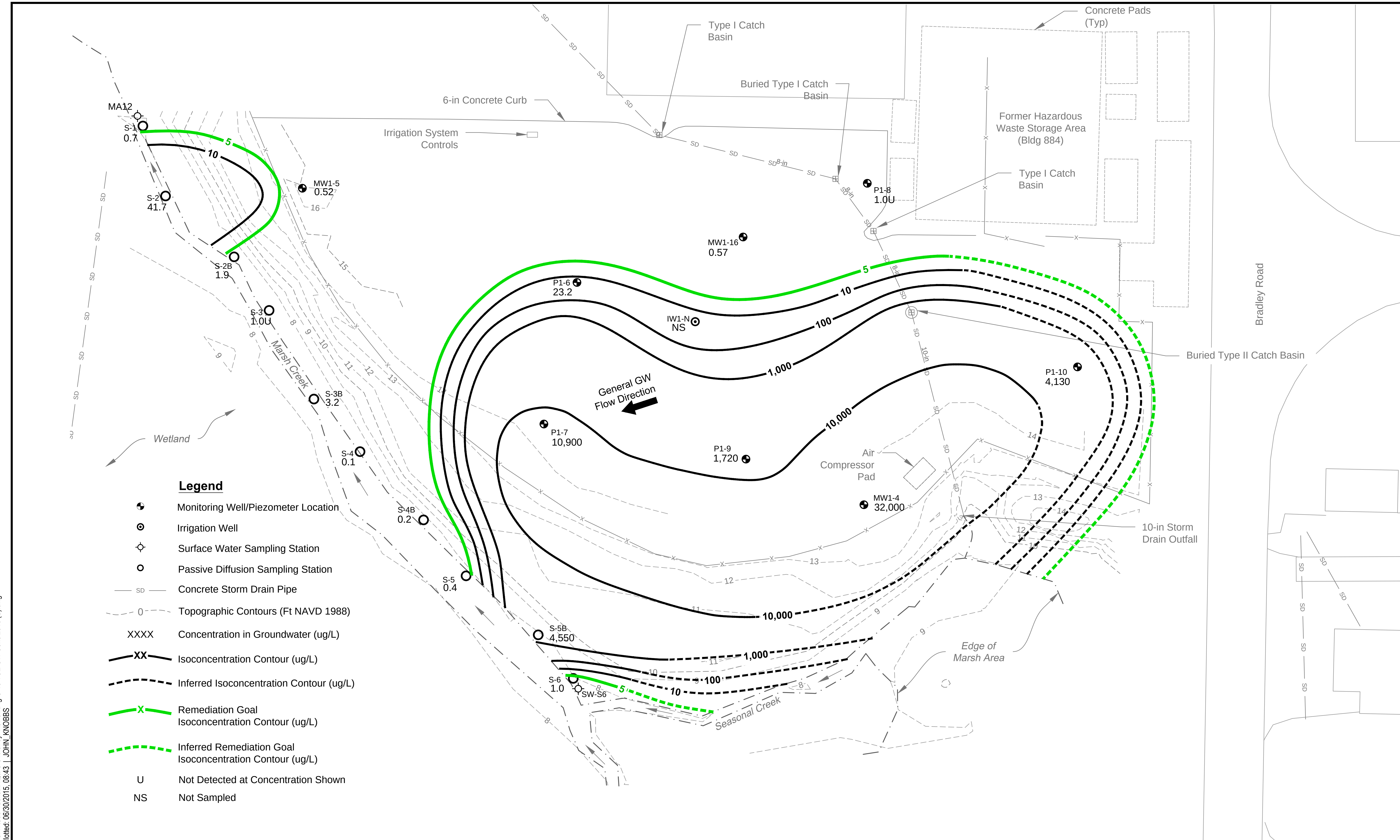

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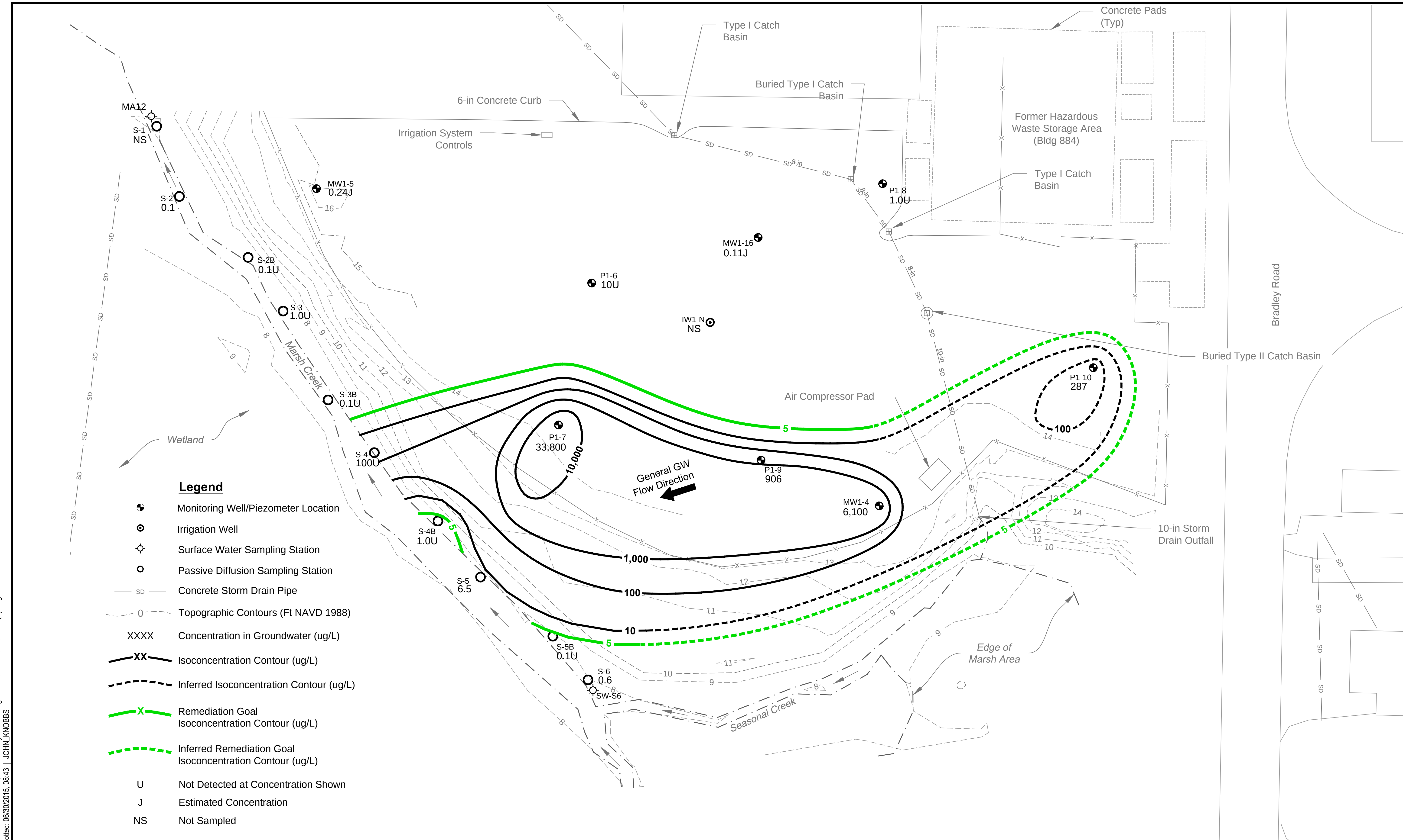
Figure C-19
OU 1, TCE Groundwater Concentrations, South Plantation Upper Aquifer, 2010



J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\DIQ\DO 81\4th 5yr Review\Fig C-20 TCE GW Conc 2014 (S).dwg
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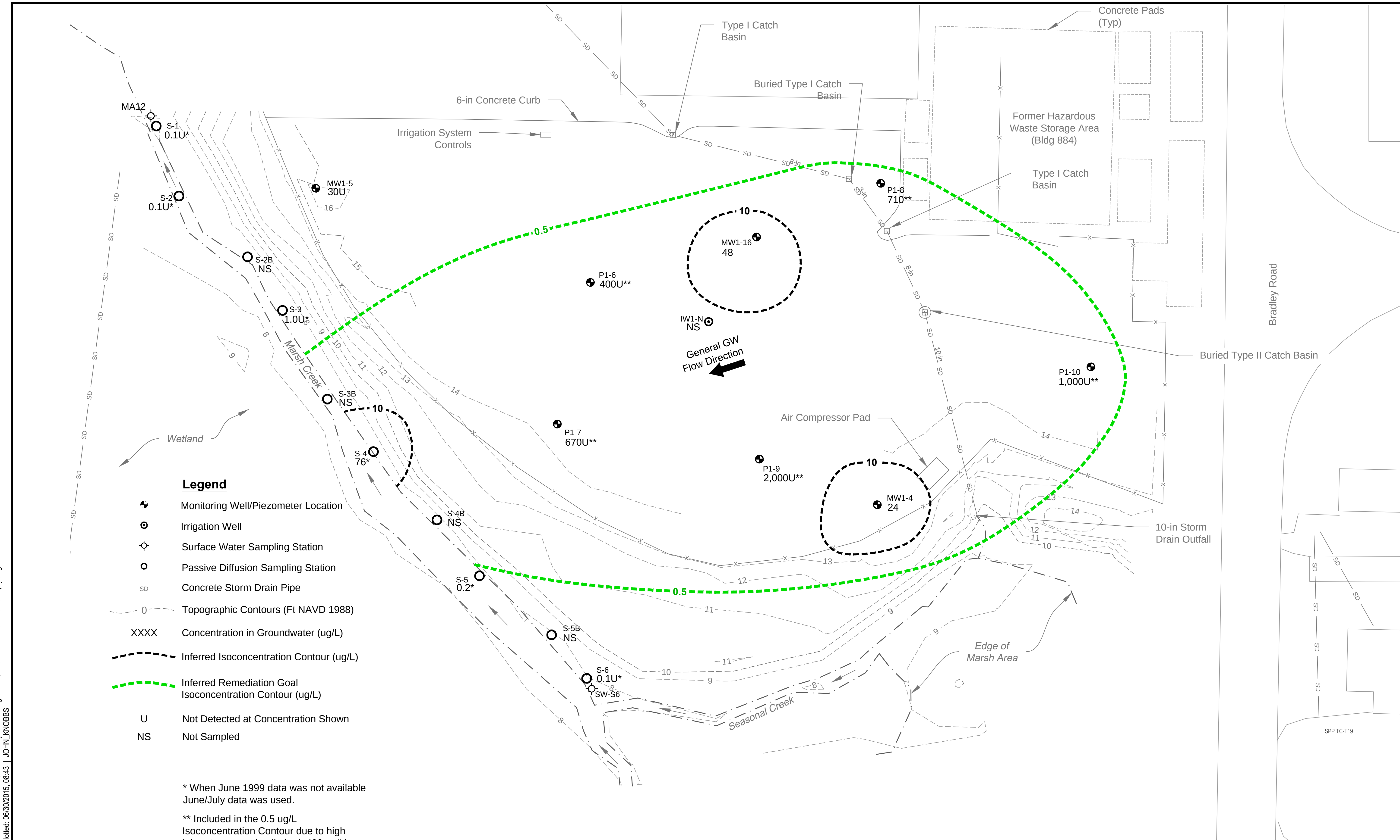
SCALE IN FEET

Figure C-20
OU 1, TCE Groundwater Concentrations, South Plantation Upper Aquifer, 2014



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Mod: 06/18/2015, 13:03 | Plotted: 06/30/2015, 08:43 | JOHN_KNOBBS

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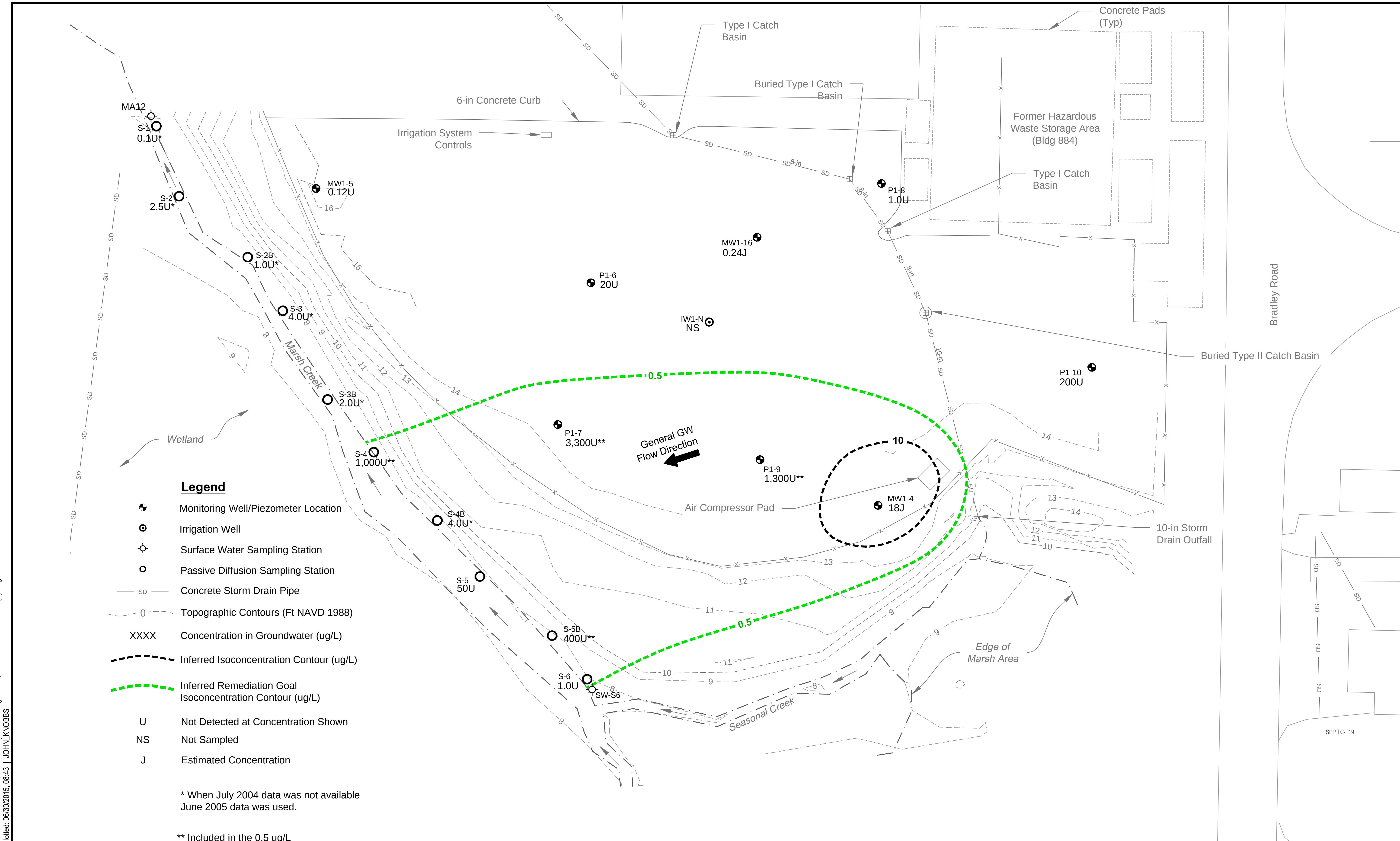
Figure C-21
OU 1, 1,1-DCE Groundwater Concentrations, South Plantation Upper Aquifer, 1999/2000



Legend

Monitoring Well/Piezometer Location

Irrigation Well

Surface Water Sampling Station

Passive Diffusion Sampling Station

SD — Concrete Storm Drain Pipe

0 — Topographic Contours (Ft NAVD 1988)

XXXX Concentration in Groundwater (ug/L)

Inferred Isoconcentration Contour (ug/L)

Inferred Remediation Goal Isoconcentration Contour (ug/L)

U Not Detected at Concentration Shown

NS Not Sampled

J Estimated Concentration

* When July 2004 data was not available June 2005 data was used.

** Included in the 0.5 ug/L Isoconcentration Contour due to high laboratory reporting limits (>400 ug/L).

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-22 1,1 DCE GW Conc 2004-5 (S).dwg
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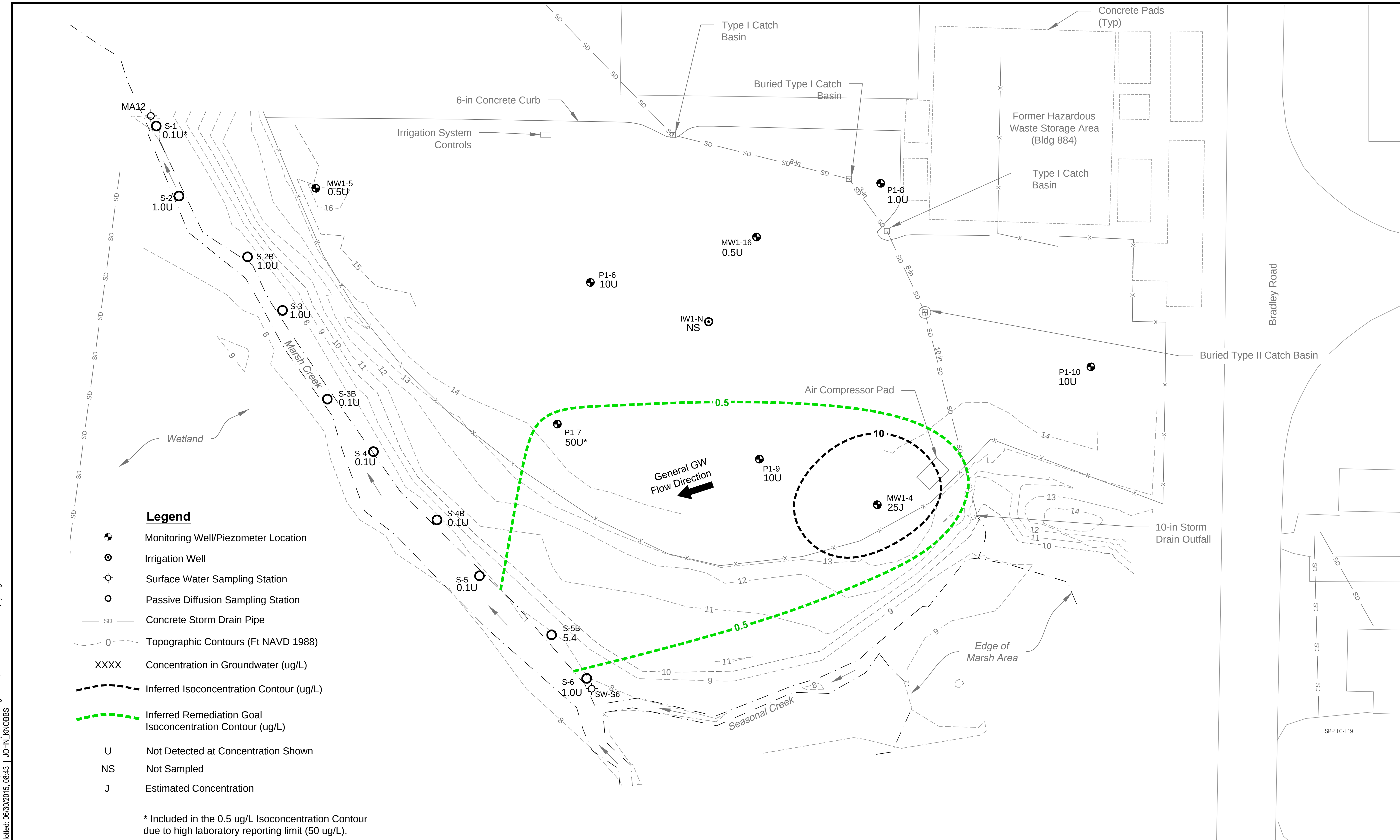
SCALE IN FEET

Figure C-22
OU 1, 1,1-DCE Groundwater Concentrations, South Plantation Upper Aquifer, 2004/2005



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REVIEW

0 15 30
SCALE IN FEET

Figure C-23
OU 1, 1,1-DCE
Groundwater Concentrations,
South Plantation Upper Aquifer, 2010

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\DIQ\DO 81\4th 5yr Review\Fig C-23 1,1 DCE GW Conc 2010 (S).dwg
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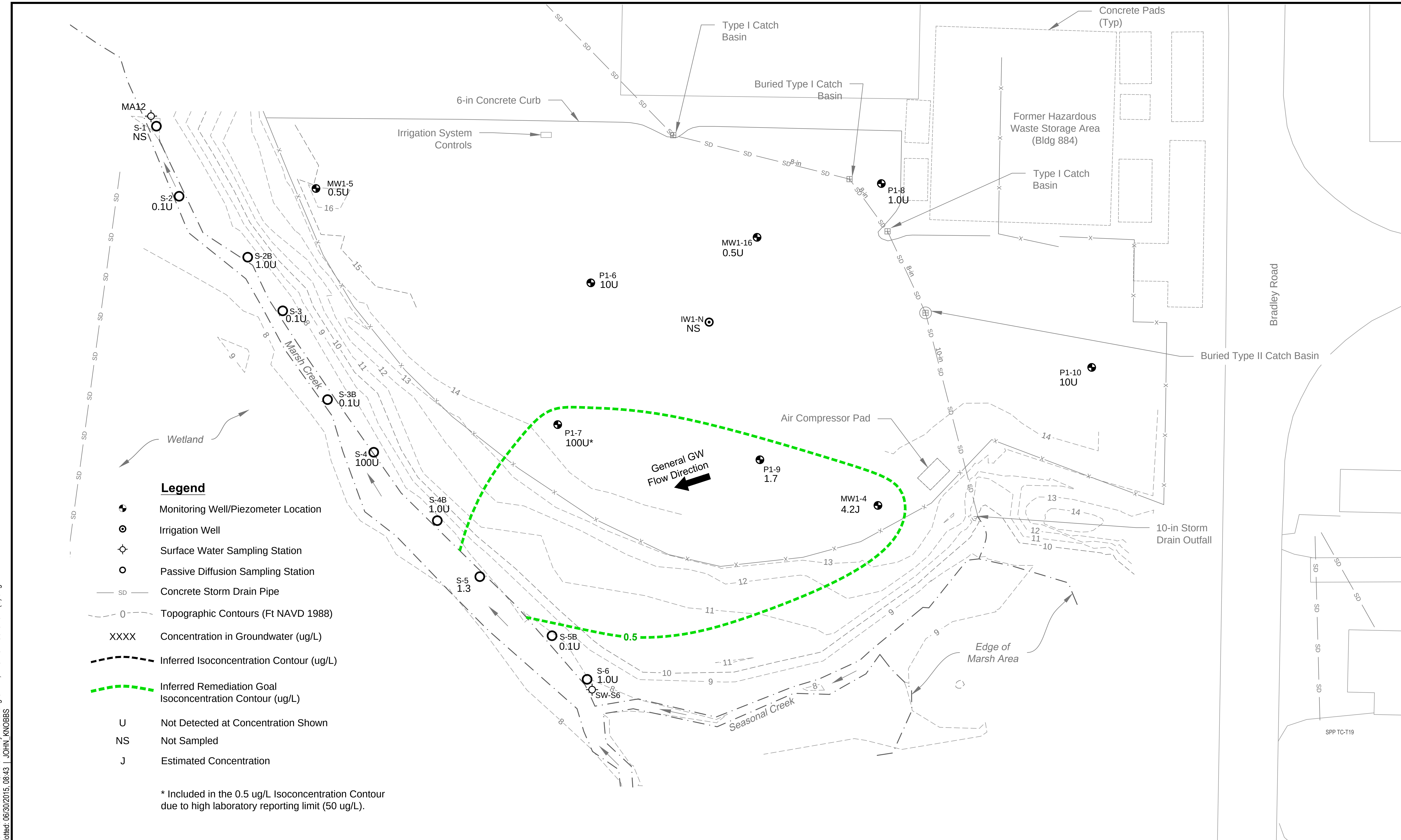

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0 15 30
SCALE IN FEET

Figure C-24
OU 1, 1,1-DCE Groundwater Concentrations, South Plantation Upper Aquifer, 2014

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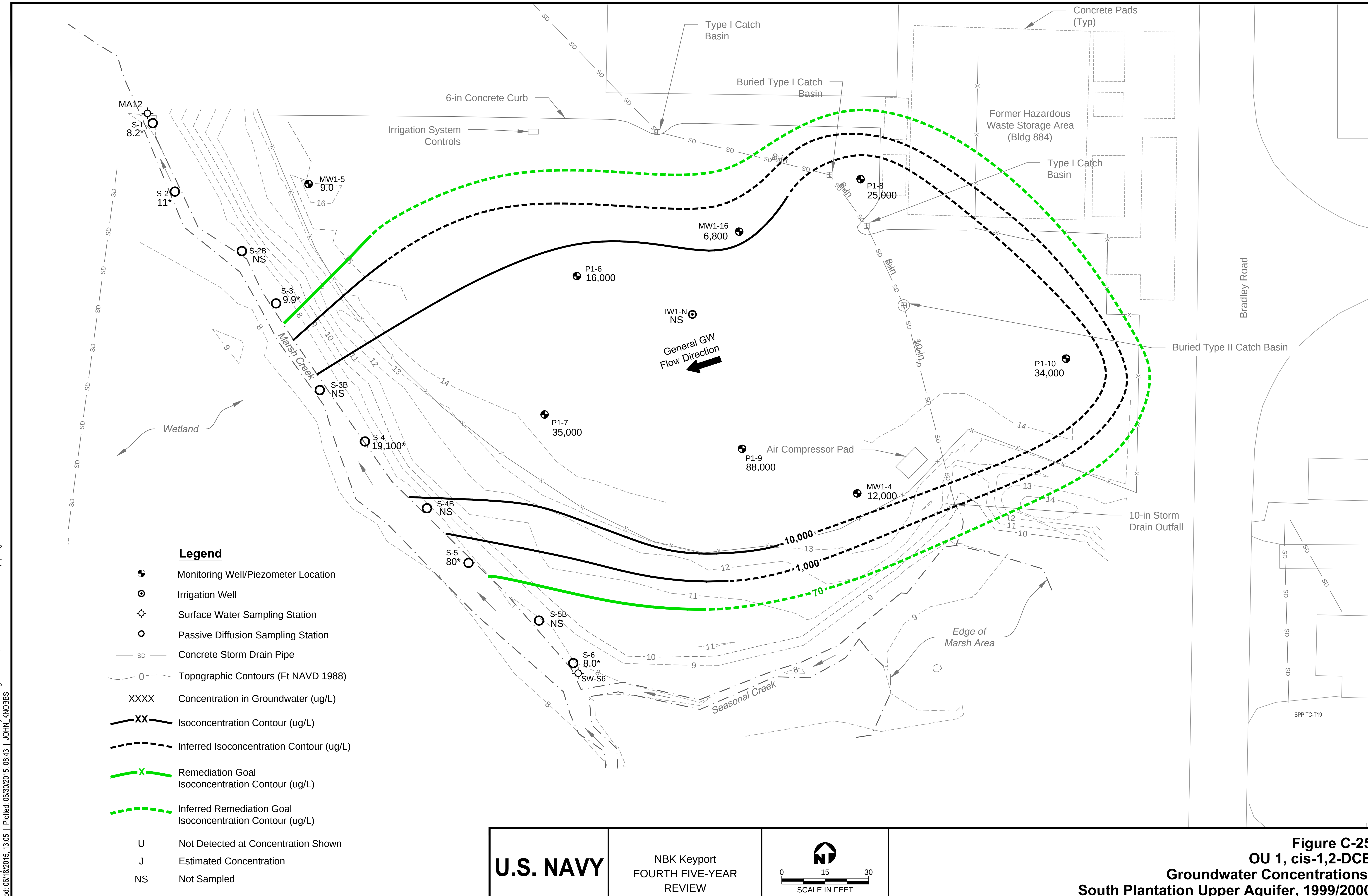

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REVIEW

Figure C-25
OU 1, cis-1,2-DCE
Groundwater Concentrations,
South Plantation Upper Aquifer, 1999/2000

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-25 cis 1,2 DCE GW Conc 1999-2000 (S).dwg
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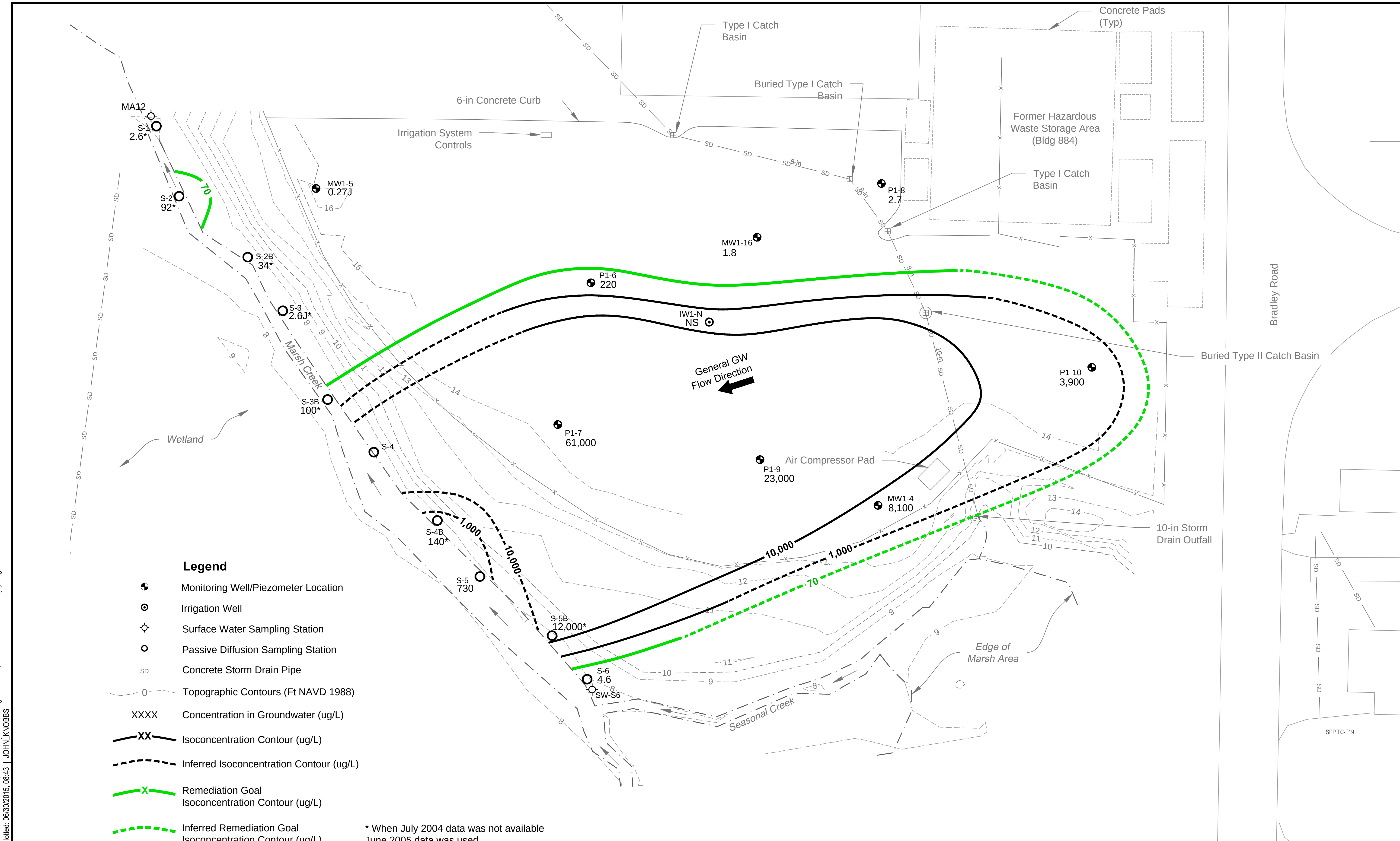

Legend

- Monitoring Well/Piezometer Location
- Irrigation Well
- Surface Water Sampling Station
- Passive Diffusion Sampling Station
- SD Concrete Storm Drain Pipe
- 0 Topographic Contours (Ft NAVD 1988)
- XXXX Concentration in Groundwater (ug/L)
- XX Isoconcentration Contour (ug/L)
- Inferred Isoconcentration Contour (ug/L)
- X Remediation Goal Isoconcentration Contour (ug/L)
- Inferred Remediation Goal Isoconcentration Contour (ug/L)
- J Estimated Concentration
- NS Not Sampled
- NA Not Analyzed

* When July 2004 data was not available June 2005 data was used.

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\DIQ\DO 81\4th 5yr Review\Fig C-26 cis 1,2 DCE GW Conc2004-5 (S).dwg
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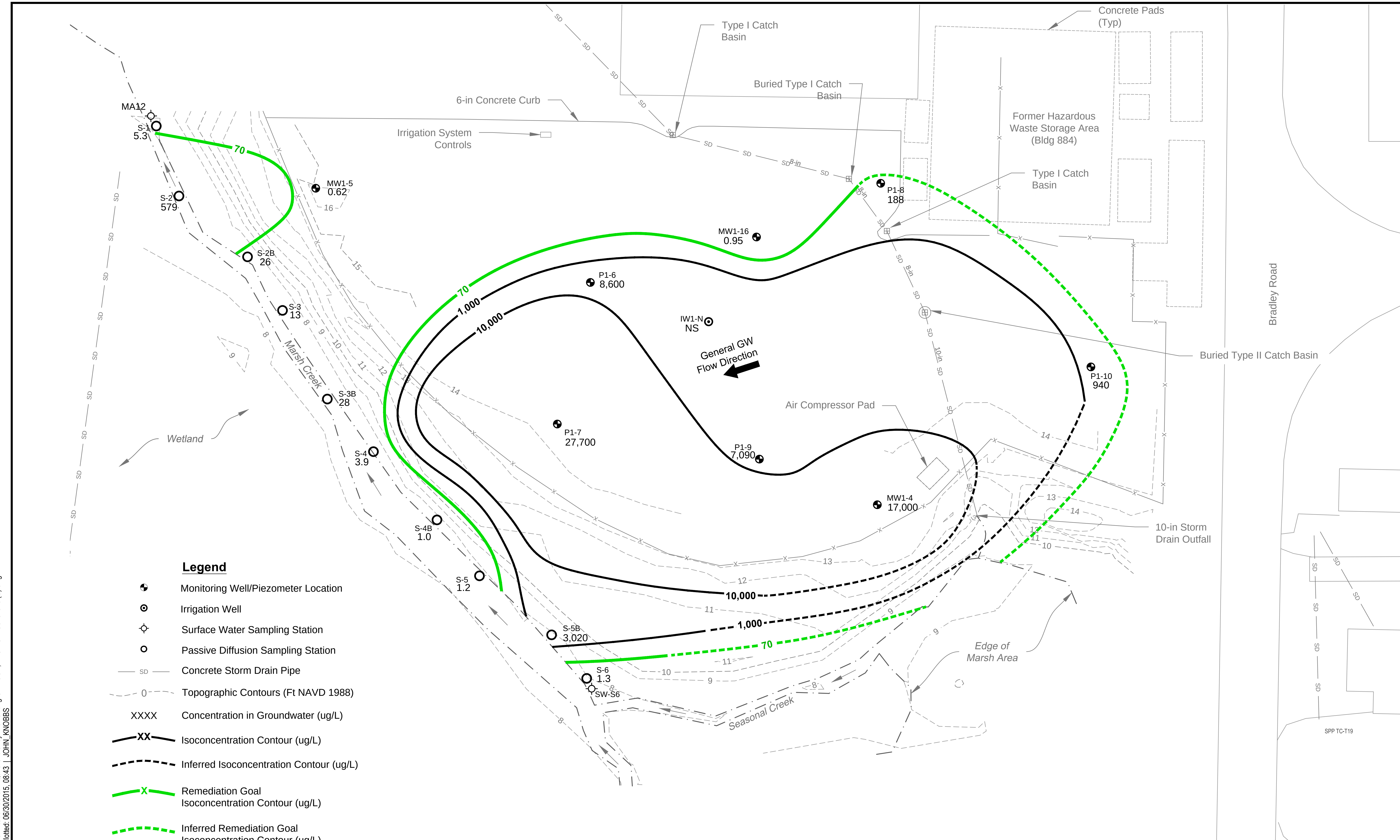
FOURTH FIVE-YEAR REVIEW

0 15 30
SCALE IN FEET

Figure C-26
OU 1, cis-1,2-DCE Groundwater Concentrations, South Plantation Upper Aquifer, 2004/2005



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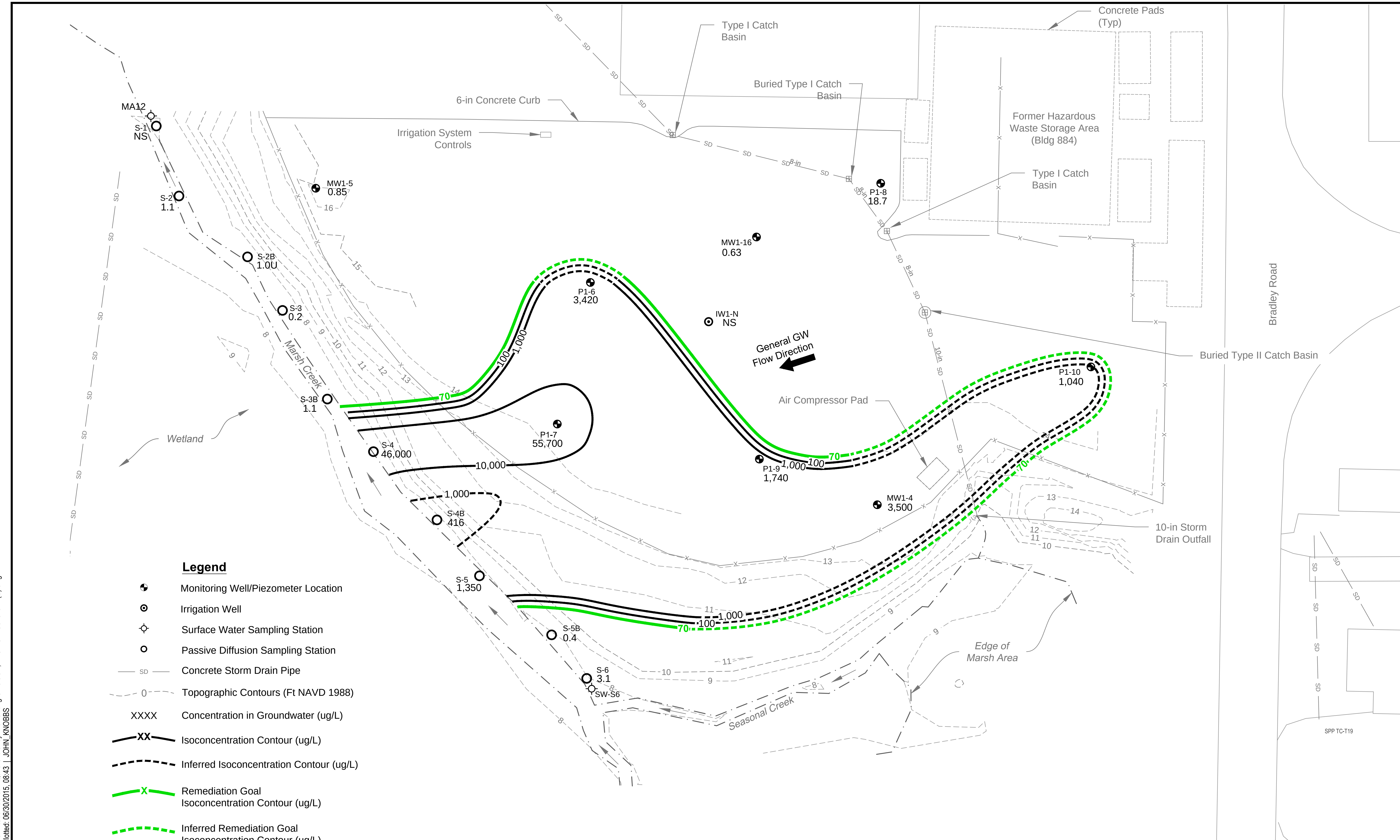
FOURTH FIVE-YEAR REVIEW

Figure C-27
OU 1, cis-1,2-DCE Groundwater Concentrations, South Plantation Upper Aquifer, 2010

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-27 cis 1,2 DCE GW Conc2010 (S).dwg
Mod: 06/18/2015, 13:05 | Plotted: 06/30/2015, 08:43 | JOHN_KNOBBS



J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\DIQ\DO 81\4th 5yr Review\Fig C-28 cis 1,2 DCE GW Conc2014 (S).dwg
Mod: 06/18/2015, 13:05 | Plotted: 06/30/2015, 08:43 | JOHN_KNOBBS

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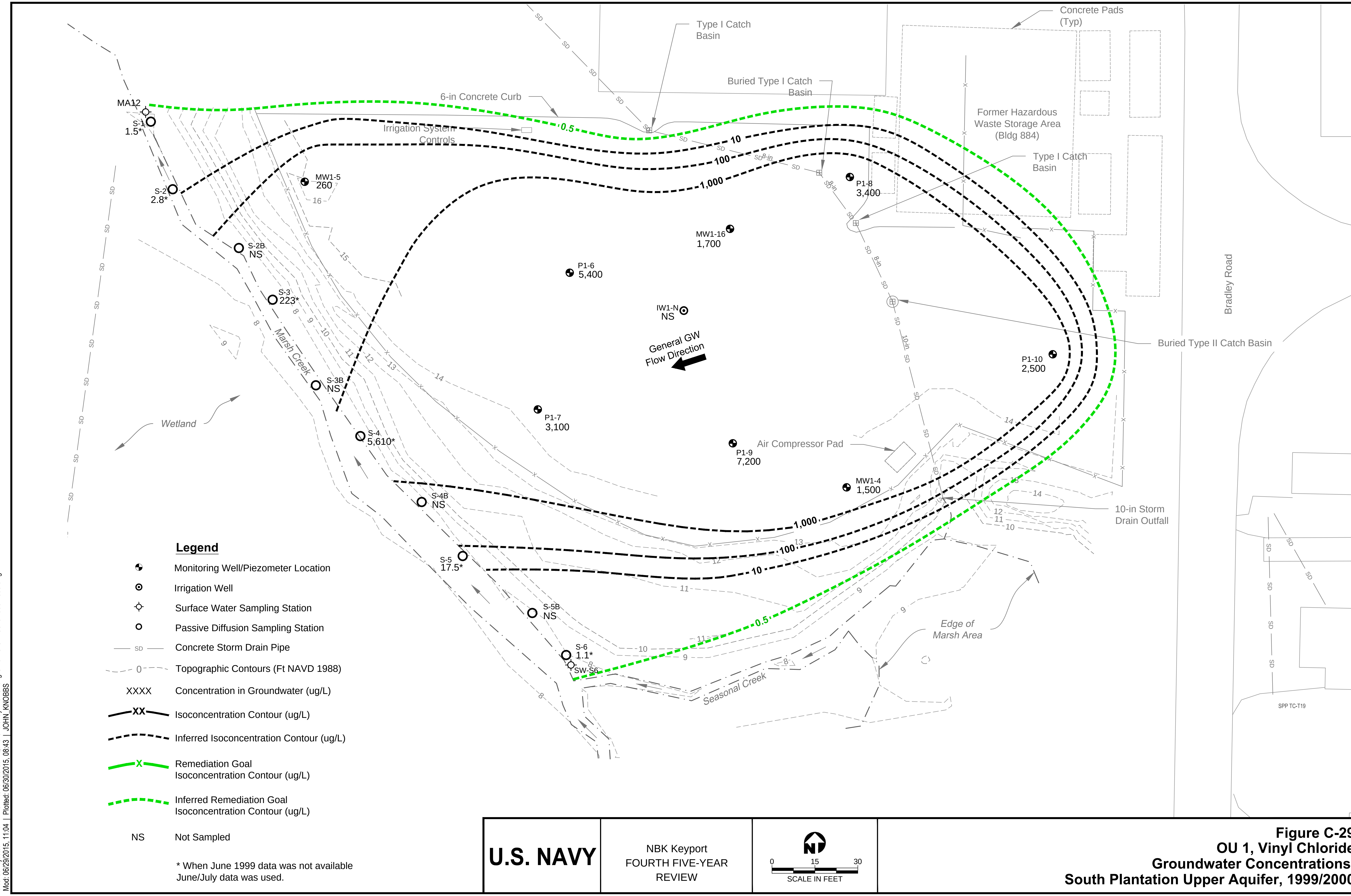
FOURTH FIVE-YEAR REVIEW

0 15 30
SCALE IN FEET

Figure C-28
OU 1, cis-1,2-DCE Groundwater Concentrations, South Plantation Upper Aquifer, 2014



J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-29 VC GW Conc 1999-2000.dwg
Mod: 06/29/2015, 11:04 | Plotted: 06/30/2015, 08:43 | JOHN_KNOBBS

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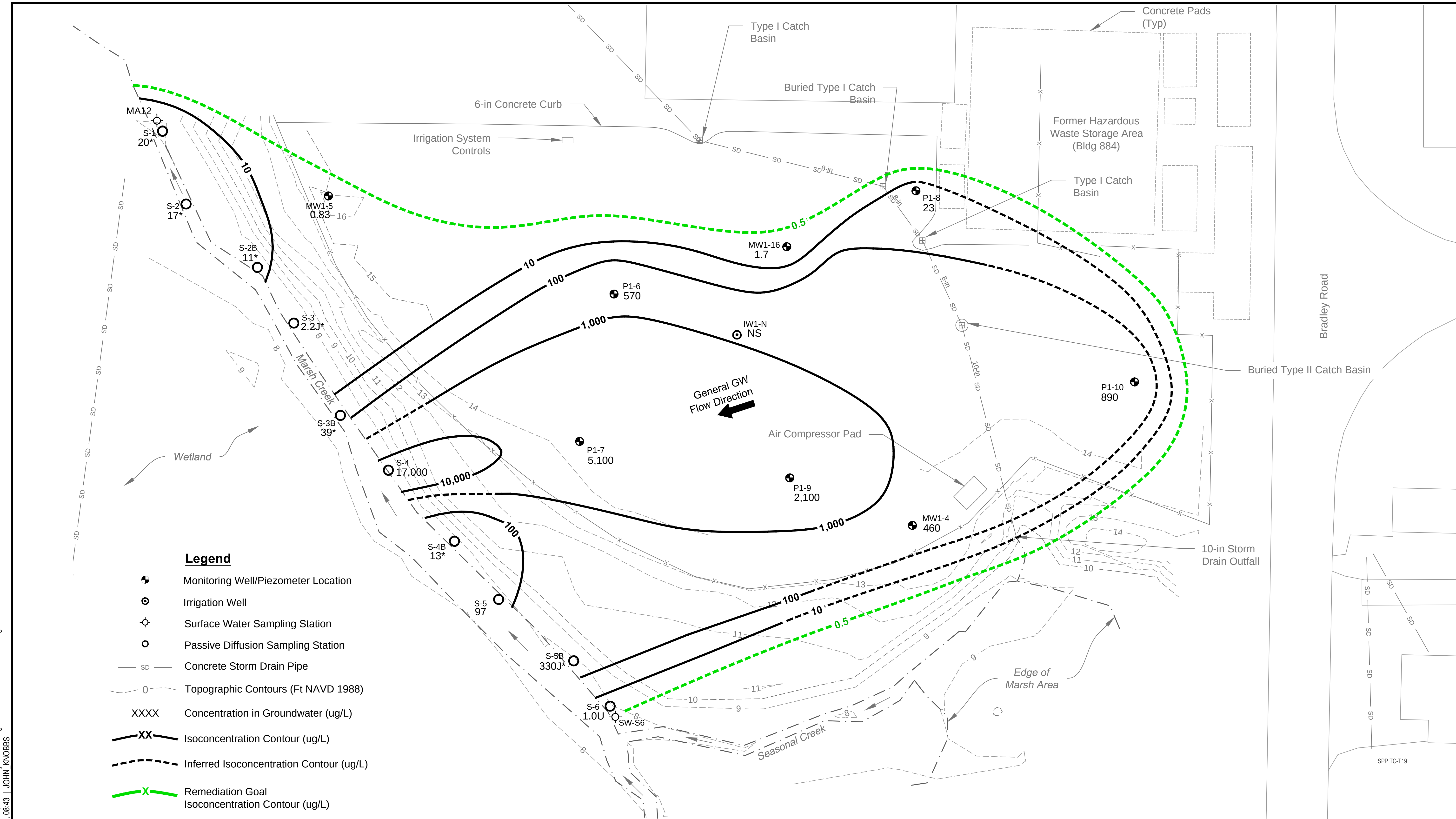
REVIEW

Figure C-29
OU 1, Vinyl Chloride
Groundwater Concentrations,
South Plantation Upper Aquifer, 1999/2000



Legend

	Monitoring Well/Piezometer Location
	Irrigation Well
	Surface Water Sampling Station
	Passive Diffusion Sampling Station
SD	Concrete Storm Drain Pipe
0	Topographic Contours (Ft NAVD 1988)
XXXX	Concentration in Groundwater (ug/L)
XX	Isoconcentration Contour (ug/L)
	Inferred Isoconcentration Contour (ug/L)
X	Remediation Goal Isoconcentration Contour (ug/L)
	Inferred Remediation Goal Isoconcentration Contour (ug/L)
U	Not Detected at Concentration Shown
J	Estimated Concentration
NS	Not Sampled

* When July 2004 data was not available June 2005 data was used.

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\DIQ\DO 81\4th 5yr Review\Fig C-30 VC GW Conc 2004-5.dwg
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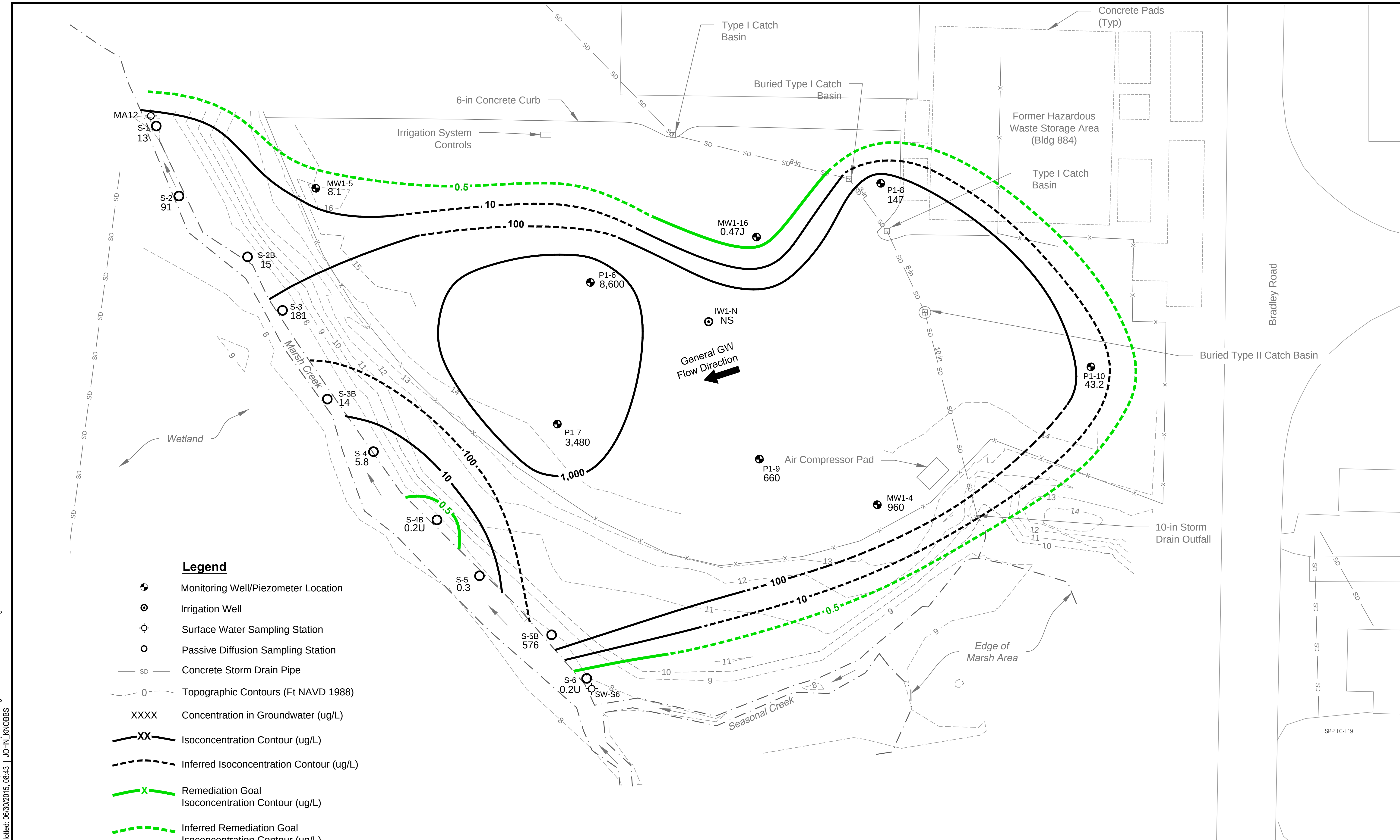
FOURTH FIVE-YEAR REVIEW

0 15 30
SCALE IN FEET

Figure C-30
OU 1, Vinyl Chloride Groundwater Concentrations, South Plantation Upper Aquifer, 2004/2005



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FOURTH FIVE-YEAR REVIEW

0 15 30
SCALE IN FEET

Figure C-31
OU 1, Vinyl Chloride Groundwater Concentrations, South Plantation Upper Aquifer, 2010

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-31 VC GW Conc 2010.dwg
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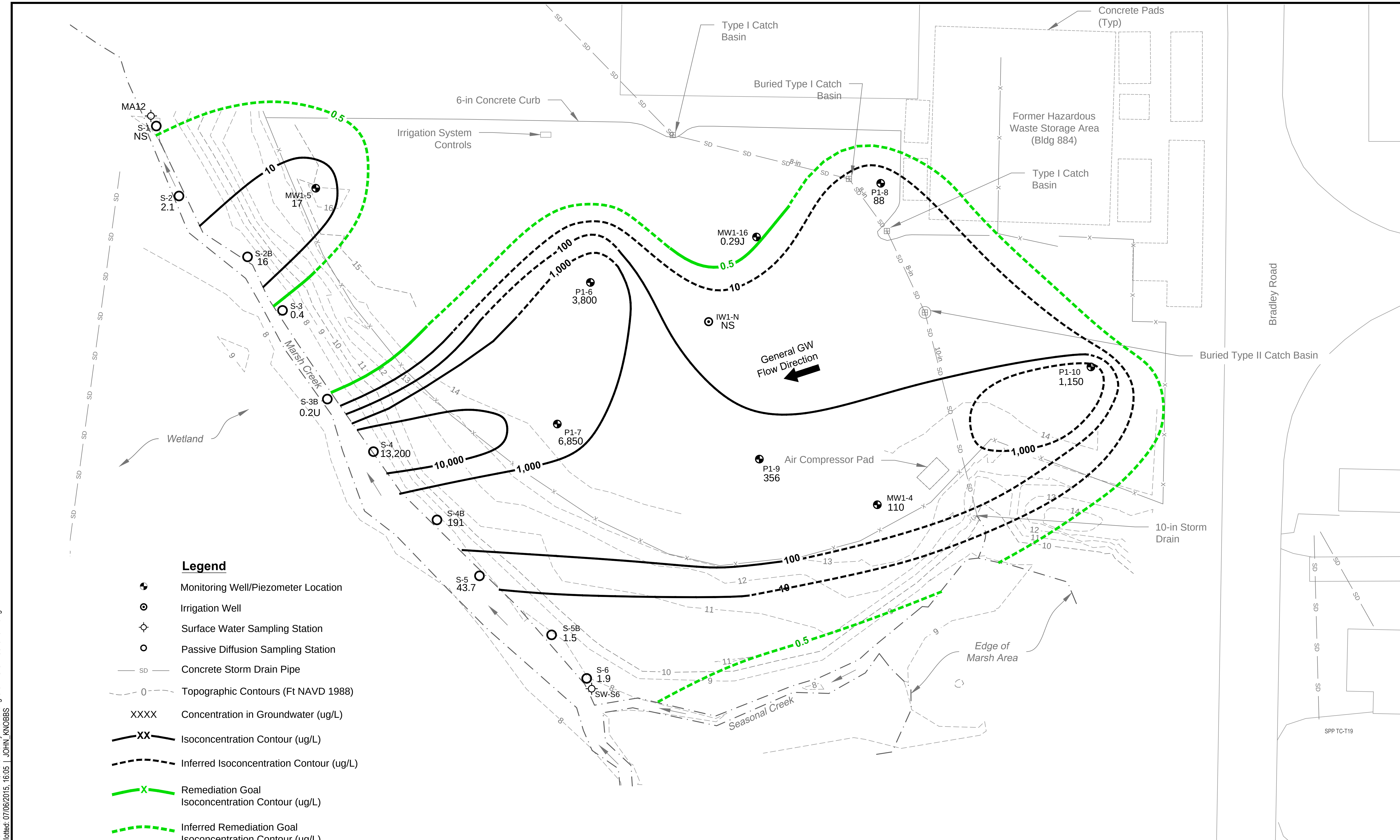

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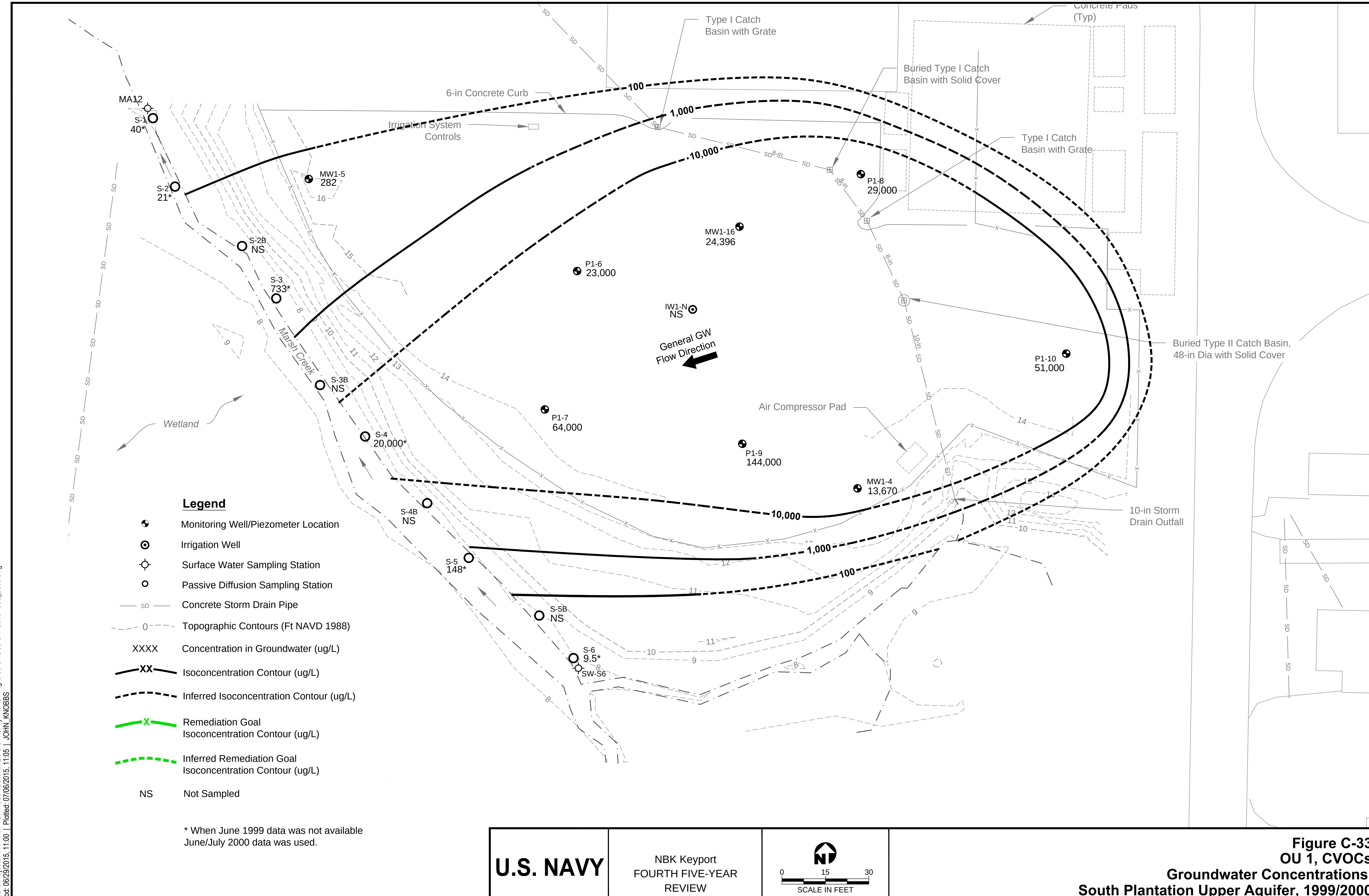
Figure C-32
OU 1, Vinyl Chloride Groundwater Concentrations, South Plantation Upper Aquifer, 2014



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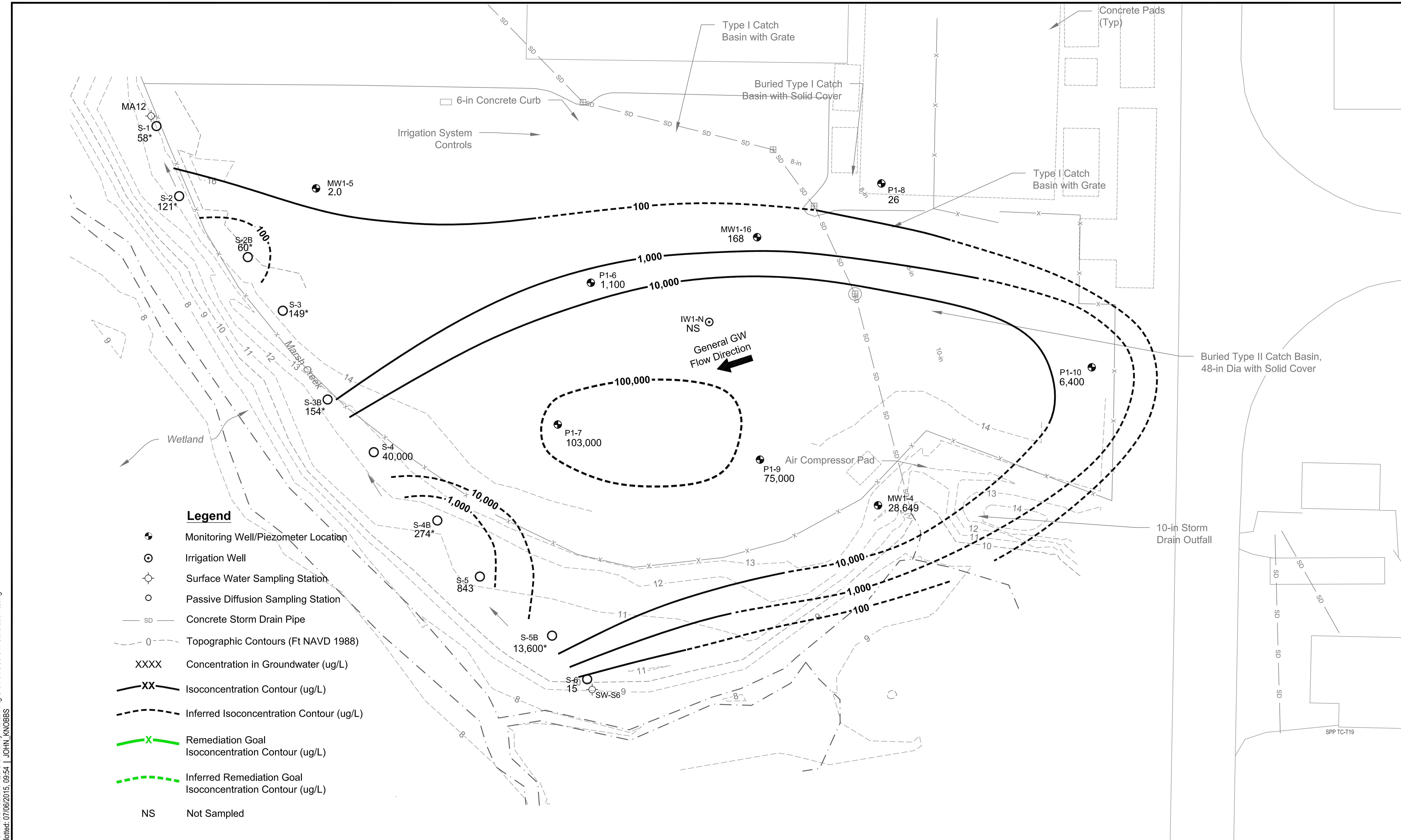
FOURTH FIVE-YEAR REVIEW

Figure C-33
OU 1, CVOCs
Groundwater Concentrations,
South Plantation Upper Aquifer, 1999/2000



Legend

- Monitoring Well/Piezometer Location
- Irrigation Well
- Surface Water Sampling Station
- Passive Diffusion Sampling Station
- SD — Concrete Storm Drain Pipe
- 0 — Topographic Contours (Ft NAVD 1988)
- XXXX — Concentration in Groundwater (ug/L)
- XX — Isoconcentration Contour (ug/L)
- Inferred Isoconcentration Contour (ug/L)
- X — Remediation Goal Isoconcentration Contour (ug/L)
- Inferred Remediation Goal Isoconcentration Contour (ug/L)
- NS — Not Sampled

* When July 2004 data was not available June 2005 data was used.

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-34 CVOCs GW Conc 2004-5.dwg
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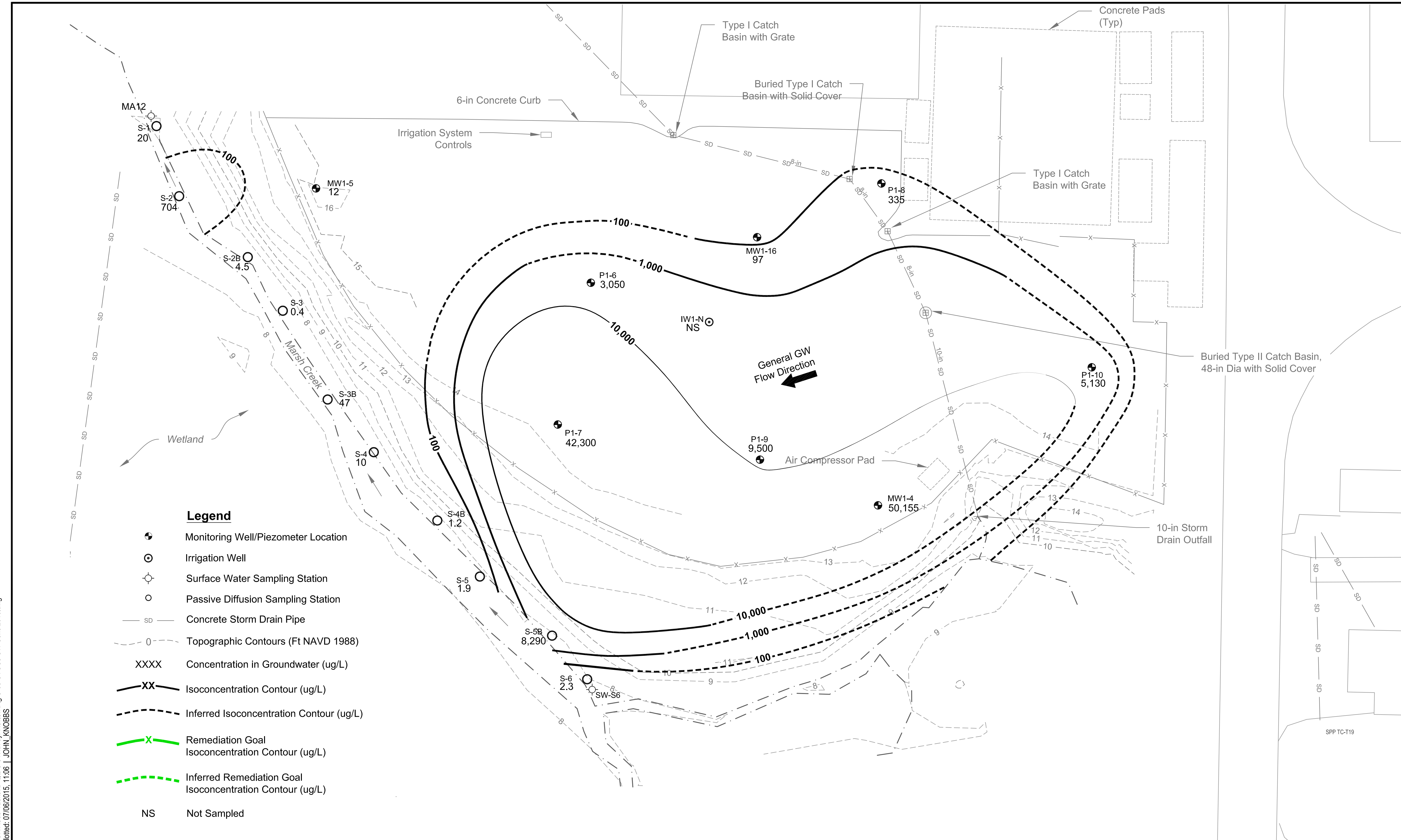
U.S. NAVY	NBK Keyport FOURTH FIVE-YEAR REVIEW	0 15 30 SCALE IN FEET	Figure C-34 OU 1, CVOCs Groundwater Concentrations, South Plantation Upper Aquifer, 2004/2005



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Mod: 07/02/2015, 11:37 | Plotted: 07/06/2015, 11:06 | JOHN_KNOBBS

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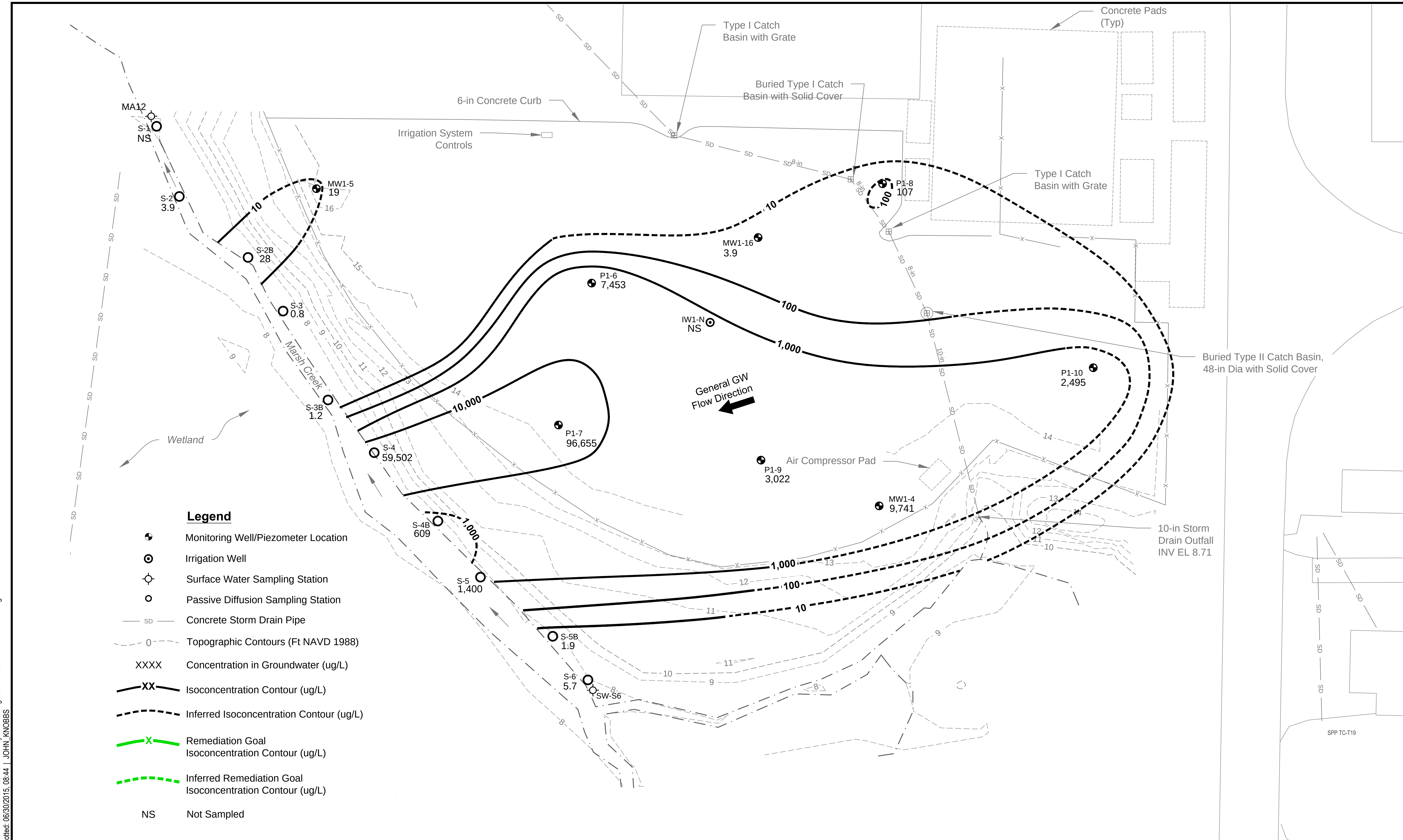
FOURTH FIVE-YEAR REVIEW

Figure C-35
OU 1, CVOCs
Groundwater Concentrations,
South Plantation Upper Aquifer, 2010



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Mod: 06/18/2015, 13:08 | Plotted: 06/30/2015, 08:44 | JOHN_KNOBBS

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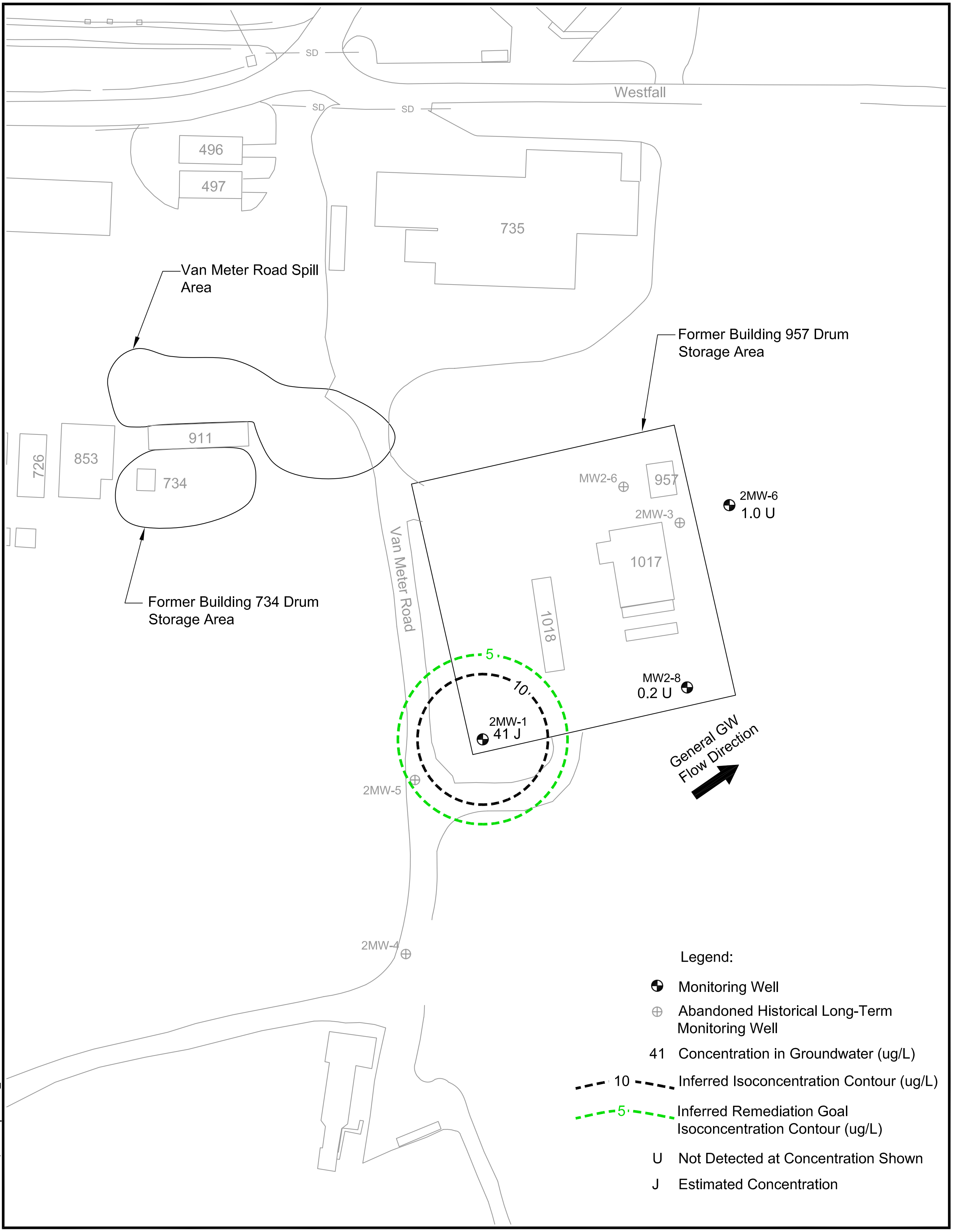
Figure C-36
OU 1, CVOCs
Groundwater Concentrations,
South Plantation Upper Aquifer, 2014



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0 50 100
SCALE IN FEET

Figure C-37
OU 2, Area 2 TCE Groundwater Concentrations, November 1995

NBK Keyport
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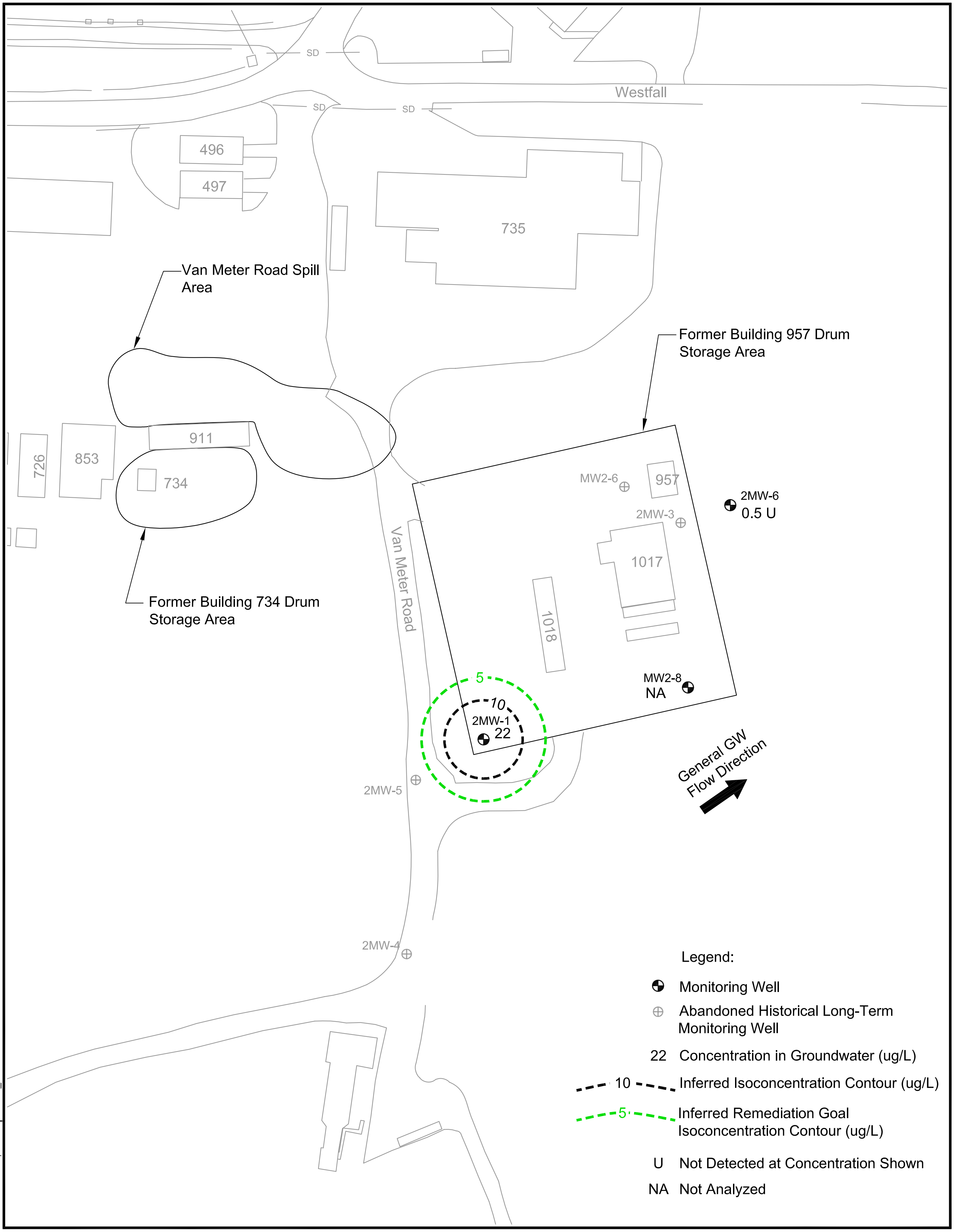

U.S. NAVY	0 50 100 SCALE IN FEET	**Figure C-38** **OU 2, Area 2 TCE Groundwater Concentrations, November 2000**	NBK Keyport FOURTH FIVE-YEAR REVIEW

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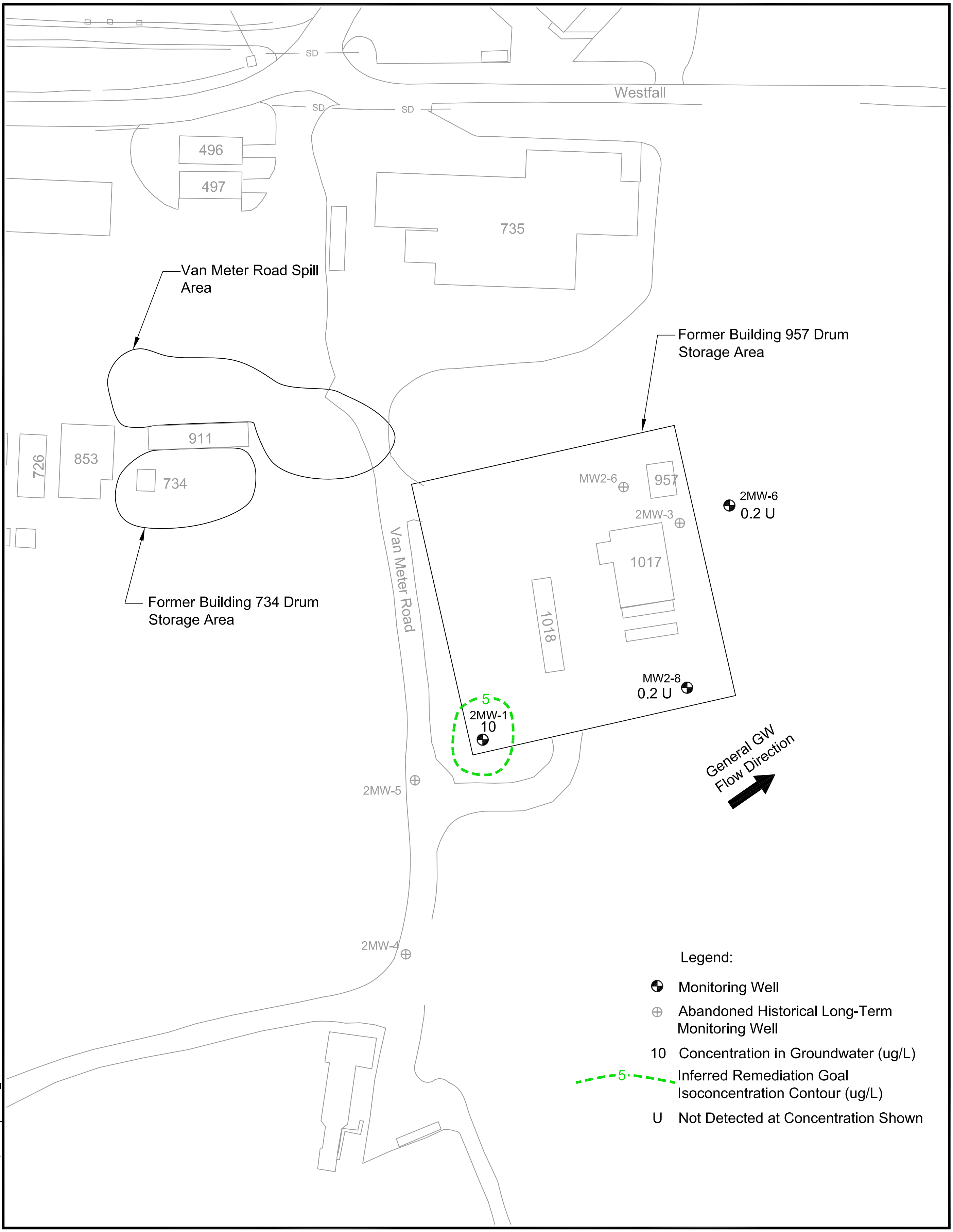
Mod: 06/18/2015, 10:55 | Plotted: 06/30/2015, 09:05 | JOHN_KNOBBS



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Mod: 06/18/2015, 10:56 | Plotted: 06/30/2015, 09:26 | JOHN_KNOBBS

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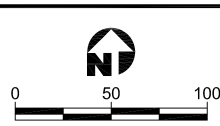

Figure C-39
OU 2, Area 2 TCE Groundwater Concentrations, June 2005

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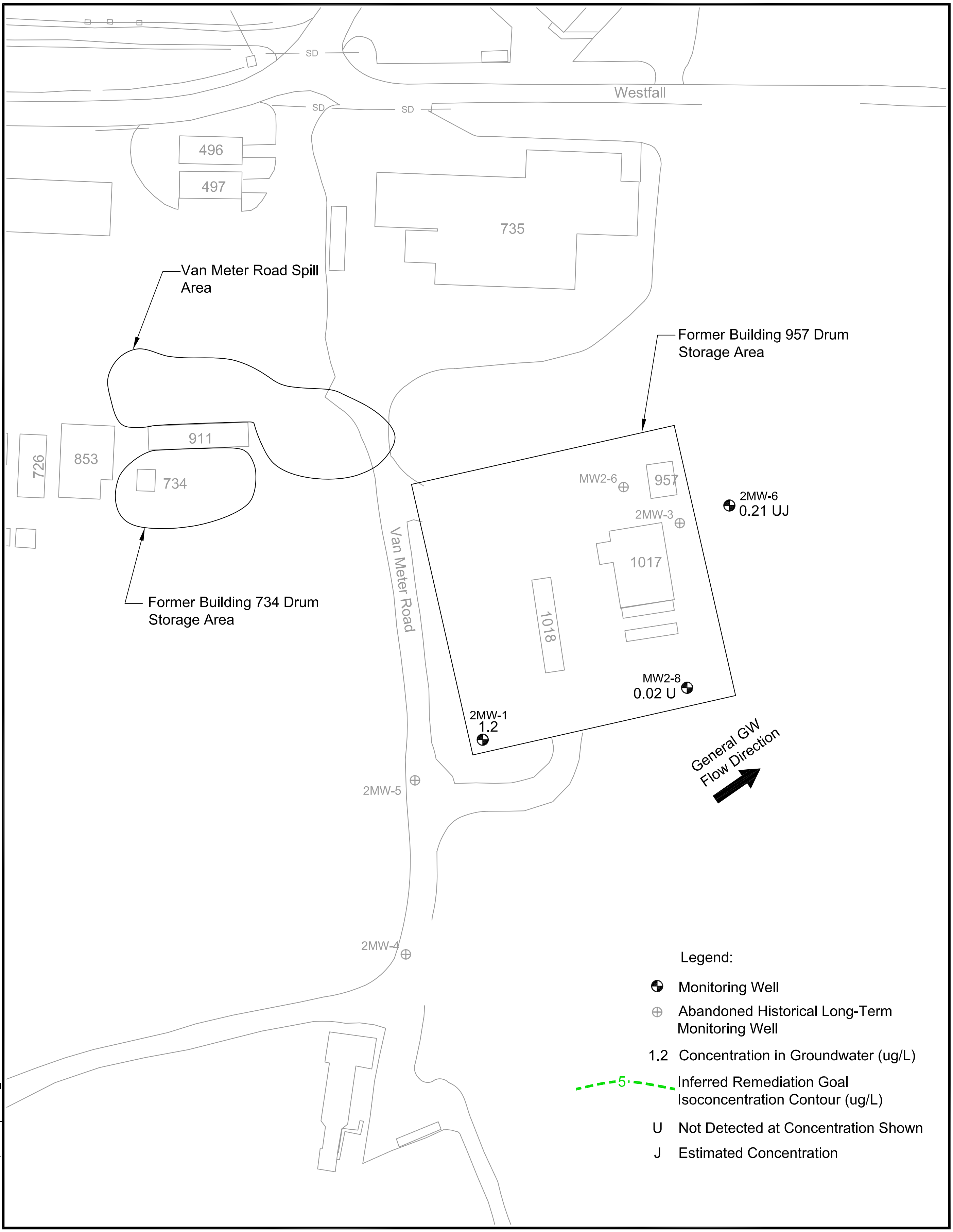

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Figure C-40
OU 2, Area 2 TCE Groundwater Concentrations, June 2014

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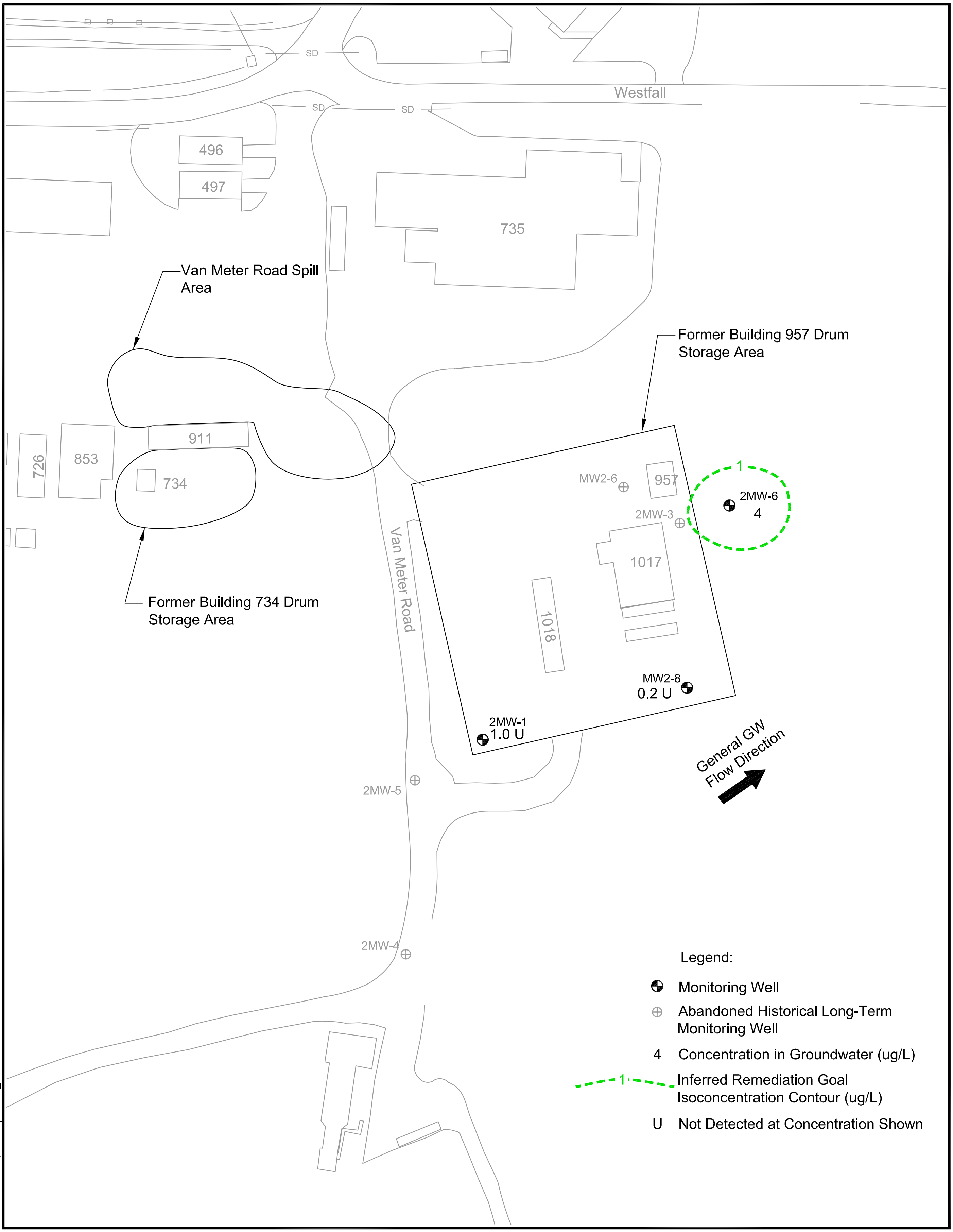

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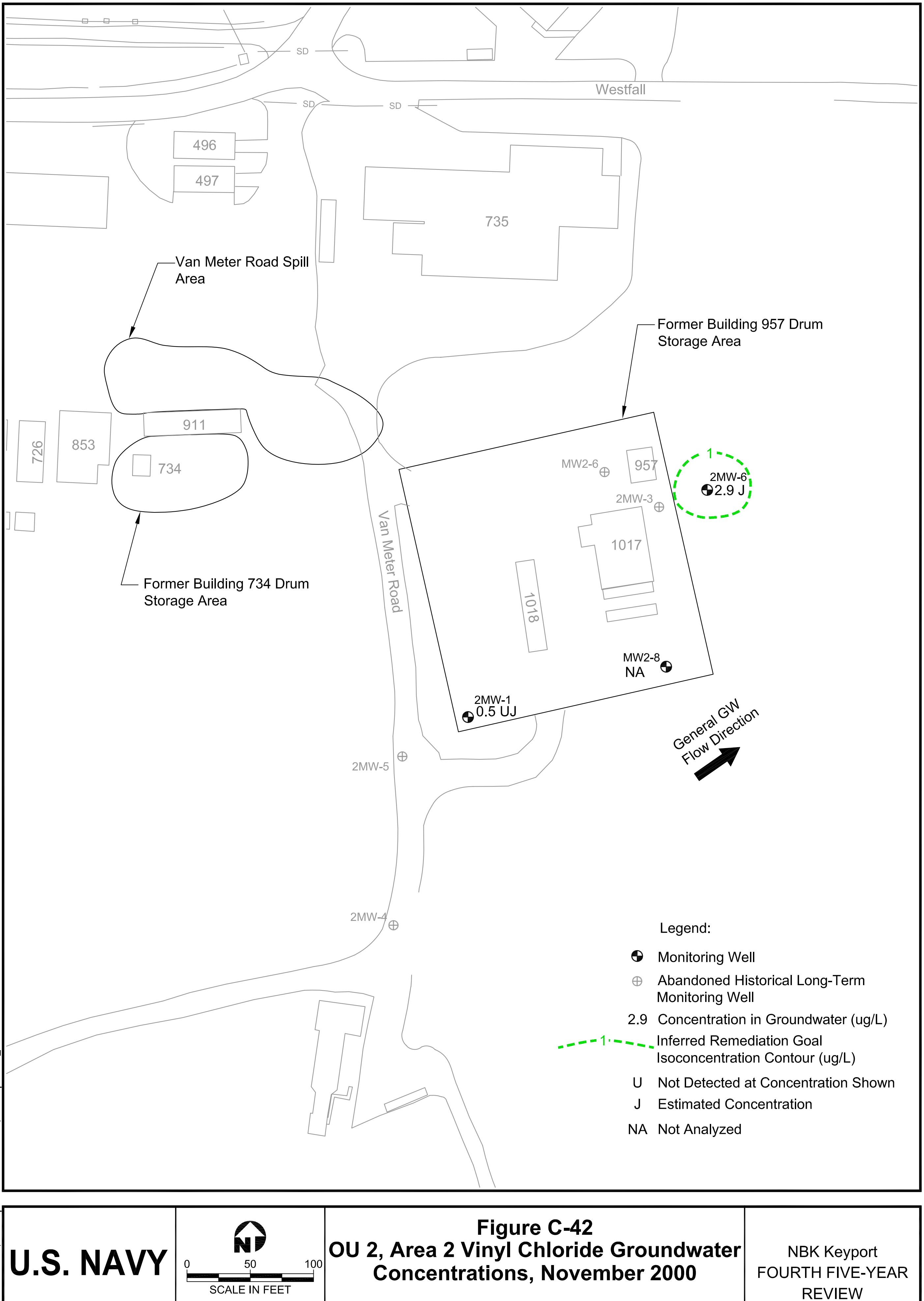
Mod: 06/18/2015, 10:57 | Plotted: 06/30/2015, 09:05 | JOHN_KNOBBS

U.S. NAVY	0 50 100 SCALE IN FEET	**Figure C-41 OU 2, Area 2 Vinyl Chloride Groundwater Concentrations, November 1995**	NBK Keyport FOURTH FIVE-YEAR REVIEW



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Mod: 06/18/2015, 10:58 | Plotted: 06/30/2015, 09:05 | JOHN_KNOBBS

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Figure C-42
OU 2, Area 2 Vinyl Chloride Groundwater Concentrations, November 2000

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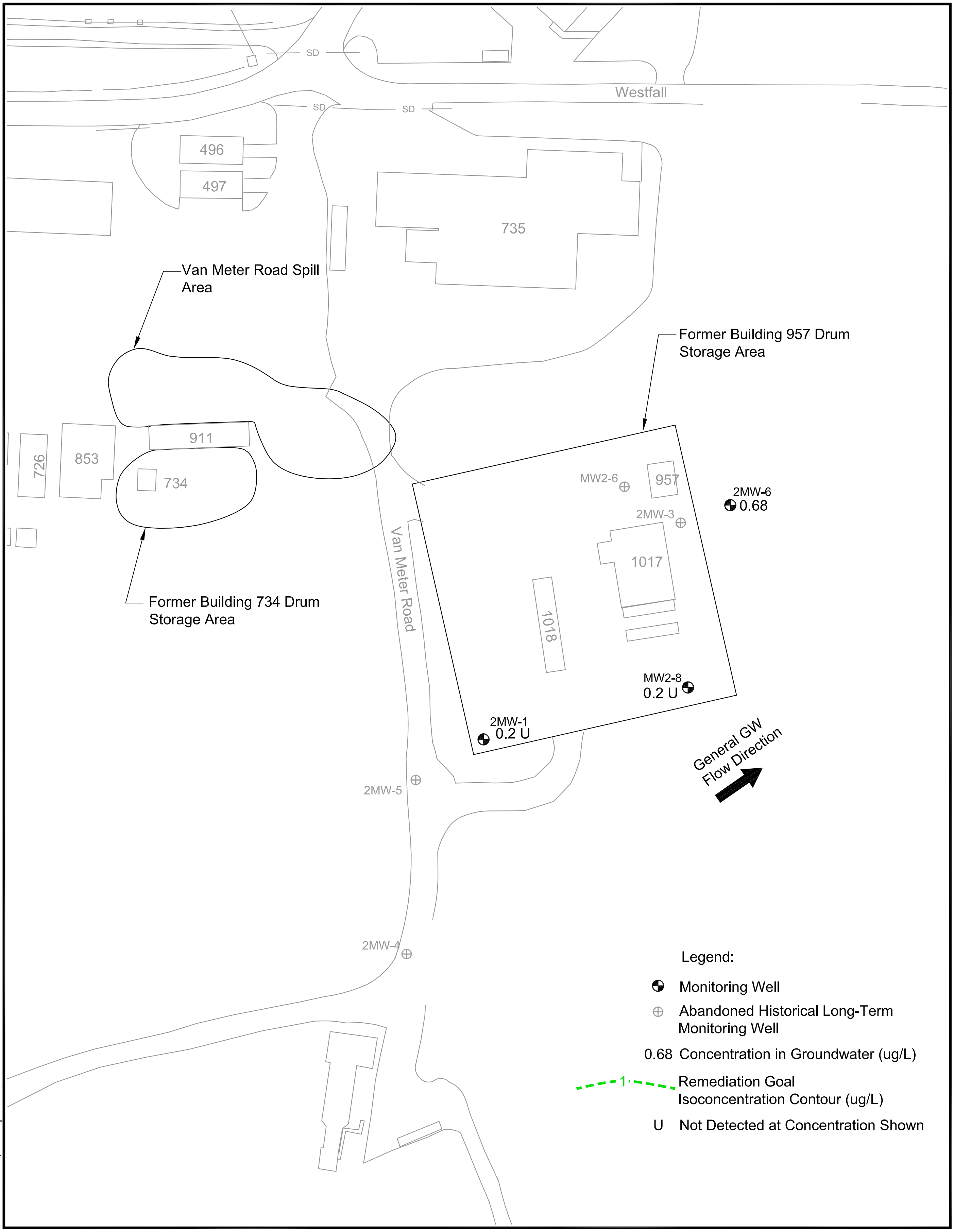

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-43 Area 2 Vinyl GW Jun 2005.dwg
Mod: 06/18/2015, 10:59 | Plotted: 06/30/2015, 09:06 | JOHN_KNOBBS

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0 50 100
SCALE IN FEET

Figure C-43
OU 2, Area 2 Vinyl Chloride Groundwater Concentrations, June 2005

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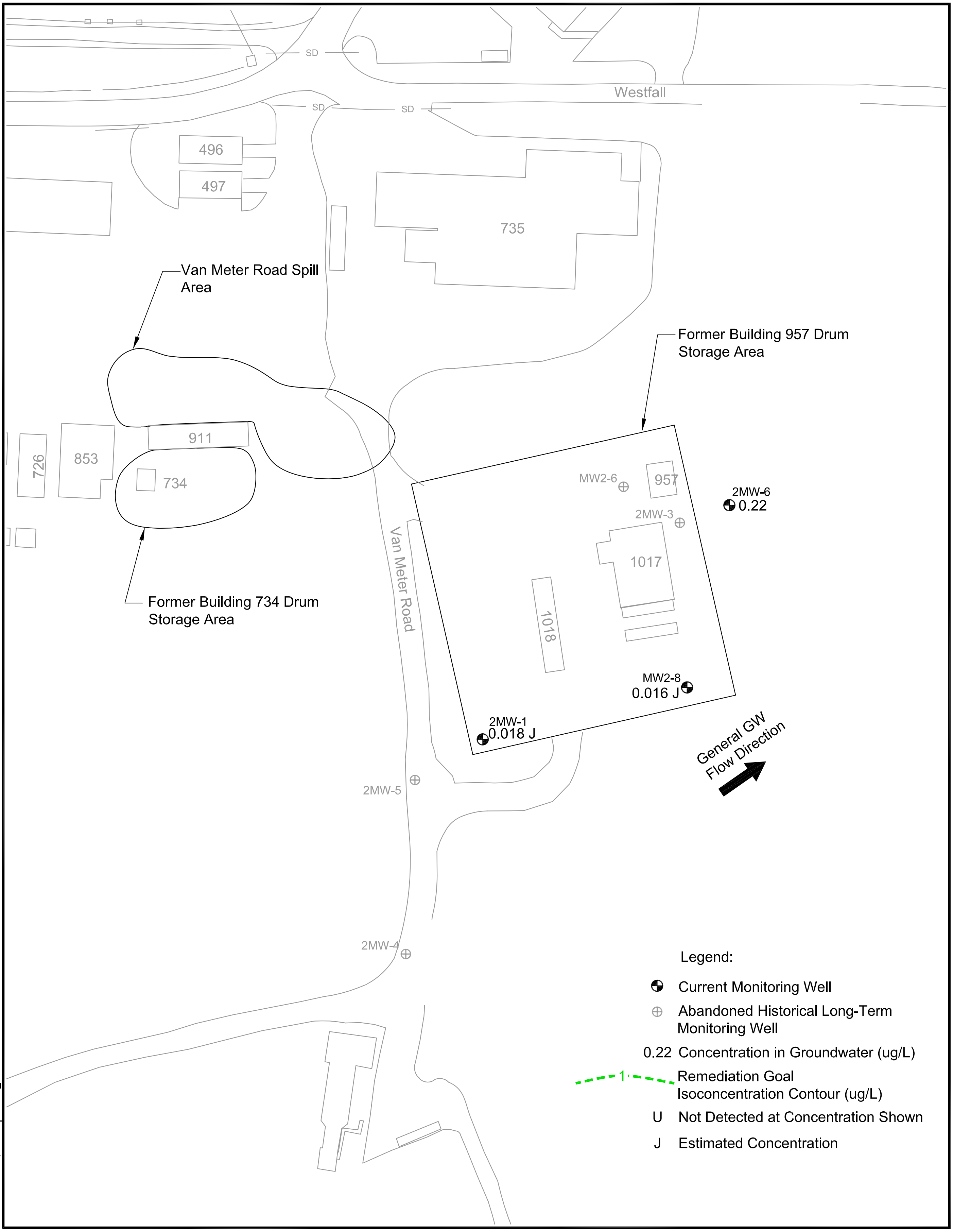

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-44 Area 2 Vinyl GW Jun 2014.dwg
Mod: 06/18/2015, 11:00 | Plotted: 06/30/2015, 09:06 | JOHN_KNOBBS

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Figure C-44
OU 2, Area 2 Vinyl Chloride Groundwater Concentrations, June 2014

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REVIEW

0 25 50
SCALE IN FEET

Figure C-45
OU 2, Area 8 TCE
Groundwater Concentrations,
November 1995

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\DIQ\DO 81\4th 5yr Review\Fig C-45 Area 8 GW Conc Nov 1995.dwg
Mod: 07/06/2015, 11:14 | Plotted: 07/06/2015, 11:14 | JOHN_KNOBBS

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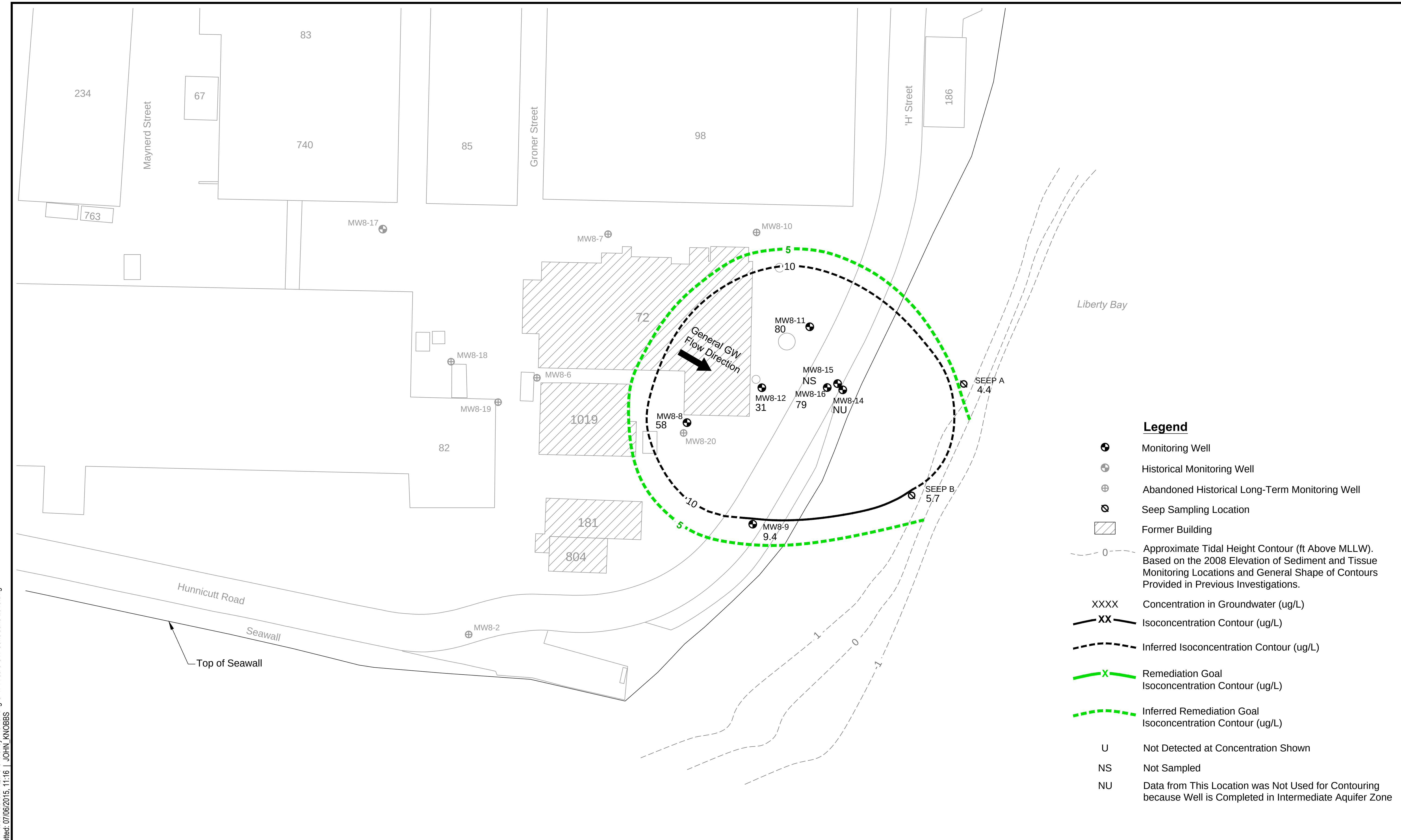
FOURTH FIVE-YEAR REVIEW

0 25 50
SCALE IN FEET

Figure C-46
OU 2, Area 8 TCE
Groundwater Concentrations,
June 2000



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NBK Keyport
FOURTH FIVE-YEAR REVIEW

0 25 50
SCALE IN FEET

Figure C-47
OU 2, Area 8 TCE
Groundwater Concentrations,
June 2010

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-47 Area 8 GW Conc June 2010.dwg
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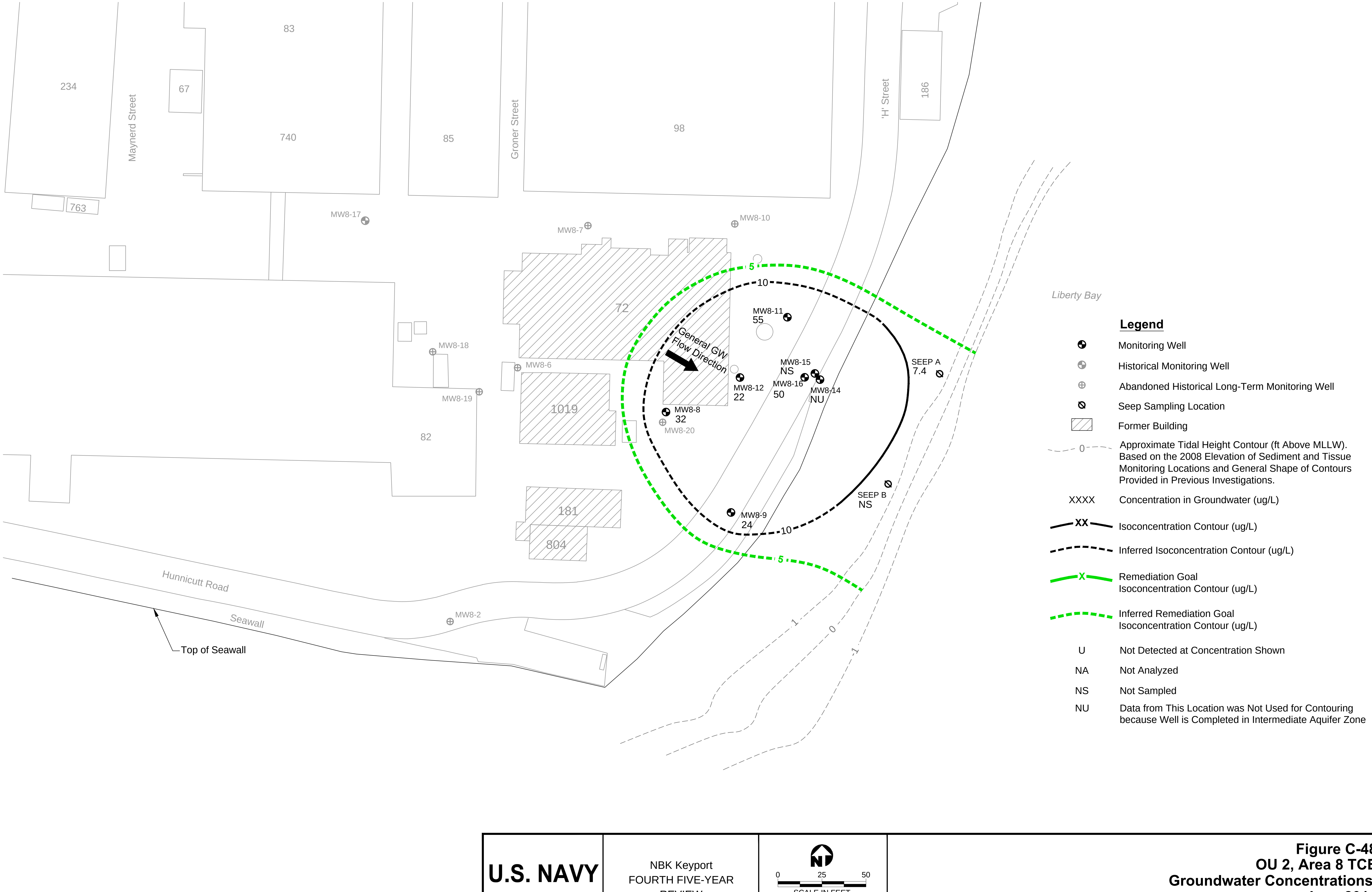

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Mod: 07/06/2015, 11:17 | Plotted: 07/06/2015, 11:17 | JOHN_KNOBBS

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FOURTH FIVE-YEAR
REVIEW

Figure C-48
OU 2, Area 8 TCE
Groundwater Concentrations,
June 2014

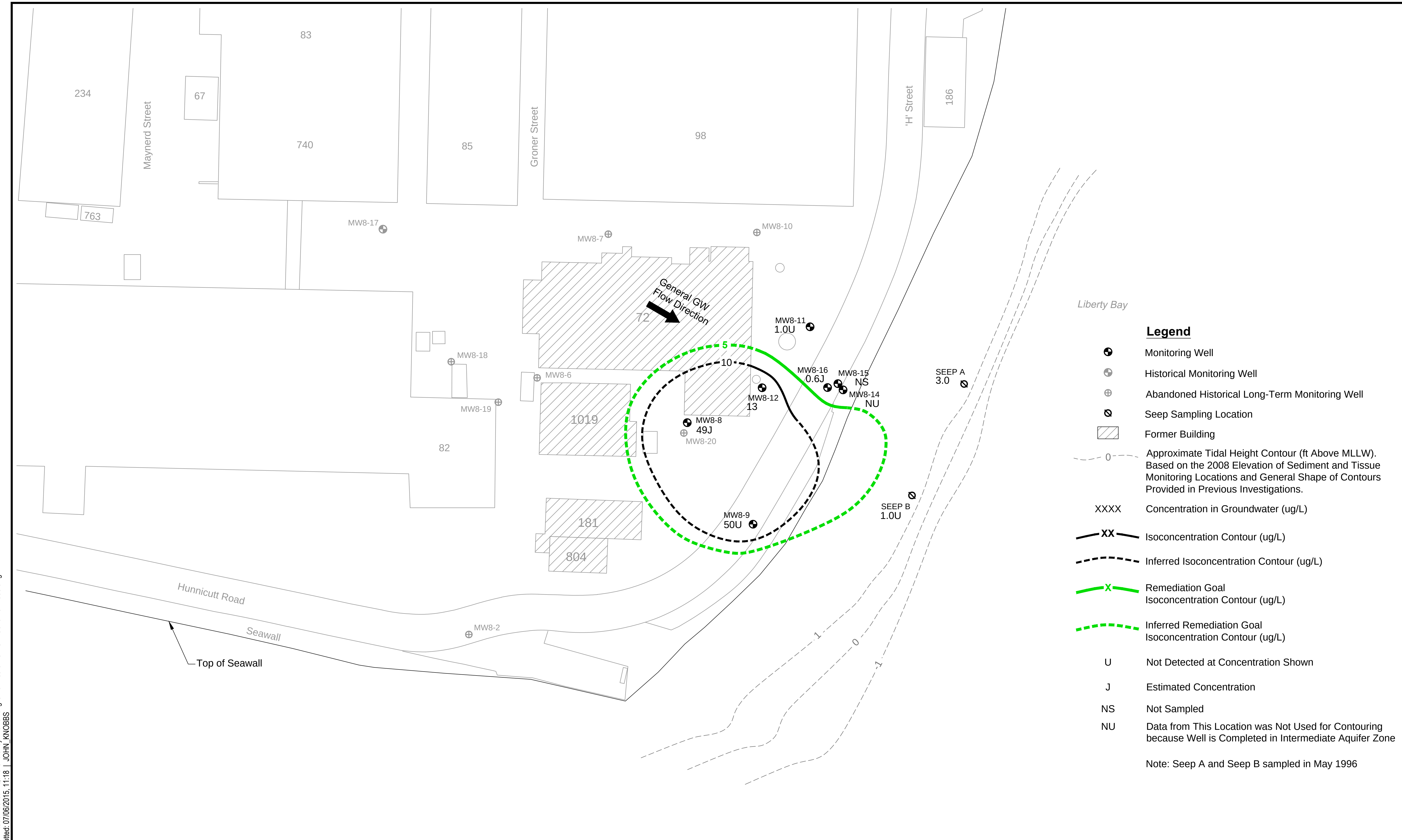

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Figure C-49
OU 2, Area 8 PCE Groundwater Concentrations, November 1995

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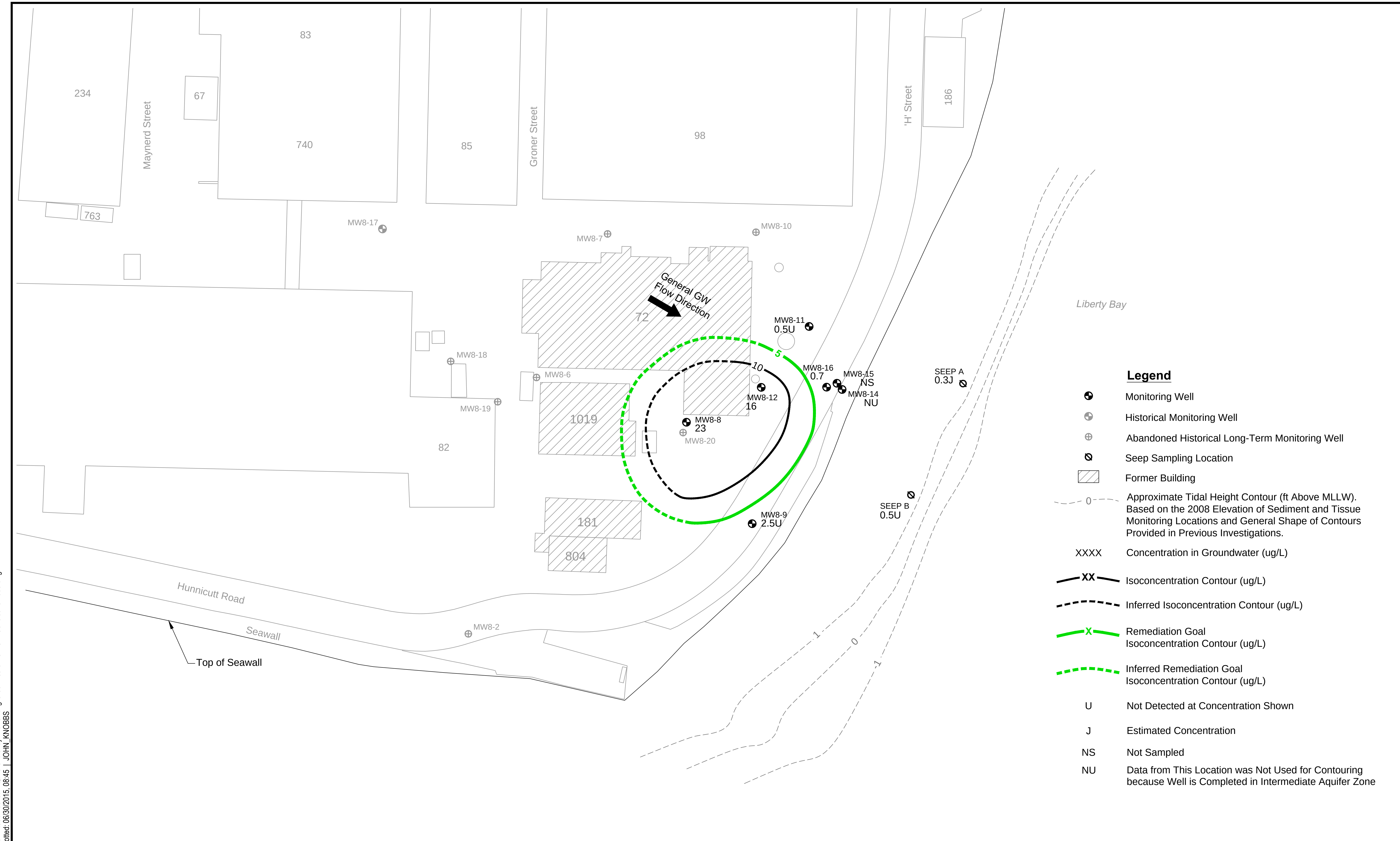

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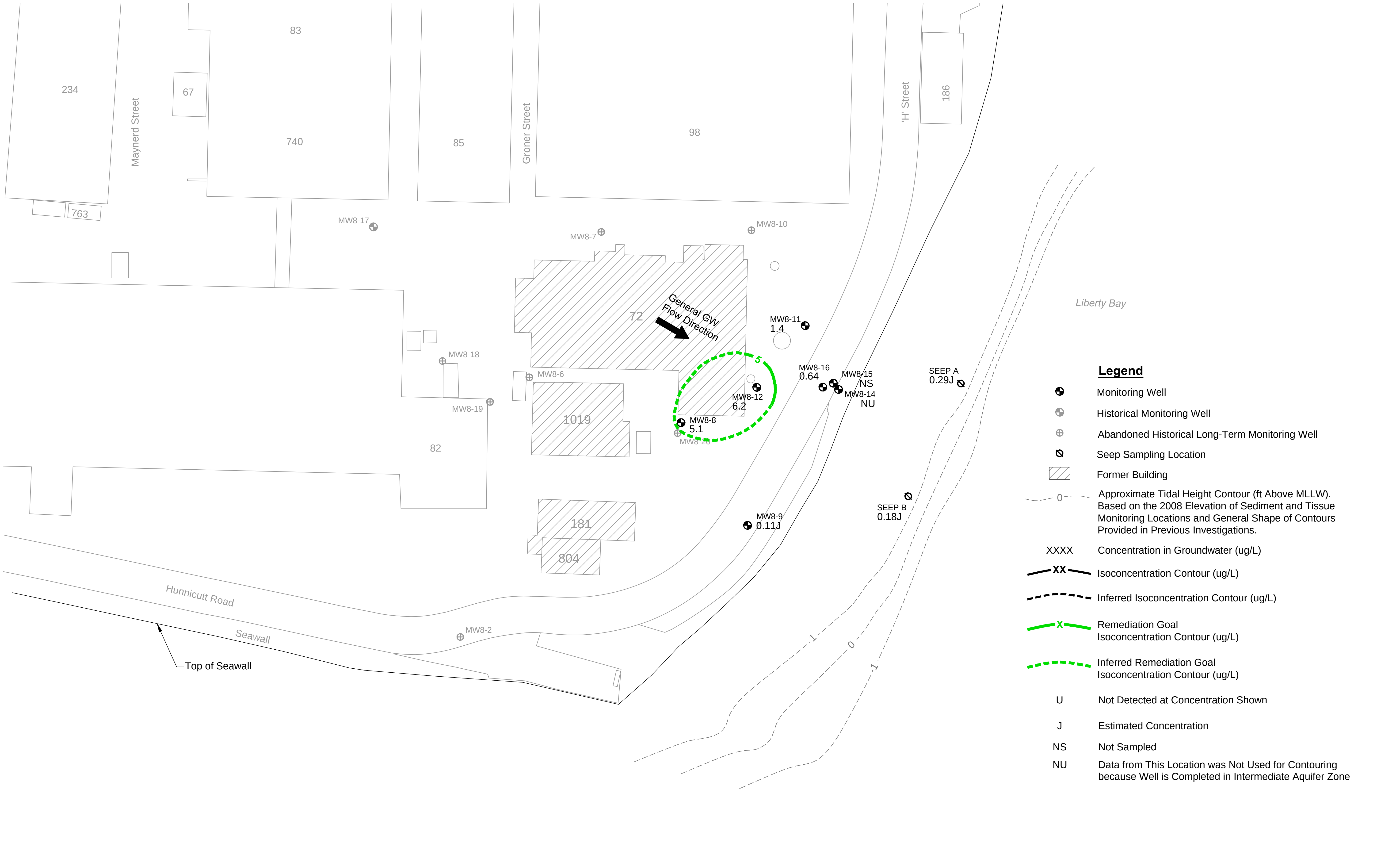
Figure C-50
OU 2, Area 8 PCE
Groundwater Concentrations, June 2000



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NBK Keyport
FOURTH FIVE-YEAR
REVIEW

0 25 50
SCALE IN FEET

Figure C-51
OU 2, Area 8 PCE
Groundwater Concentrations,
June 2010

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-51 Area 8 PCE GW Conc June 2010.dwg
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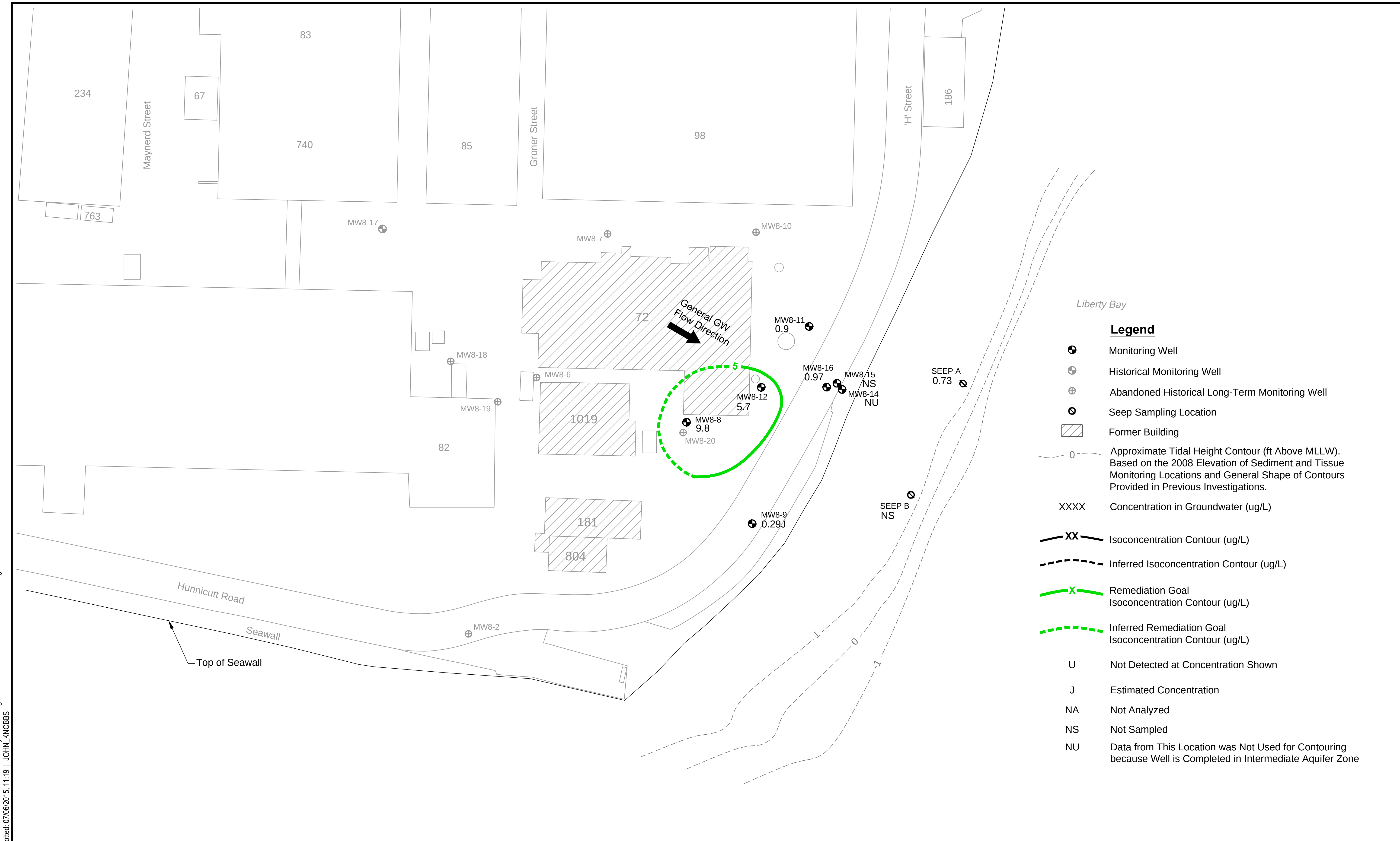

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NBK Keyport
FOURTH FIVE-YEAR REVIEW

Figure C-52
OU 2, Area 8 PCE Groundwater Concentrations, June 2014

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\D\Q\DO 81\4th 5yr Review\Fig C-52 Area 8 PCE GW Conc June 2014.dwg
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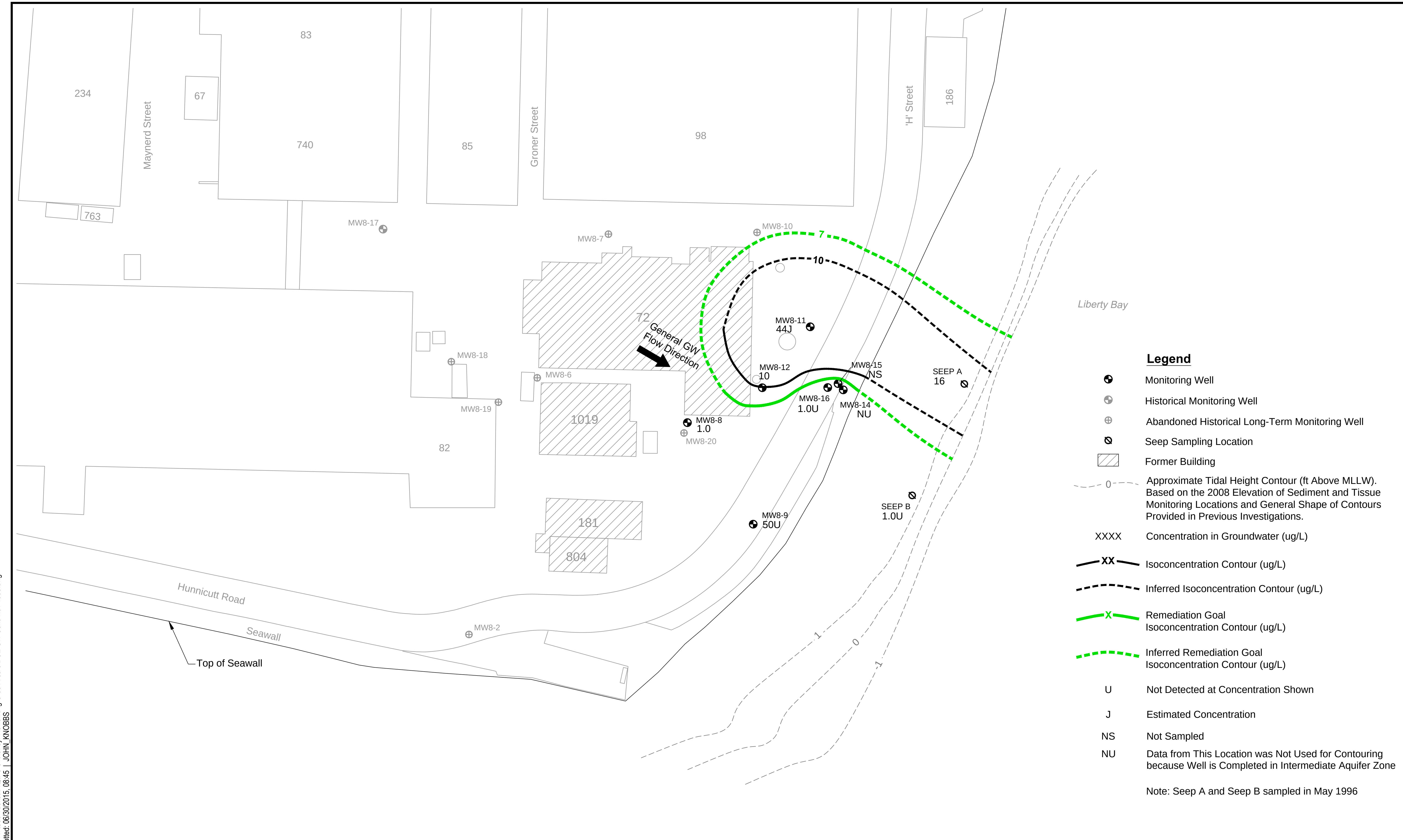

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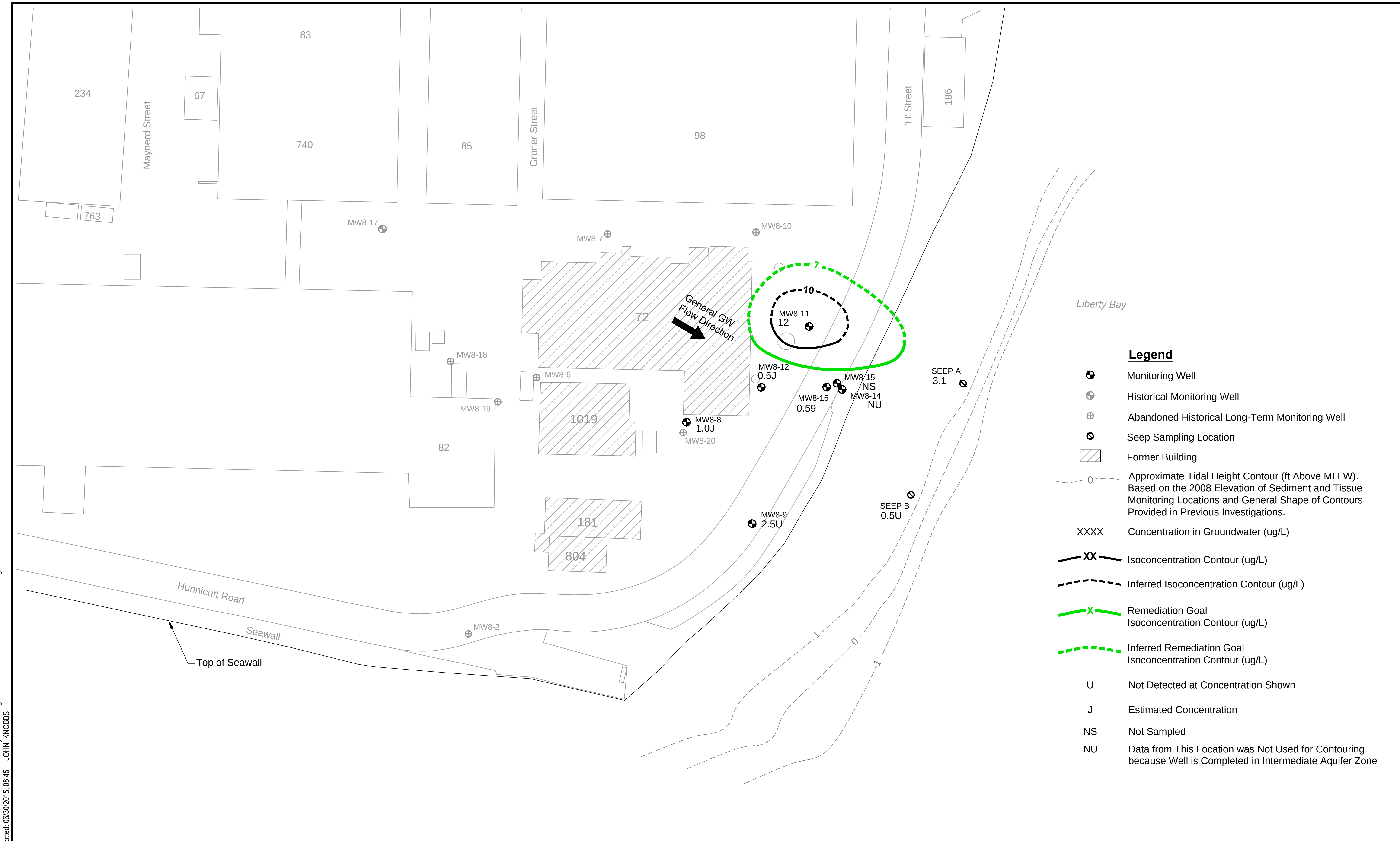
FOURTH FIVE-YEAR
REVIEW

Figure C-53
OU 2, Area 8 1,1-DCE
Groundwater Concentrations,
November 1995

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-53 Area 8 DCE GW Conc Nov 1995.dwg
Mod: 06/29/2015, 10:49 | Plotted: 06/30/2015, 08:45 | JOHN_KNOBBS



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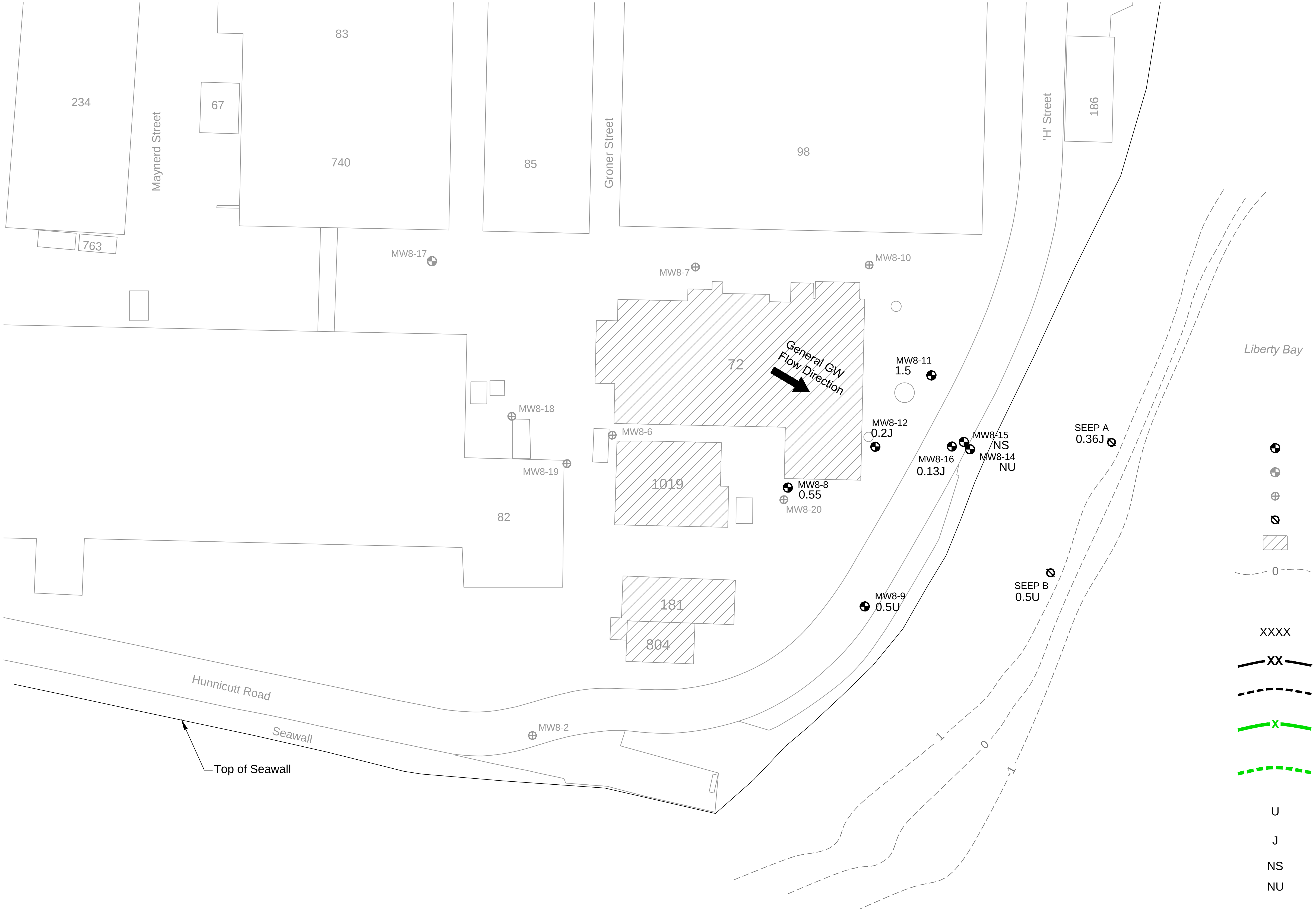
Mod: 06/29/2015, 10:49 | Plotted: 06/30/2015, 08:45 | JOHN_KNOBBS

U.S. NAVY	NBK Keyport FOURTH FIVE-YEAR REVIEW		**Figure C-54** **OU 2, Area 8 1,1-DCE** **Groundwater Concentrations** **June 2000**



Legend

- Monitoring Well
- Historical Monitoring Well
- Abandoned Historical Long-Term Monitoring Well
- Seep Sampling Location
- Former Building
- 0 — Approximate Tidal Height Contour (ft Above MLLW). Based on the 2008 Elevation of Sediment and Tissue Monitoring Locations and General Shape of Contours Provided in Previous Investigations.
- XXXX — Concentration in Groundwater (ug/L)
- XX — Isoconcentration Contour (ug/L)
- Inferred Isoconcentration Contour (ug/L)
- X — Remediation Goal Isoconcentration Contour (ug/L)
- Inferred Remediation Goal Isoconcentration Contour (ug/L)
- U — Not Detected at Concentration Shown
- J — Estimated Concentration
- NS — Not Sampled
- NU — Data from This Location was Not Used for Contouring because Well is Completed in Intermediate Aquifer Zone

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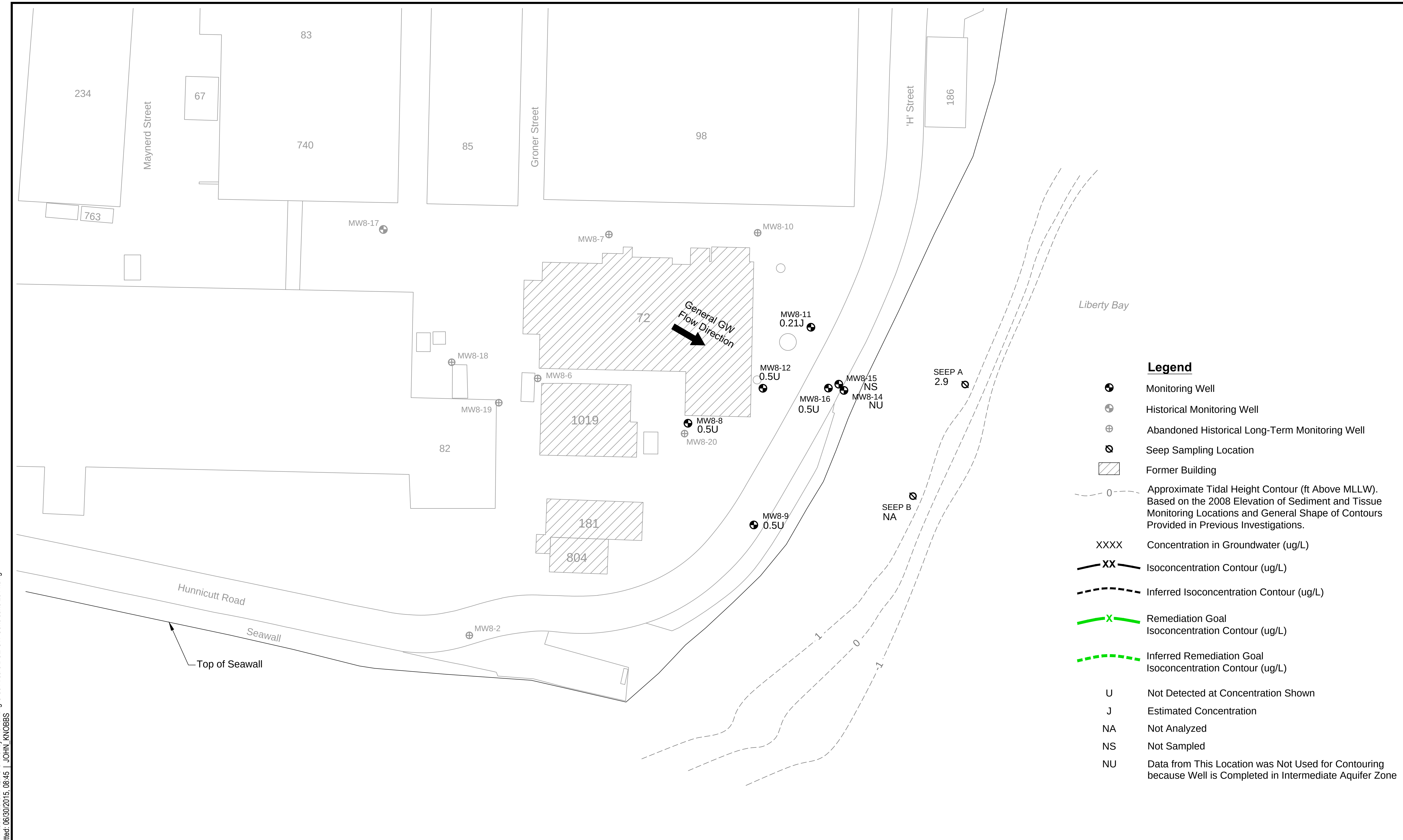
FOURTH FIVE-YEAR
REVIEW

N
0 25 50
SCALE IN FEET

Figure C-55
OU 2, Area 8 1,1-DCE
Groundwater Concentrations,
June 2010

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\DI\DO 81\4th 5yr Review\Fig C-55 Area 8 DCE GW Conc June 2010.dwg
Mod: 06/29/2015, 10:48 | Plotted: 06/30/2015, 08:45 | JOHN_KNOBBS



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FOURTH FIVE-YEAR
REVIEW

0 25 50
SCALE IN FEET

Figure C-56
OU 2, Area 8 1,1-DCE
Groundwater Concentrations,
June 2014

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\DIQ\DO 81\4th 5yr Review\Fig C-56 Area 8 DCE GW Conc June 2014.dwg
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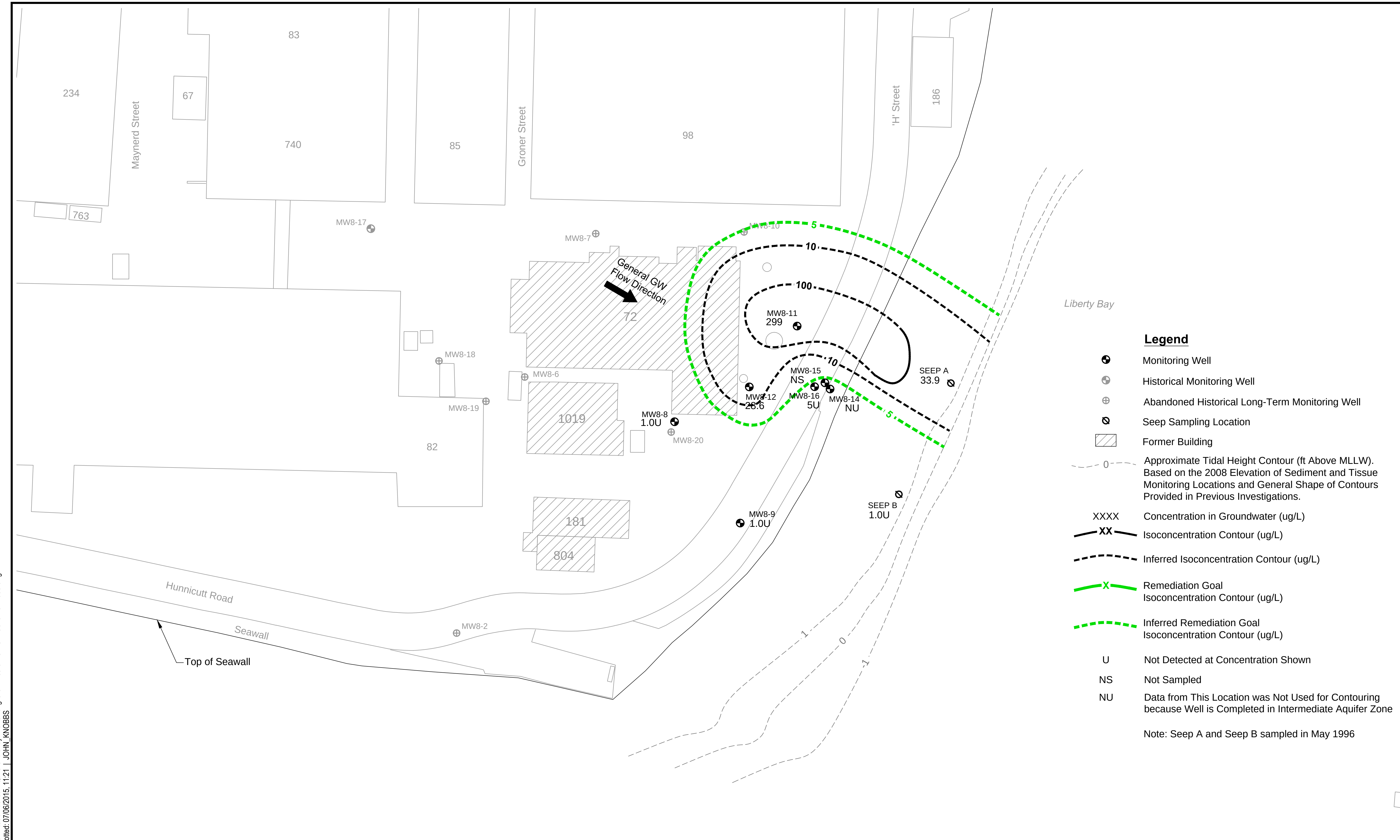

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Mod: 06/29/2015, 10:46 | Plotted: 07/06/2015, 11:21 | JOHN_KNOBBS

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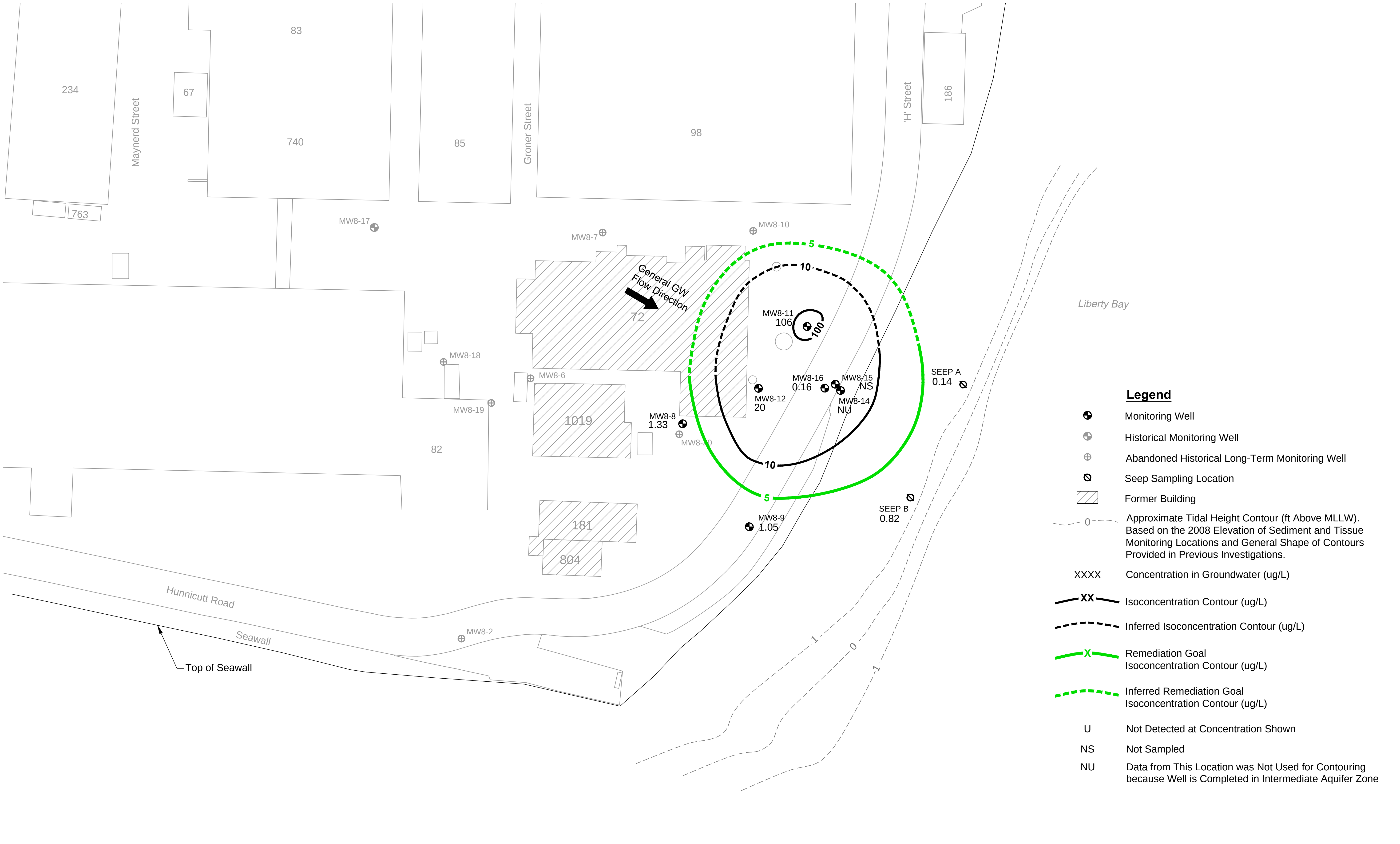
NBK Keyport
FOURTH FIVE-YEAR
REVIEW

Figure C-57
OU 2, Area 8 Dissolved Cadmium Groundwater Concentrations, November 1995



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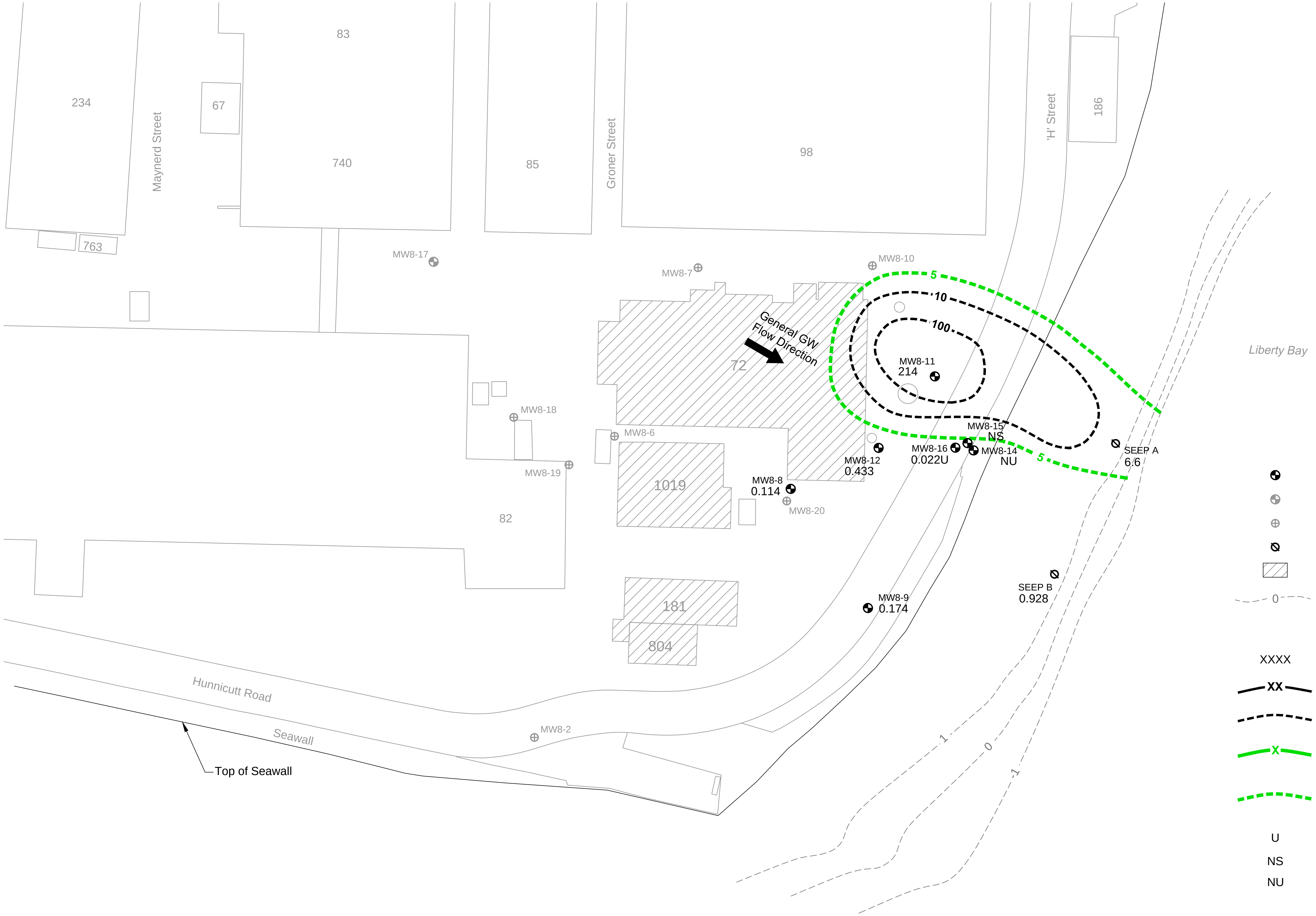
NBK Keyport
FOURTH FIVE-YEAR
REVIEW

Figure C-58
OU 2, Area 8 Dissolved Cadmium Groundwater Concentrations, June 2000

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\IDIQ\DO 81\4th 5yr Review\Fig C-58 Area 8 DCA GW Conc June 2000.dwg
Mod: 06/29/2015, 10:45 | Plotted: 06/30/2015, 08:45 | JOHN_KNOBBS



Legend

(symbol)	Monitoring Well
(symbol)	Historical Monitoring Well
(symbol)	Abandoned Historical Long-Term Monitoring Well
(symbol)	Seep Sampling Location
(symbol)	Former Building
0	Approximate Tidal Height Contour (ft Above MLLW). Based on the 2008 Elevation of Sediment and Tissue Monitoring Locations and General Shape of Contours Provided in Previous Investigations.
XXXX	Concentration in Groundwater (ug/L)
XX	Isoconcentration Contour (ug/L)
(symbol)	Inferred Isoconcentration Contour (ug/L)
X	Remediation Goal Isoconcentration Contour (ug/L)
(symbol)	Inferred Remediation Goal Isoconcentration Contour (ug/L)
U	Not Detected at Concentration Shown
NS	Not Sampled
NU	Data from This Location was Not Used for Contouring because Well is Completed in Intermediate Aquifer Zone

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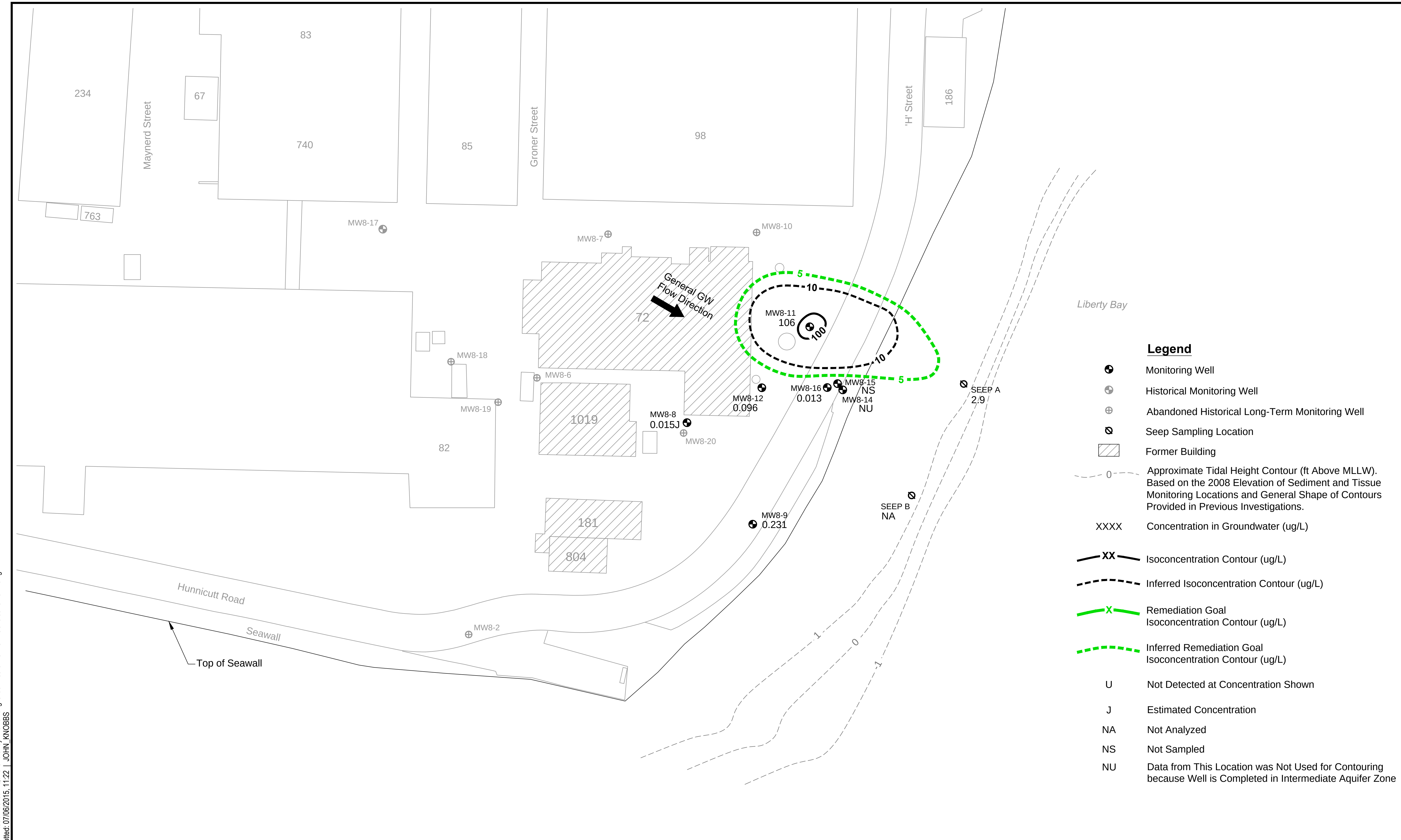
FOURTH FIVE-YEAR REVIEW

0 25 50
SCALE IN FEET

Figure C-59
OU 2, Area 8 Dissolved Cadmium Groundwater Concentrations, June 2010

C:\Users\JOHN_KNOBBS\appdata\local\temp\AcPublish_1752\Fig C-59 Area 8 DCA GW Conc June 2010.dwg
Mod: 07/02/2015, 11:39 | Plotted: 07/06/2015, 09:44 | JOHN_KNOBBS



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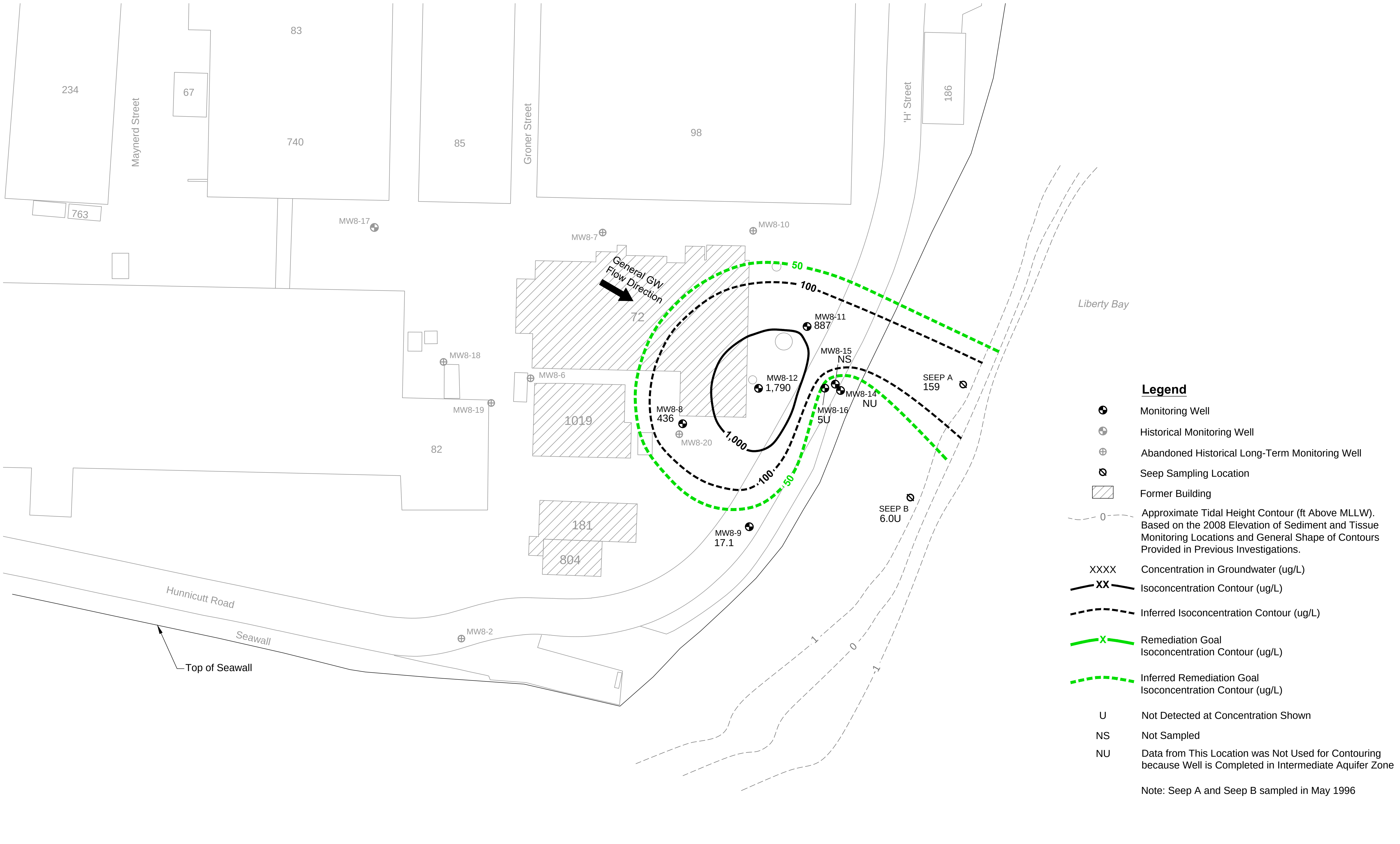
FOURTH FIVE-YEAR
REVIEW

Figure C-60
OU 2, Area 8 Dissolved Cadmium Groundwater Concentrations, June 2014



J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\DI\Q\DO 81\4th 5yr Review\Fig C-61 Area 8 DCH GW Conc Nov 1995.dwg
Mod: 07/06/2015, 11:23 | Plotted: 07/06/2015, 11:23 | JOHN_KNOBBS

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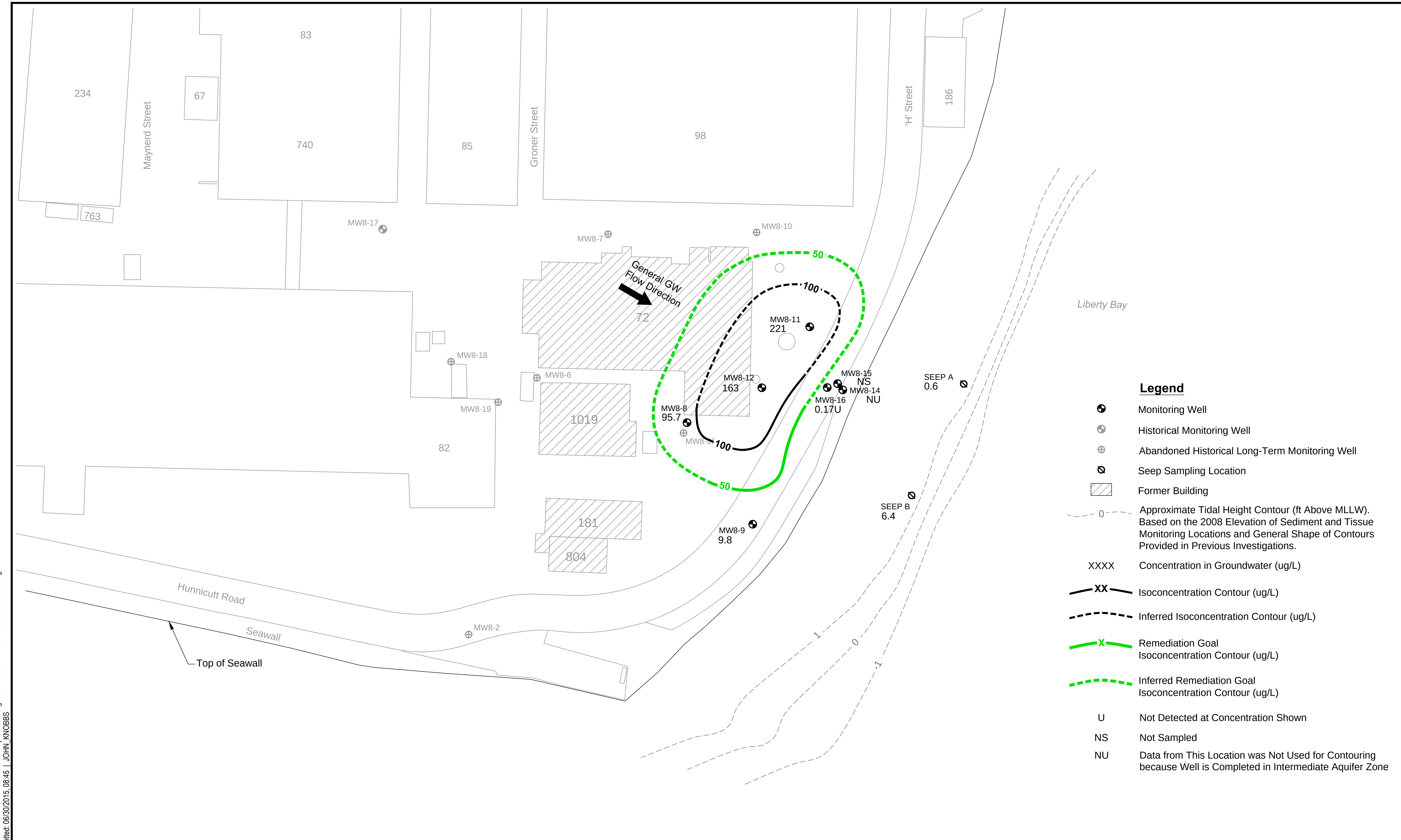
FOURTH FIVE-YEAR REVIEW

Figure C-61
OU 2, Area 8 Dissolved Chromium Groundwater Concentrations, November 1995



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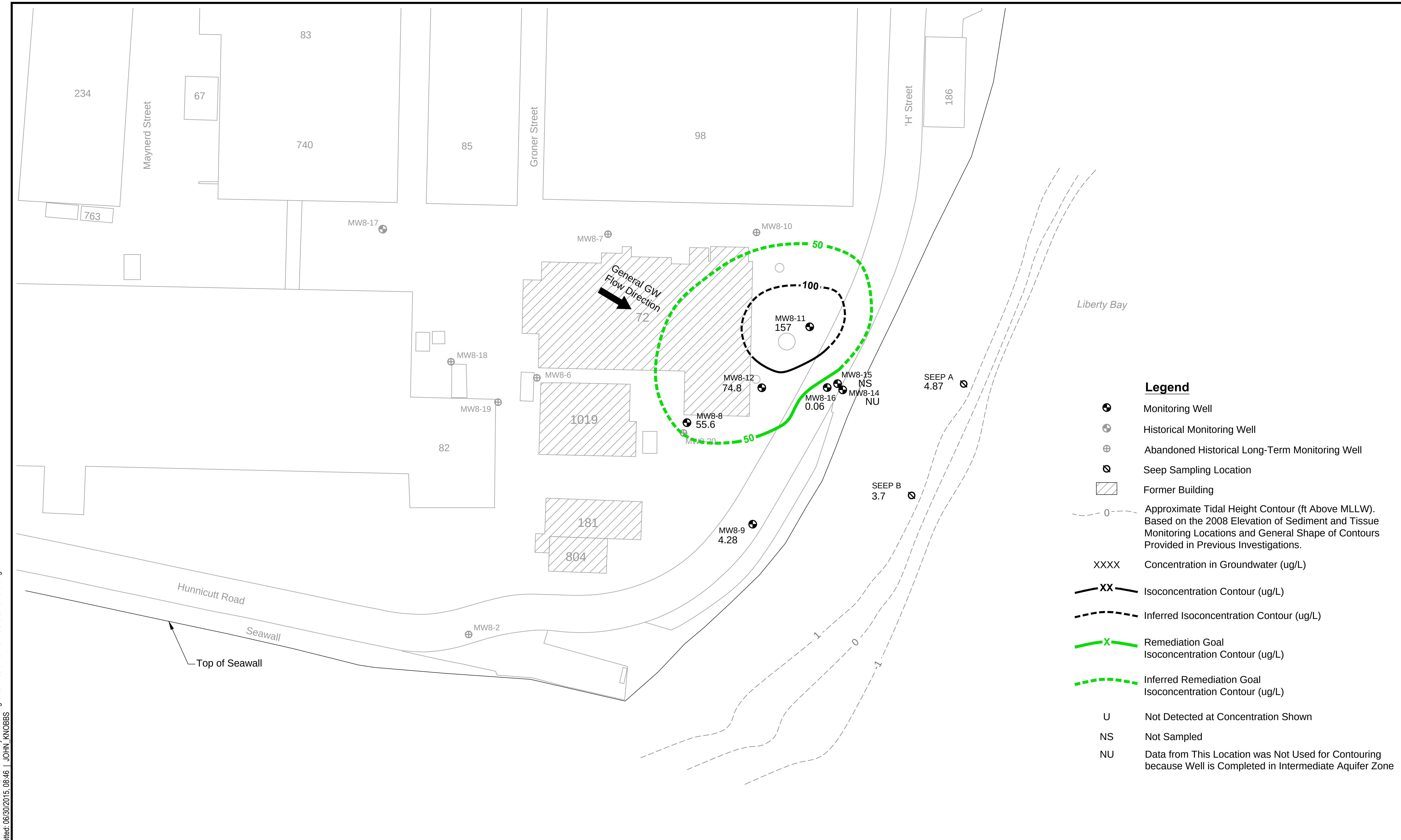
NBK Keyport
FOURTH FIVE-YEAR
REVIEW

0 25 50
SCALE IN FEET

Figure C-62
OU 2, Area 8 Dissolved Chromium Groundwater Concentrations, June 2000

J:\GIS\Projects\NAVY\KEYPORT\Sub-Tasks\ID\IQ\DO 81\4th 5yr Review\Fig C-62 Area 8 DCH GW Conc June 2000.dwg
Mod: 06/29/2015, 10:38 | Plotted: 06/30/2015, 08:45 | JOHN_KNOBBS



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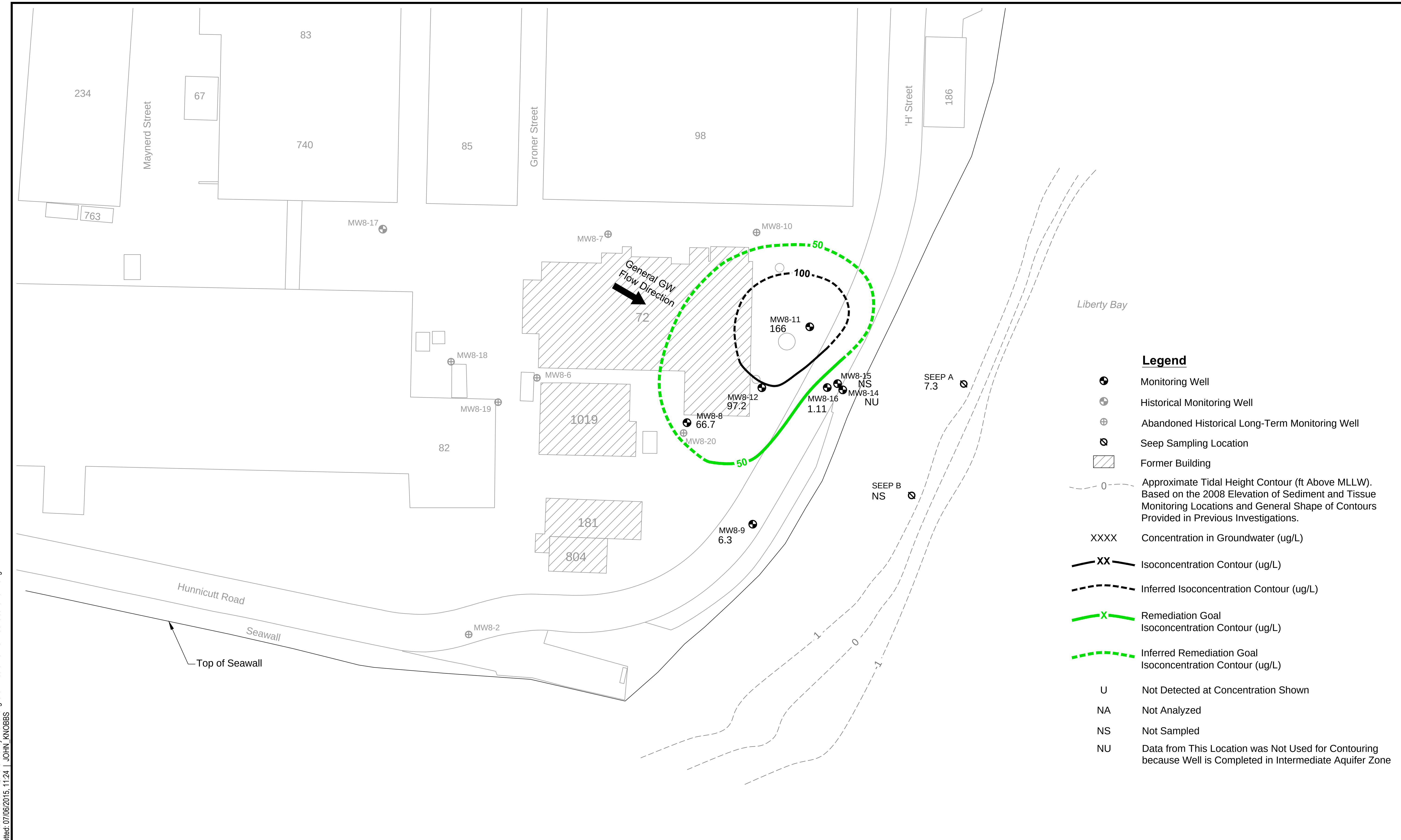
U.S. NAVY	NBK Keyport FOURTH FIVE-YEAR REVIEW	0 25 50 SCALE IN FEET	**Figure C-63** **OU 2, Area 8 Dissolved Chromium Groundwater Concentrations, June 2010**



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FOURTH FIVE-YEAR REVIEW

Figure C-64
OU 2, Area 8 Dissolved Chromium Groundwater Concentrations, June 2014

APPENDIX D

Trend Graphs for Groundwater Data at OU 1 (Area 1) and OU 2 (Areas 2 and 8)

CONTENTS

Notes Regarding Trend Graphs: Only those chemicals with a high frequency of detection and detections above remediation goals were graphed. The results reported as not detected, in most cases, have been set to 0.1 µg/L during long-term monitoring reporting, regardless if the laboratory reporting limit value was reported above or below this number. At Area 1, well MW1-04, and Area 8 wells and seeps, the actual laboratory reporting limit values were used in the graphs instead of the set reporting limit of 0.1 µg/L, because the lower artificial reporting limit skewed the data.

FIGURES

OU 1 – North Plantation

OU 1 – South Plantation

OU 1 – Central Landfill

OU 1 – Surface Water

CONTENTS (Continued)

OU 2, Area 2

OU 2 Area 8

Figure D-1a. Area 1 North Plantation
1MW-1 VOC Trends

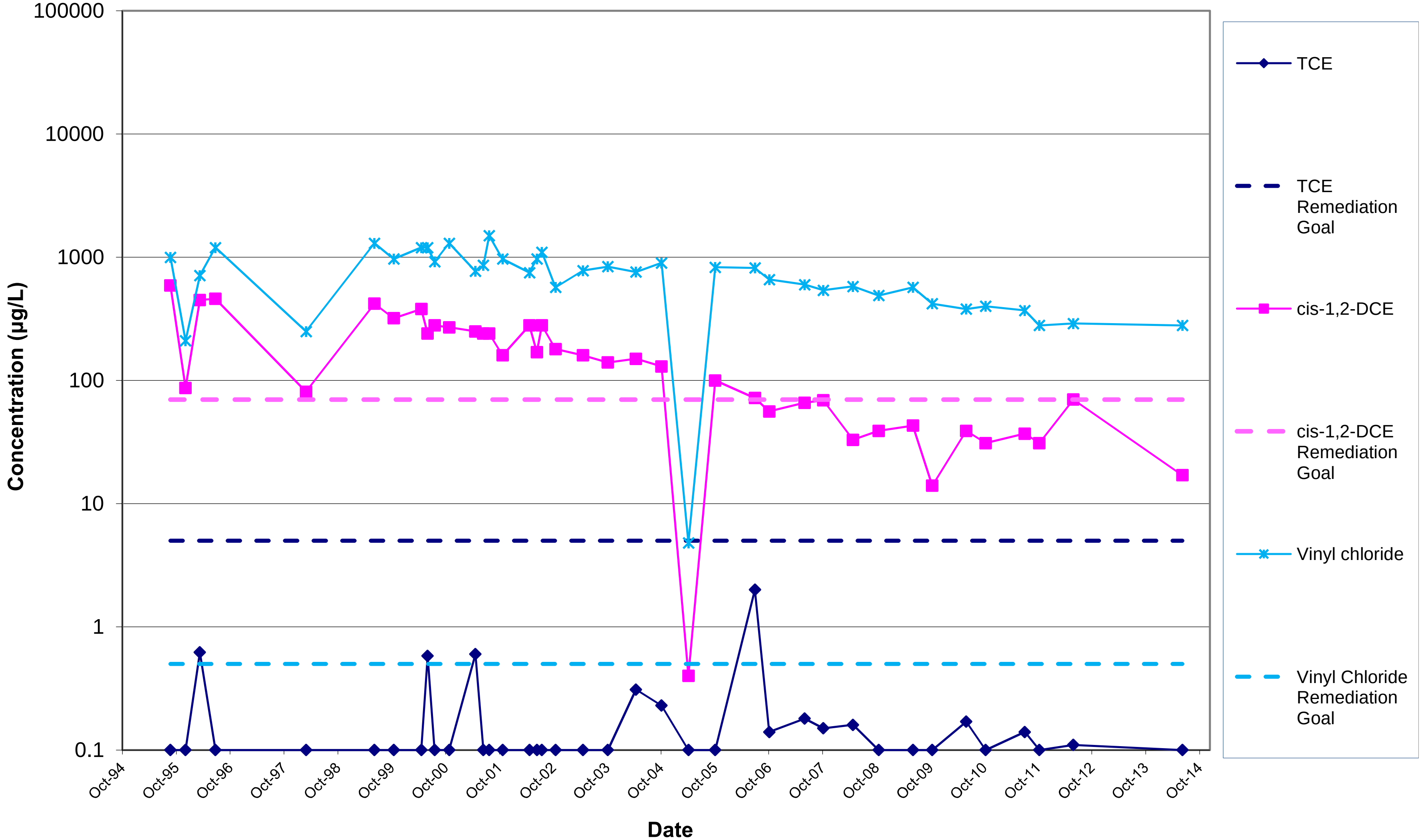
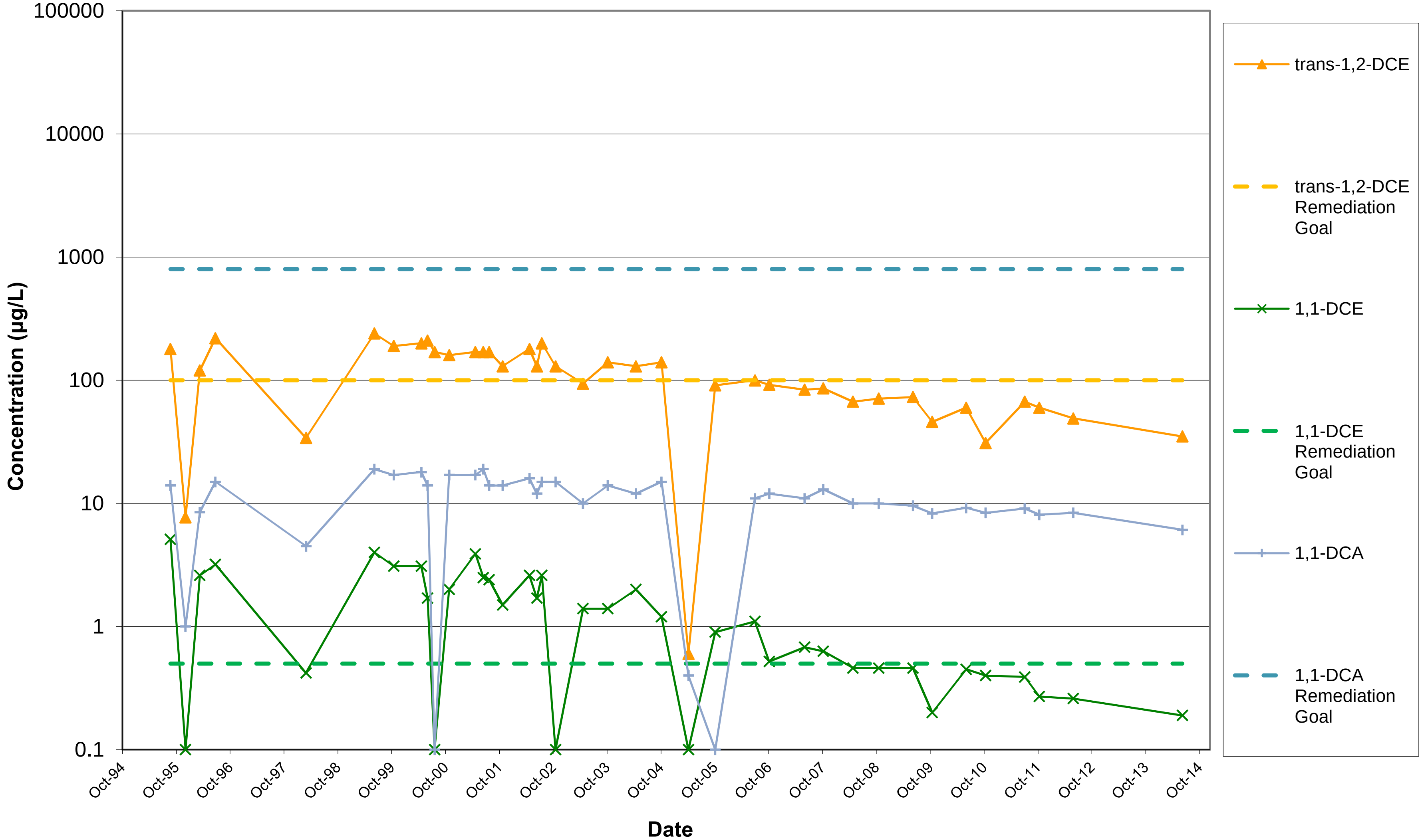


Figure D-1b. North Plantation
1MW-1 VOC Trends



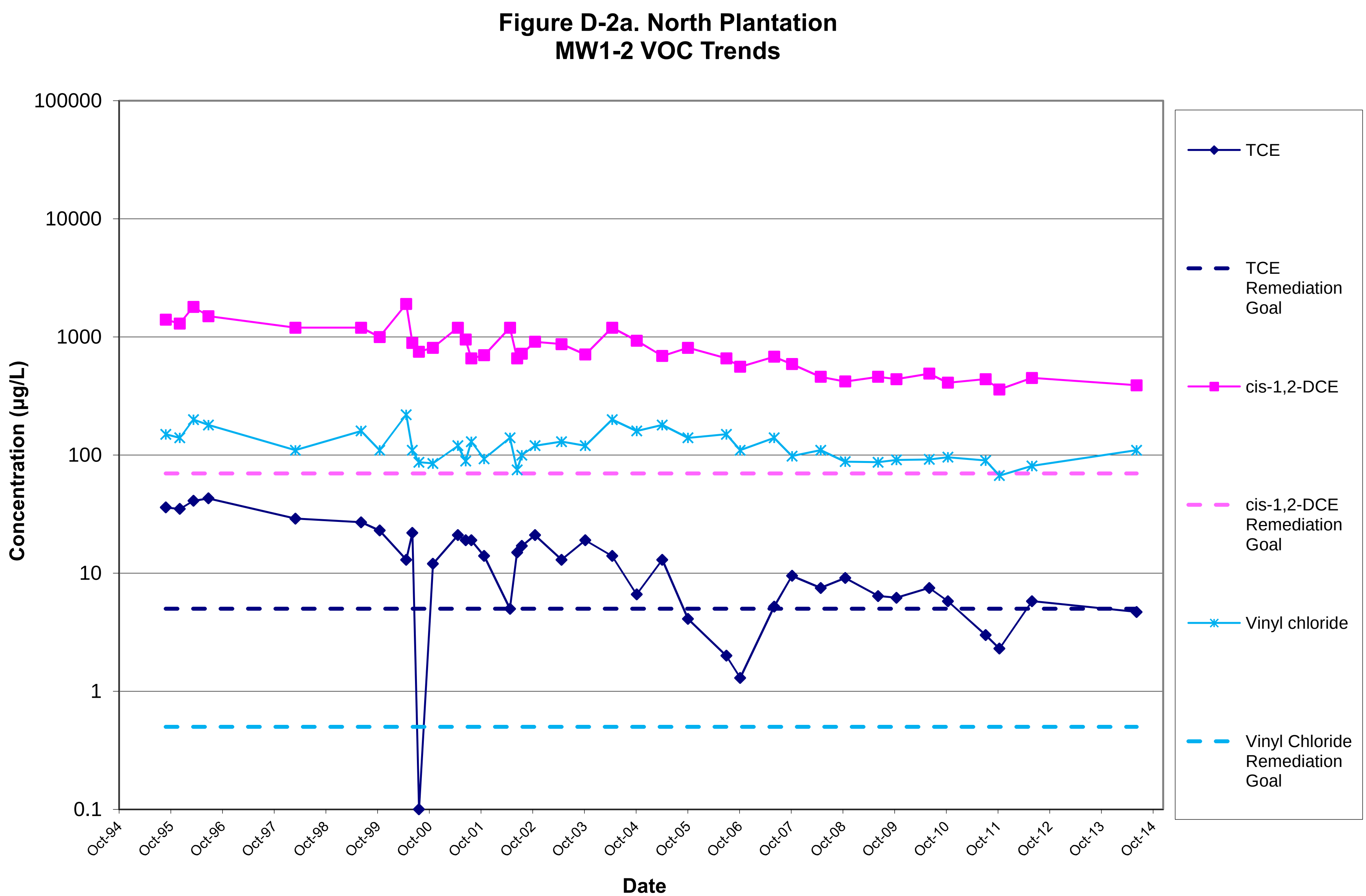


Figure D-2a. North Plantation
MW1-2 VOC Trends
Concentration (µg/L)
100000
10000
1000
100
10
1
0.1
Oct-94
Oct-95
Oct-96
Oct-97
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Date
TCE
TCE Remediation Goal
cis-1,2-DCE
cis-1,2-DCE Remediation Goal
Vinyl chloride
Vinyl Chloride Remediation Goal

Figure D-2b. North Plantation
MW1-2 VOC Trends

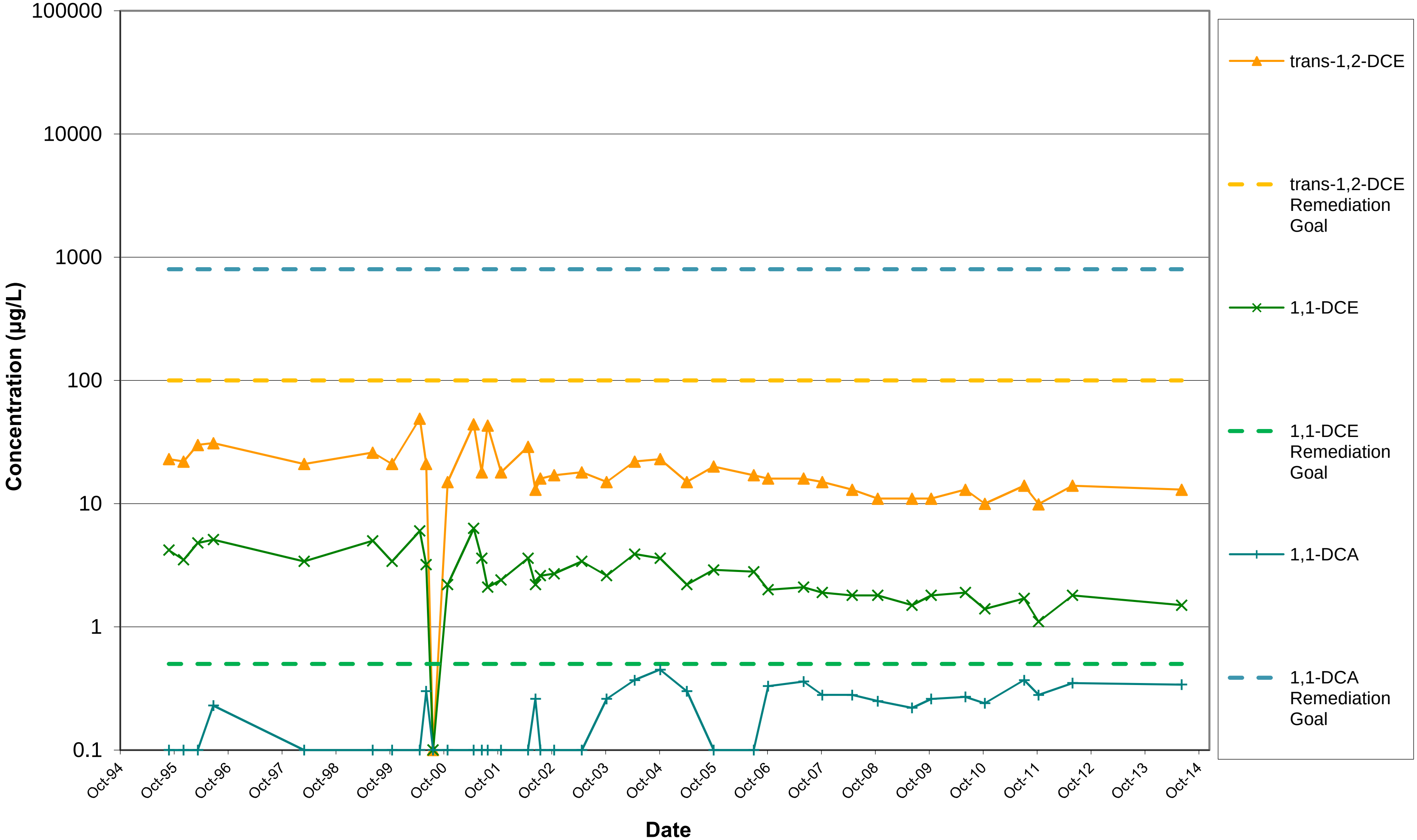
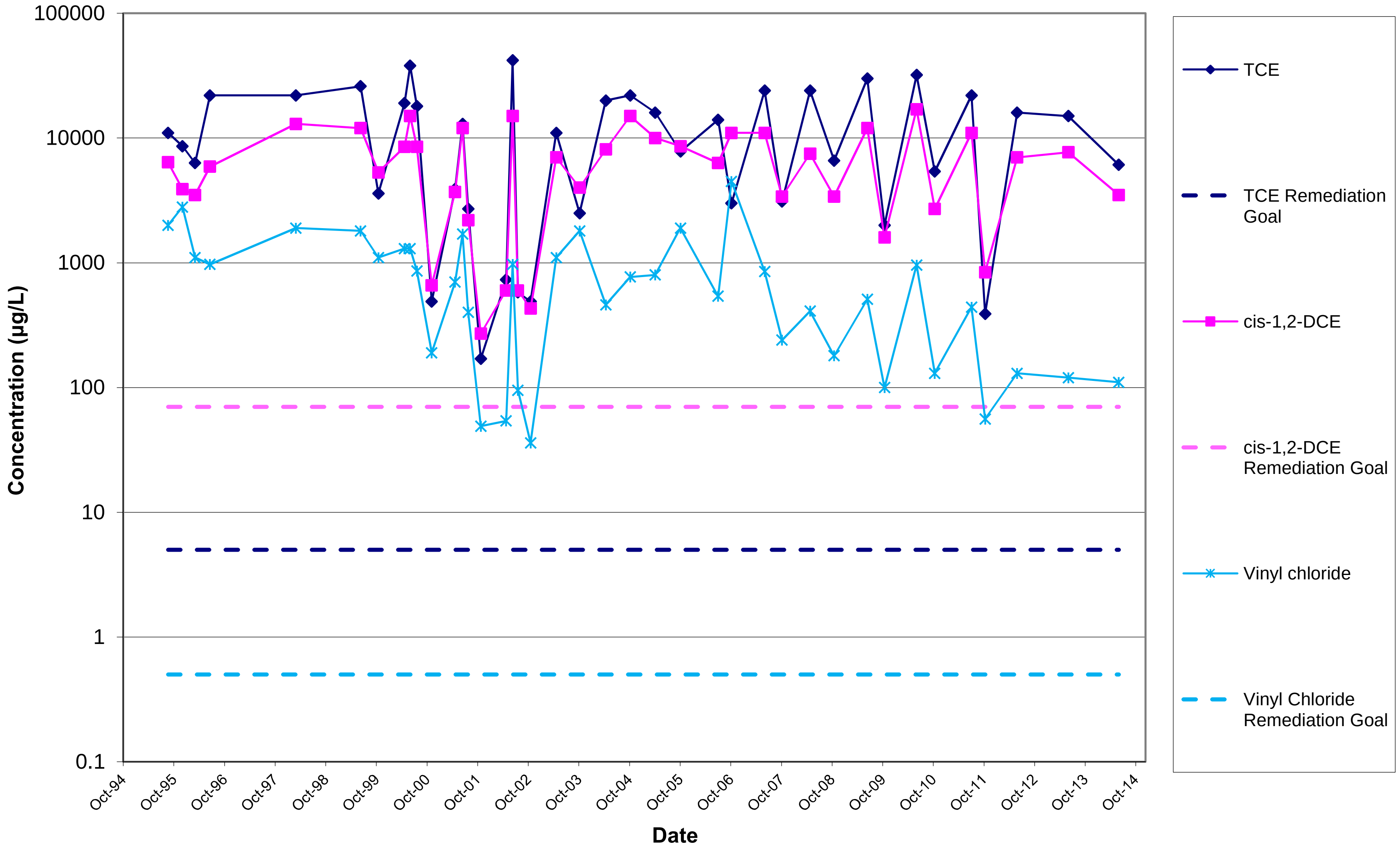


Figure D-3a. South Plantation
MW1-04 VOC Trends



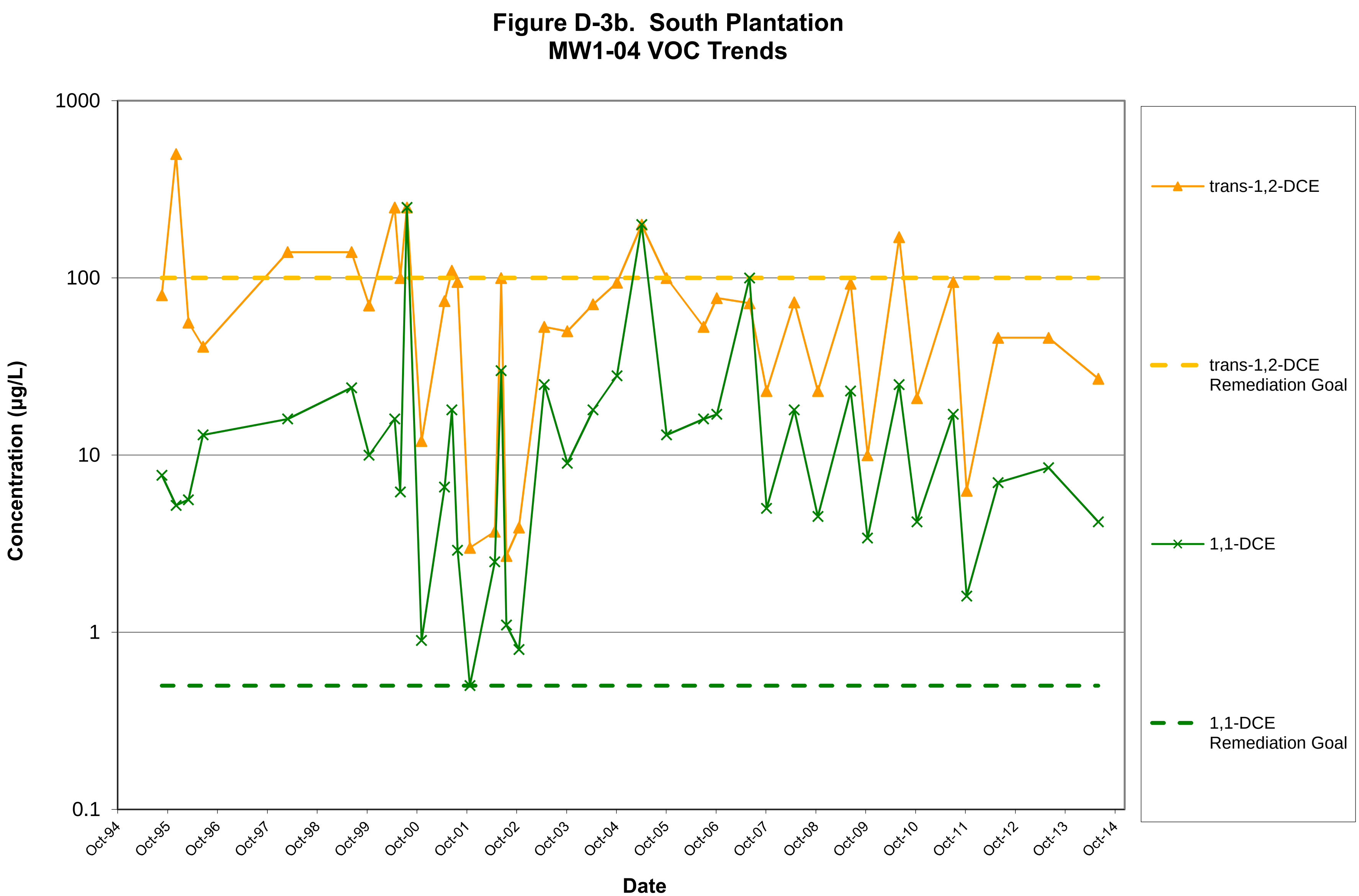


Figure D-3b. South Plantation
MW1-04 VOC Trends
1000
100
10
1
0.1
Concentration (µg/L)
Oct-94
Oct-95
Oct-96
Oct-97
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Date
trans-1,2-DCE
trans-1,2-DCE Remediation Goal
1,1-DCE
1,1-DCE Remediation Goal

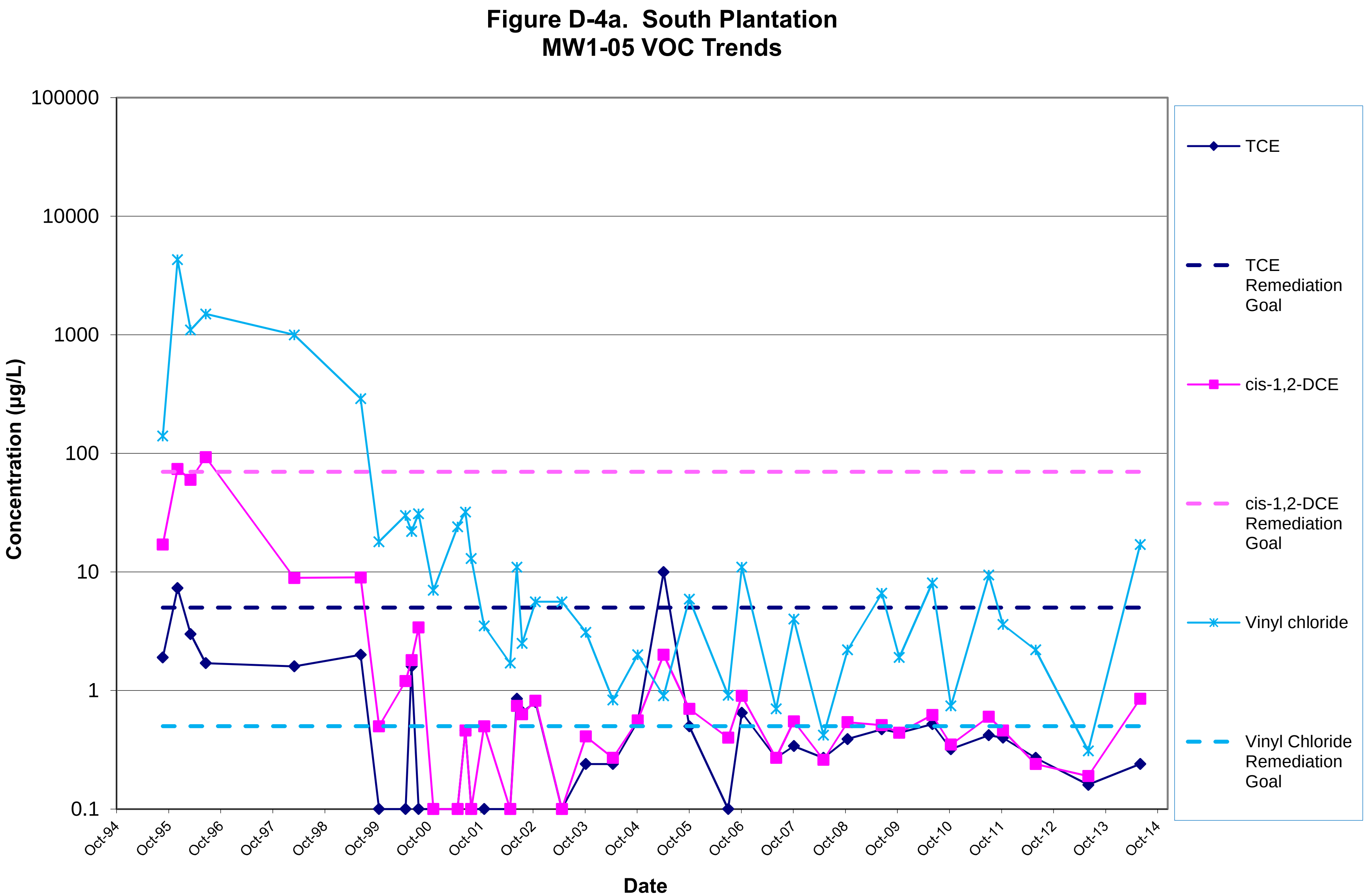


Figure D-4a. South Plantation
MW1-05 VOC Trends
Concentration (µg/L)
100000
10000
1000
100
10
1
0.1
Oct-94
Oct-95
Oct-96
Oct-97
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Date
TCE
TCE Remediation Goal
cis-1,2-DCE
cis-1,2-DCE Remediation Goal
Vinyl chloride
Vinyl Chloride Remediation Goal

Figure D-4b. South Plantation
MW1-05 VOC Trends

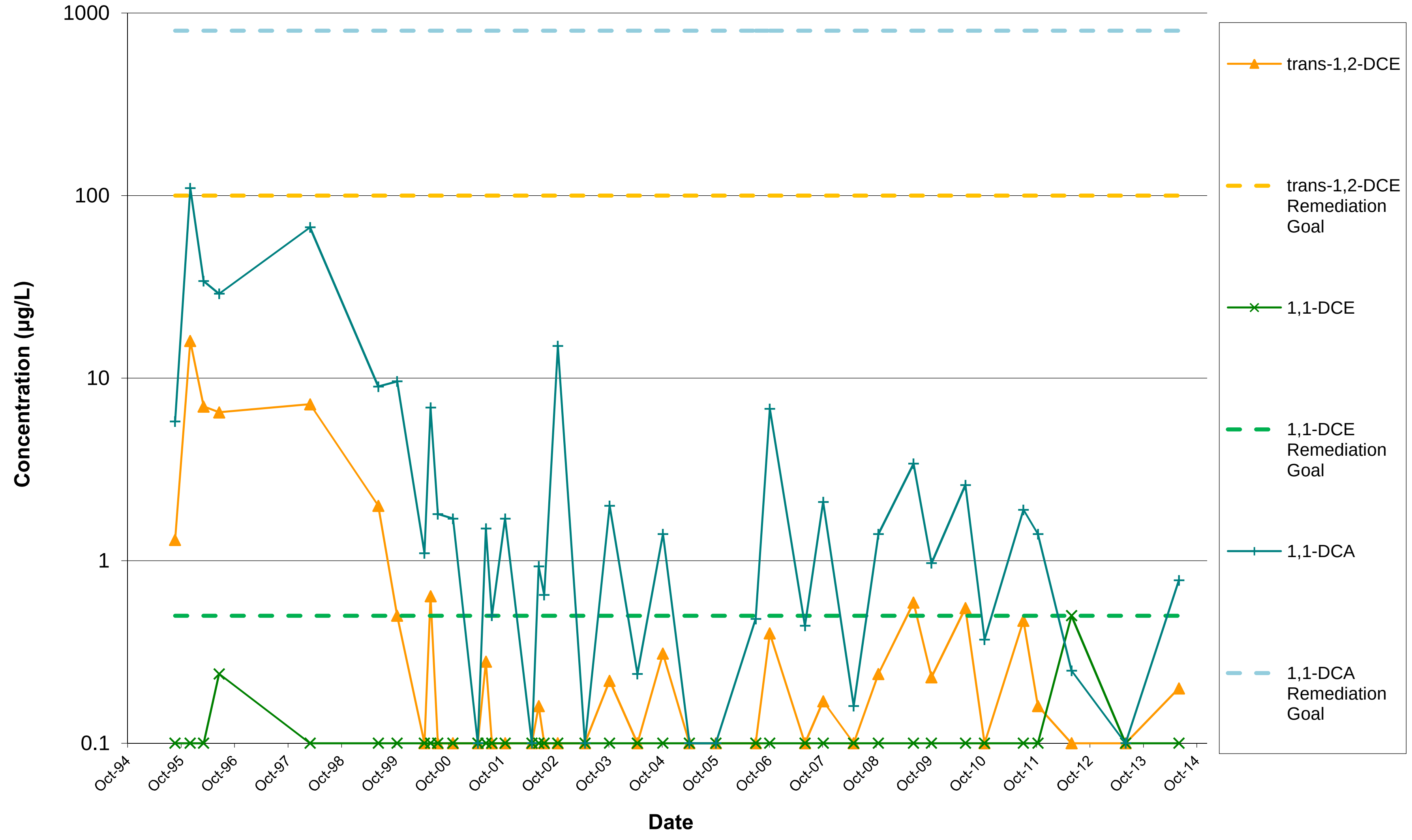


Figure D-5a. South Plantation
MW1-16 VOC Trends

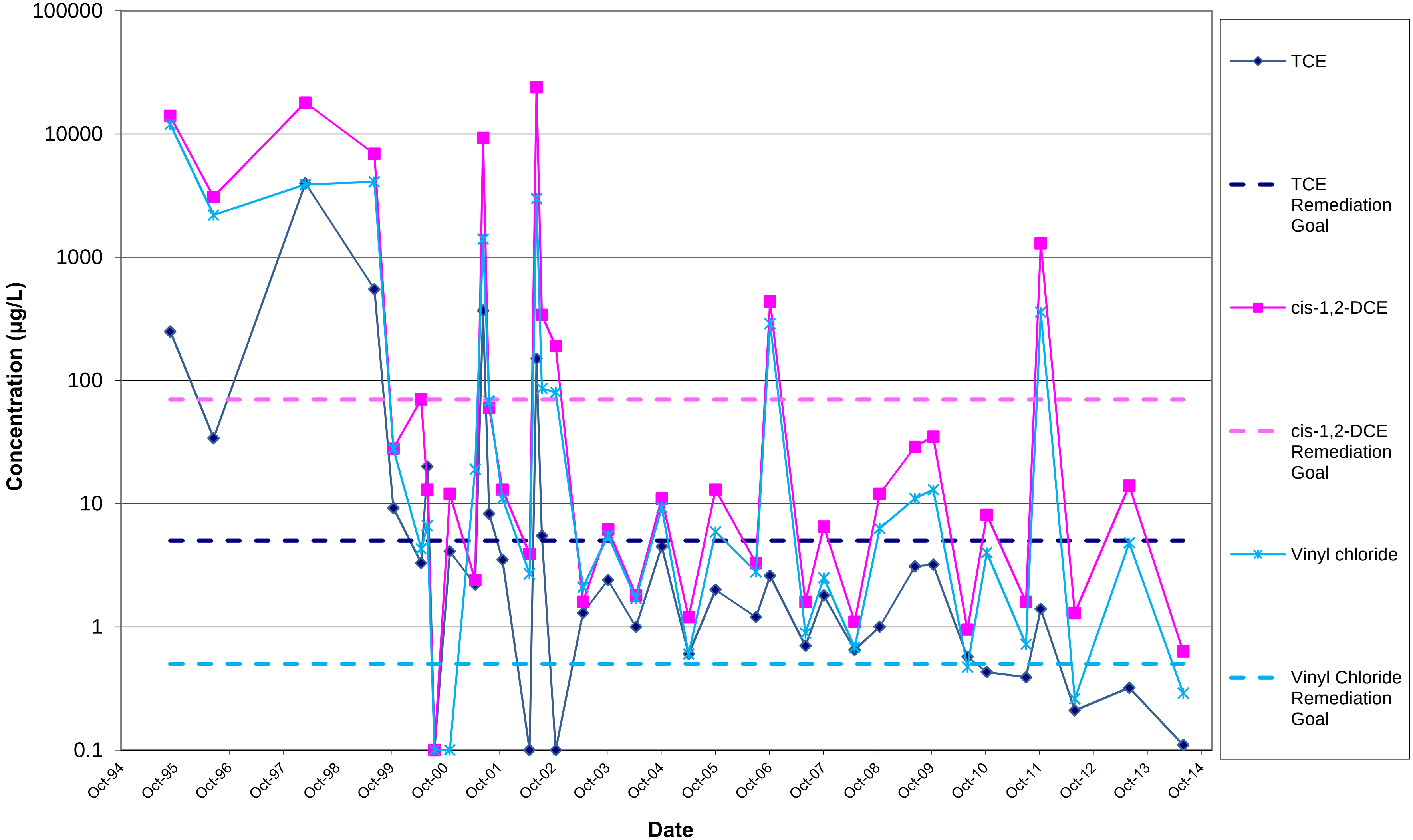


Figure D-5b. South Plantation
MW1-16 VOC Trends

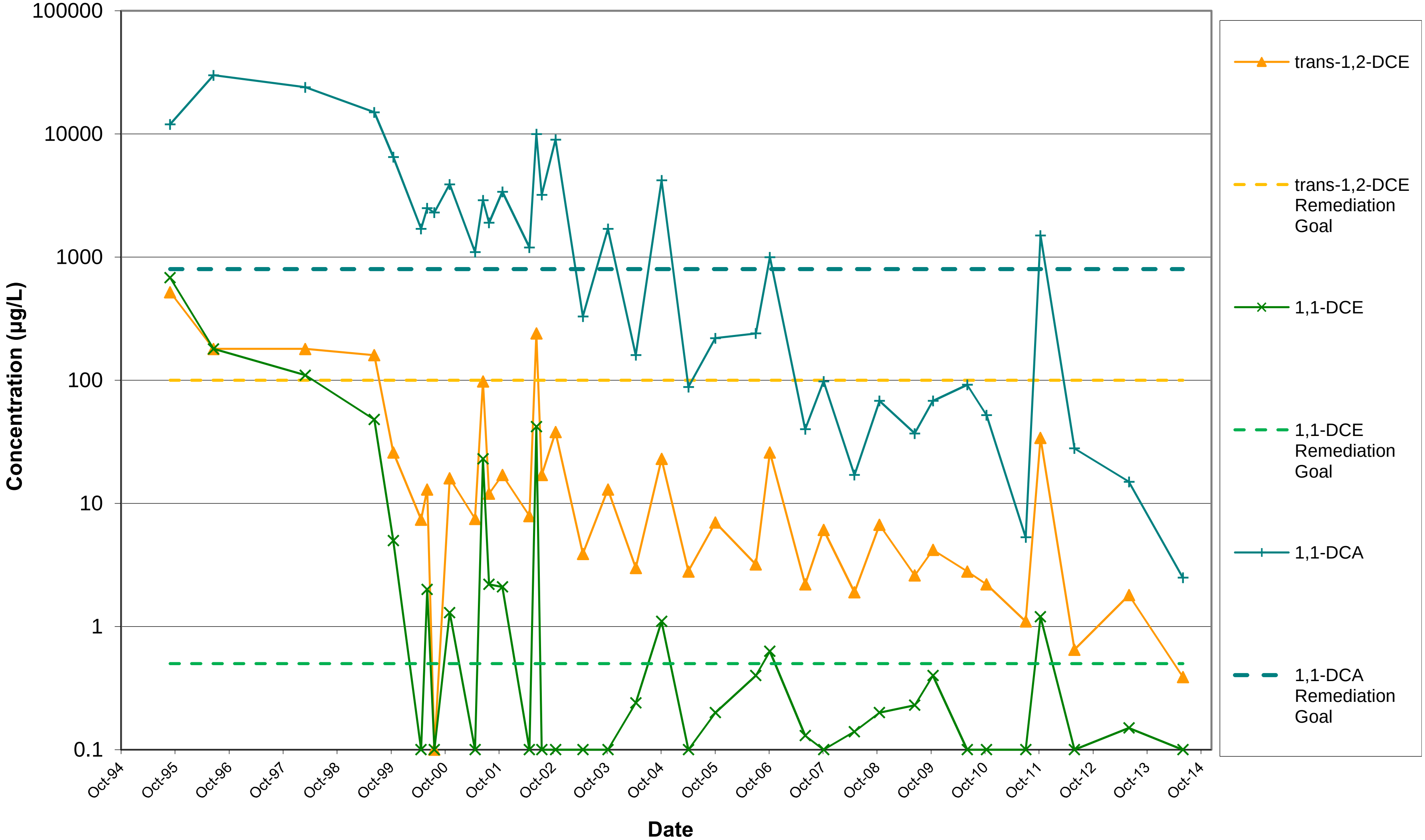


Figure D-6a. Area 1 South Plantation
P1-6 VOC Trends

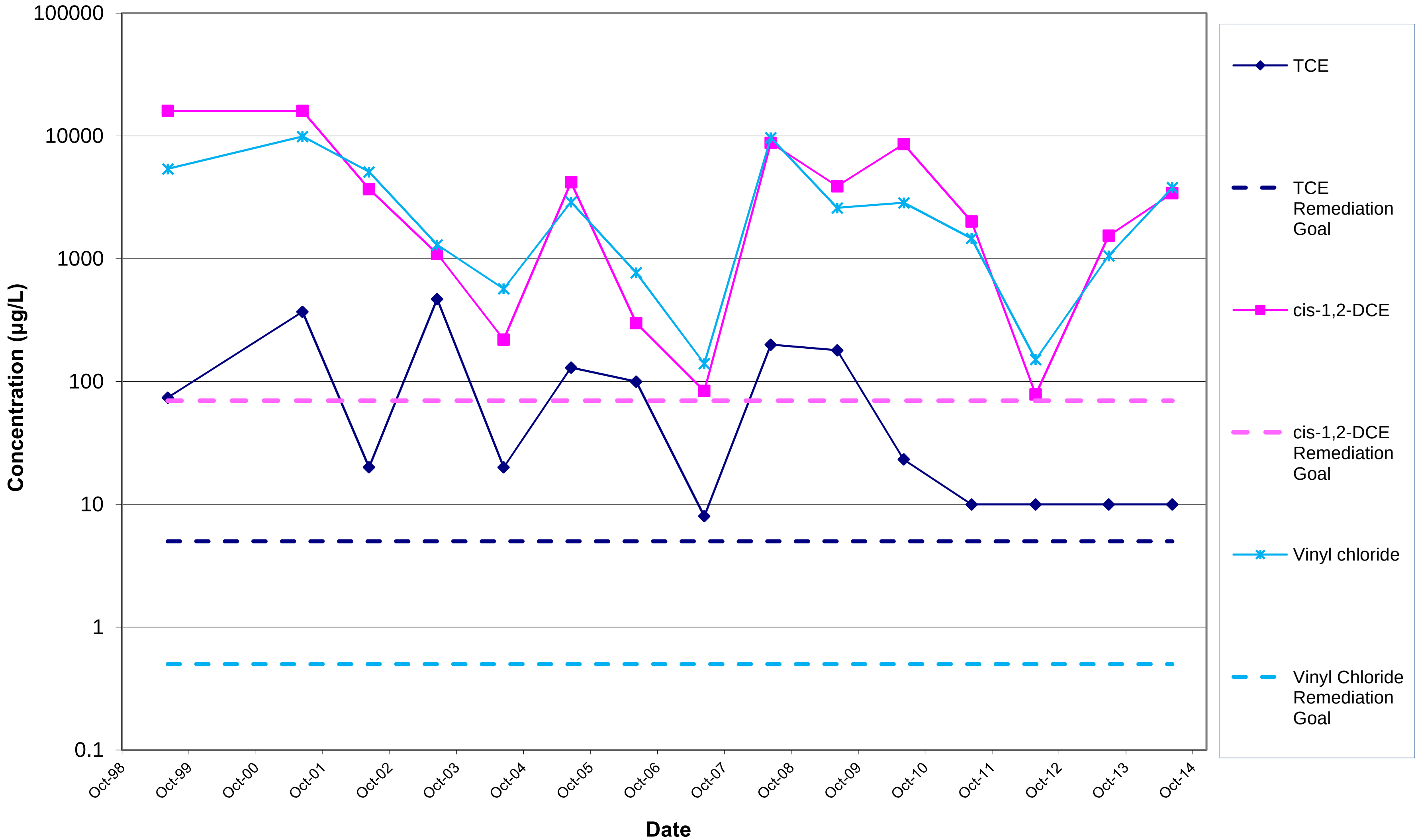
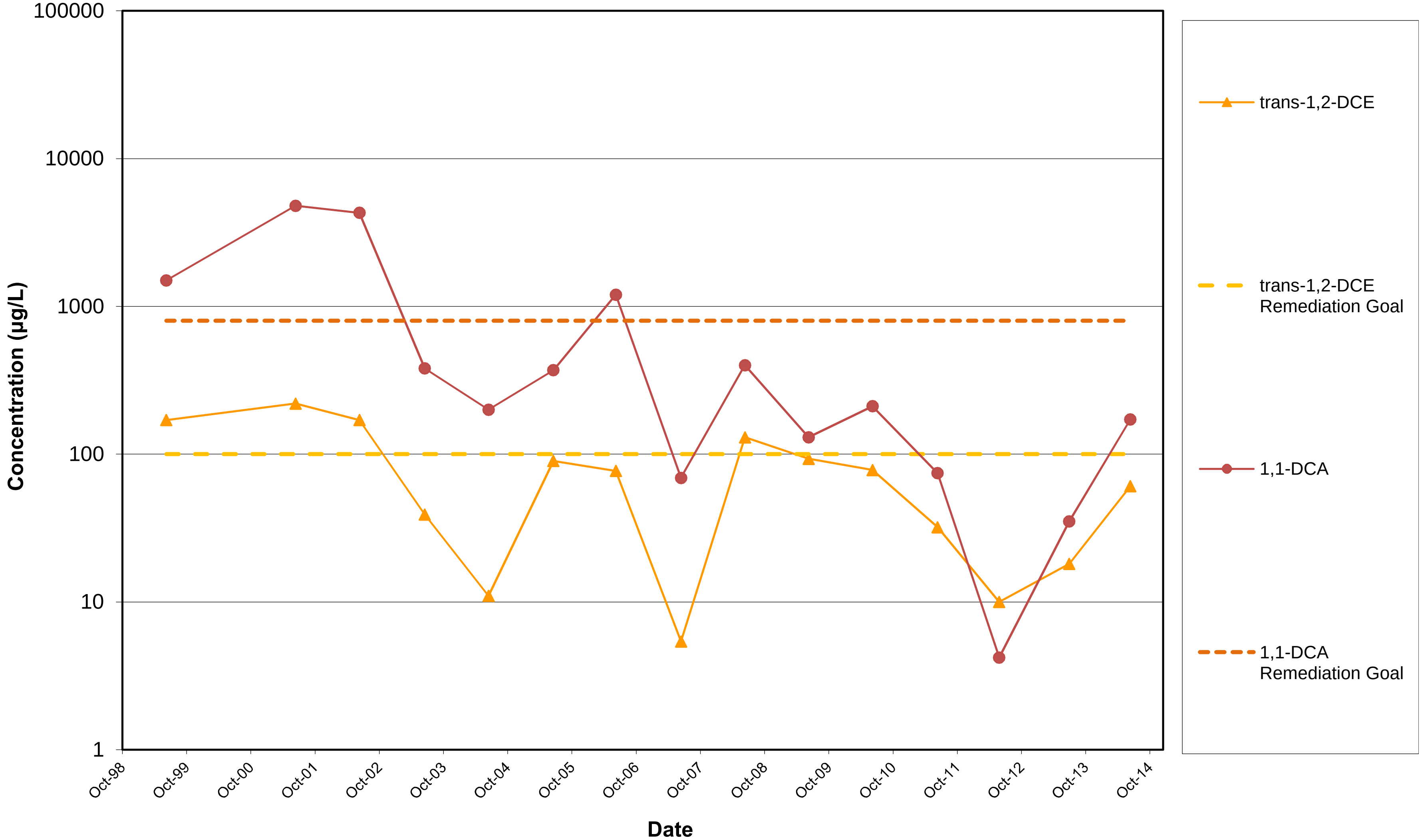


Figure D-6b. Area 1 South Plantation
P1-6 VOC Trends



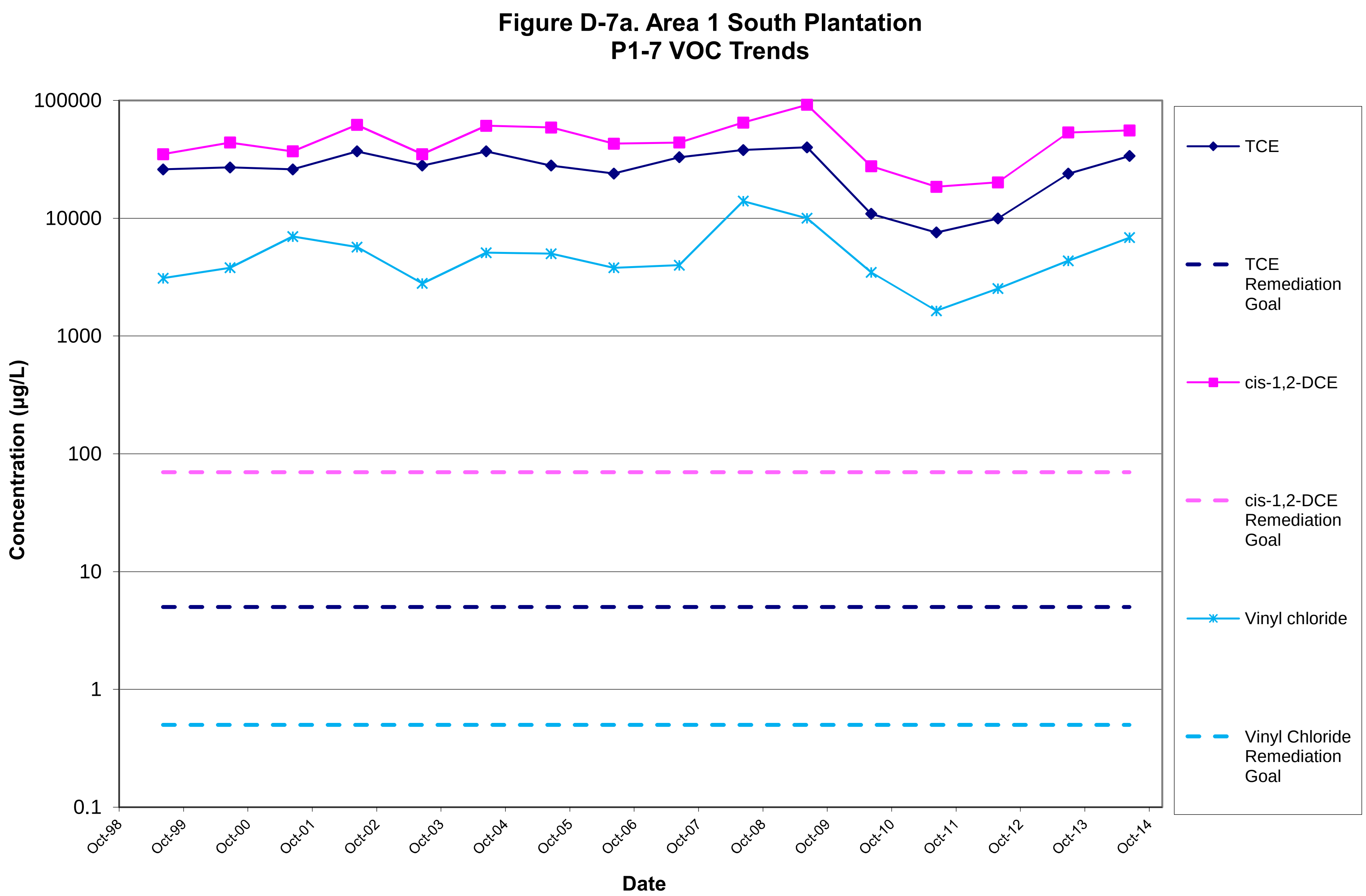


Figure D-7a. Area 1 South Plantation
P1-7 VOC Trends
100000
10000
1000
100
10
1
0.1
Concentration (µg/L)
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Date
TCE
TCE Remediation Goal
cis-1,2-DCE
cis-1,2-DCE Remediation Goal
Vinyl chloride
Vinyl Chloride Remediation Goal

Figure D-7b. Area 1 South Plantation
P1-7 VOC Trends

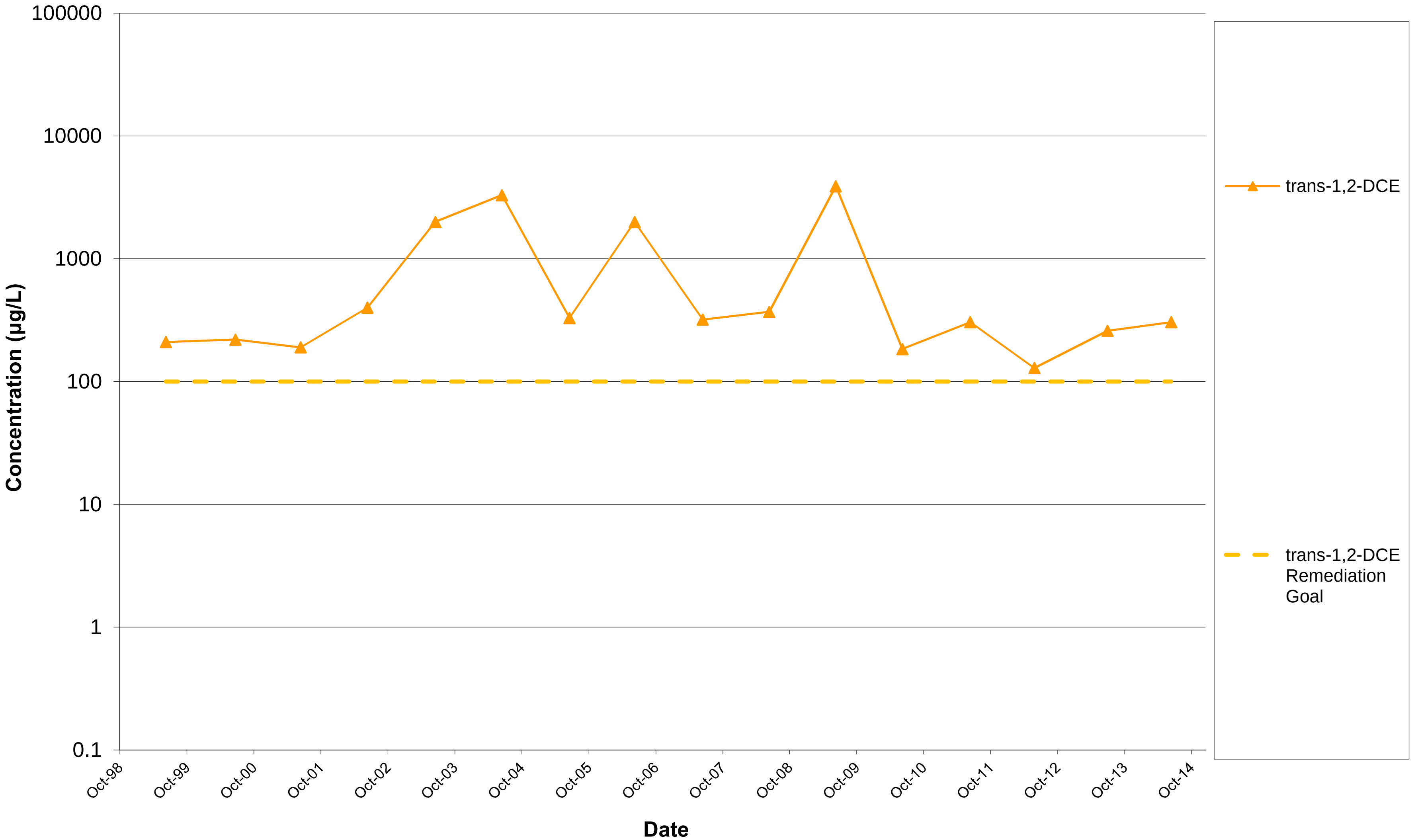
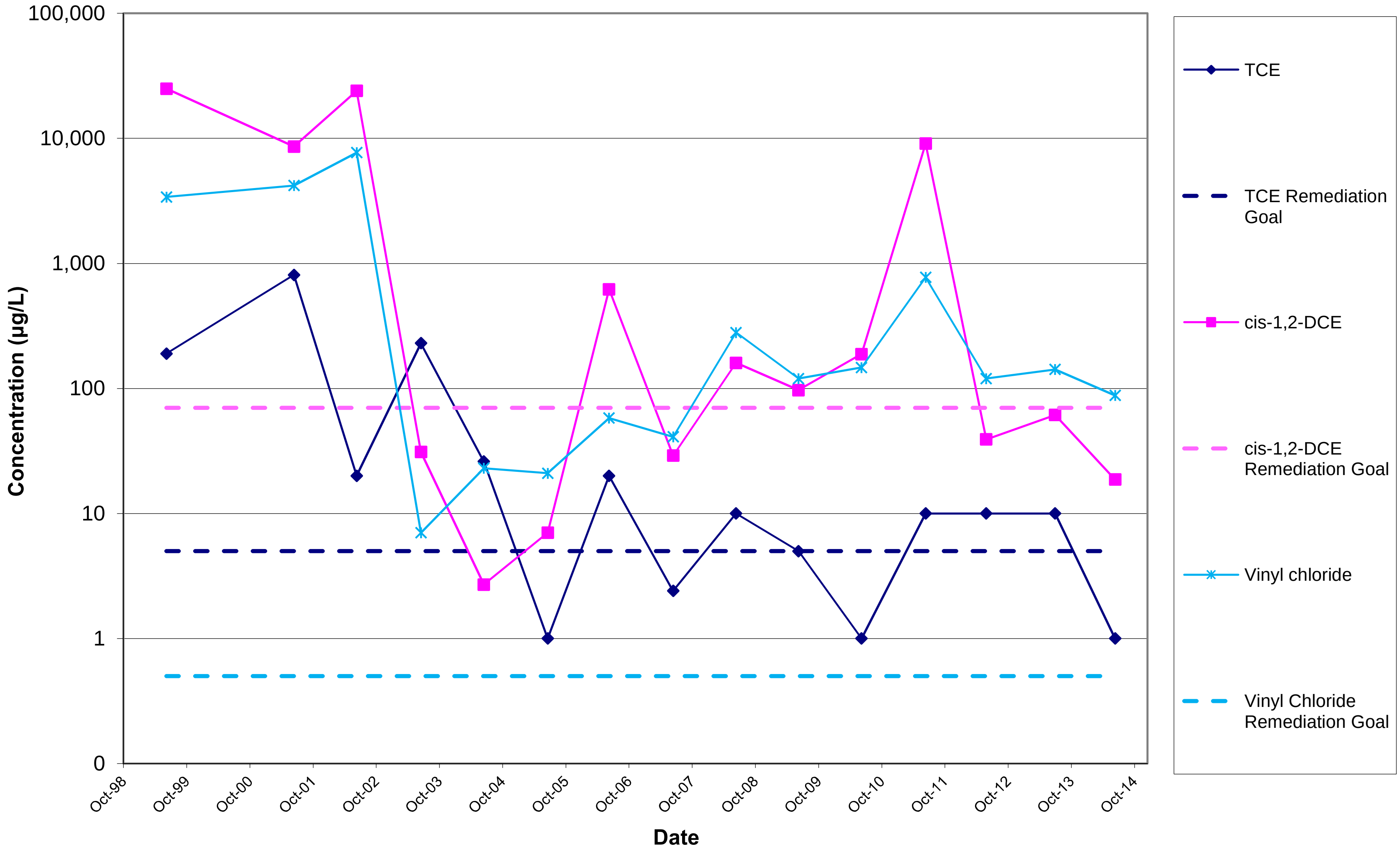


Figure D-8a. Area 1 South Plantation
P1-8 VOC Trends



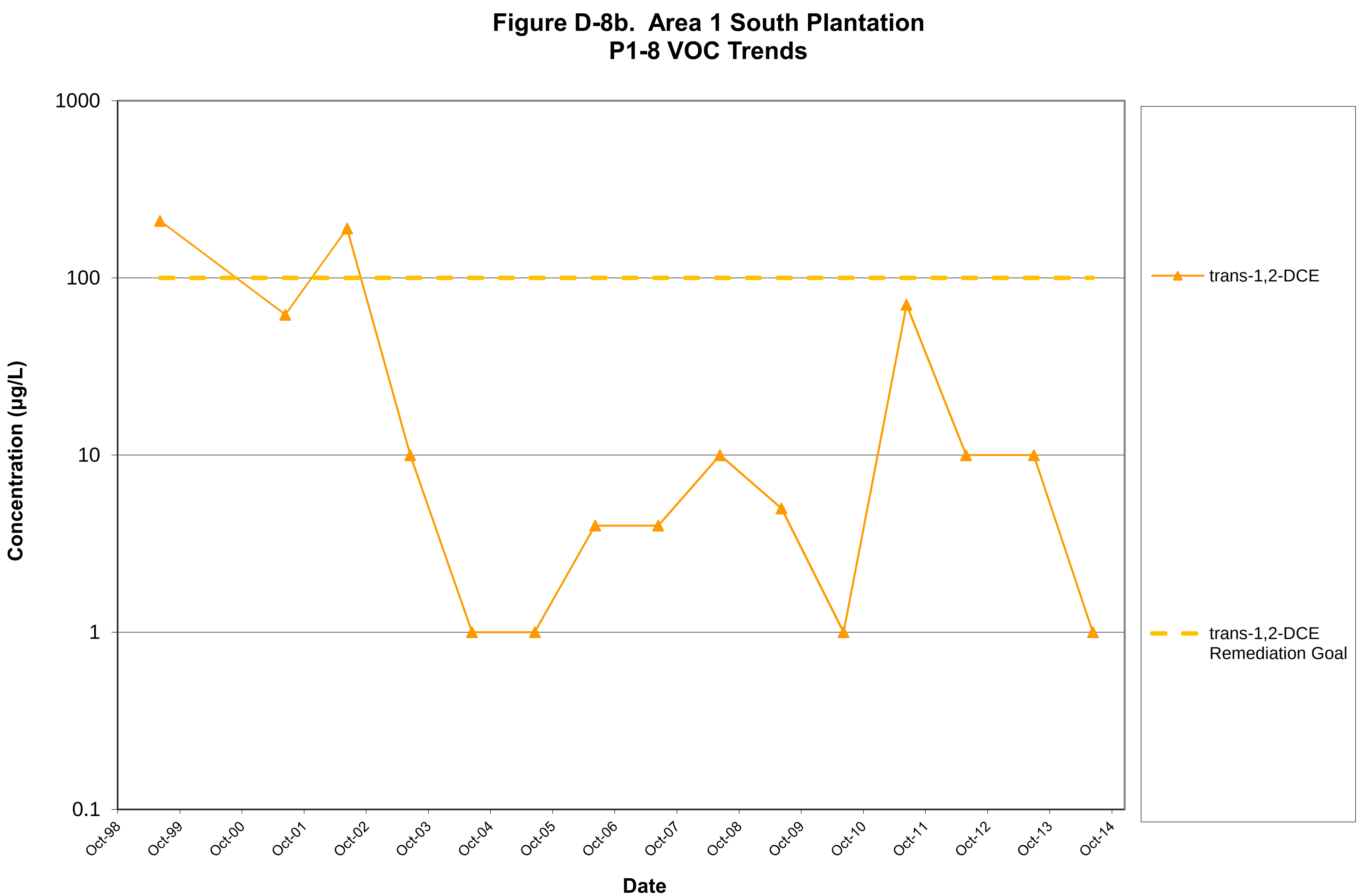


Figure D-8b. Area 1 South Plantation
P1-8 VOC Trends
Concentration (µg/L)
1000
100
10
1
0.1
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Date
trans-1,2-DCE
trans-1,2-DCE Remediation Goal

Figure D-9a. Area 1 South Plantation
P1-9 VOC Trends

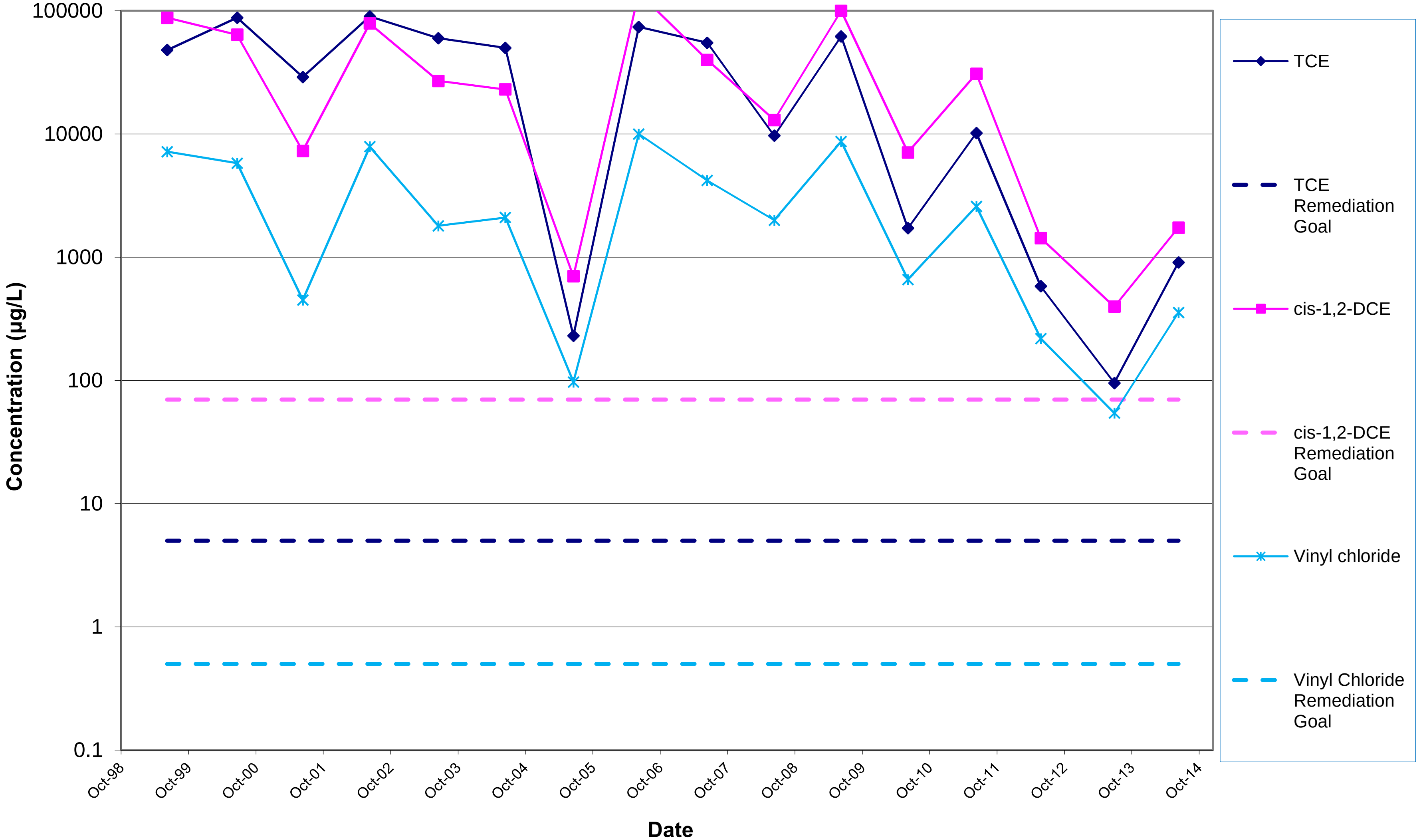
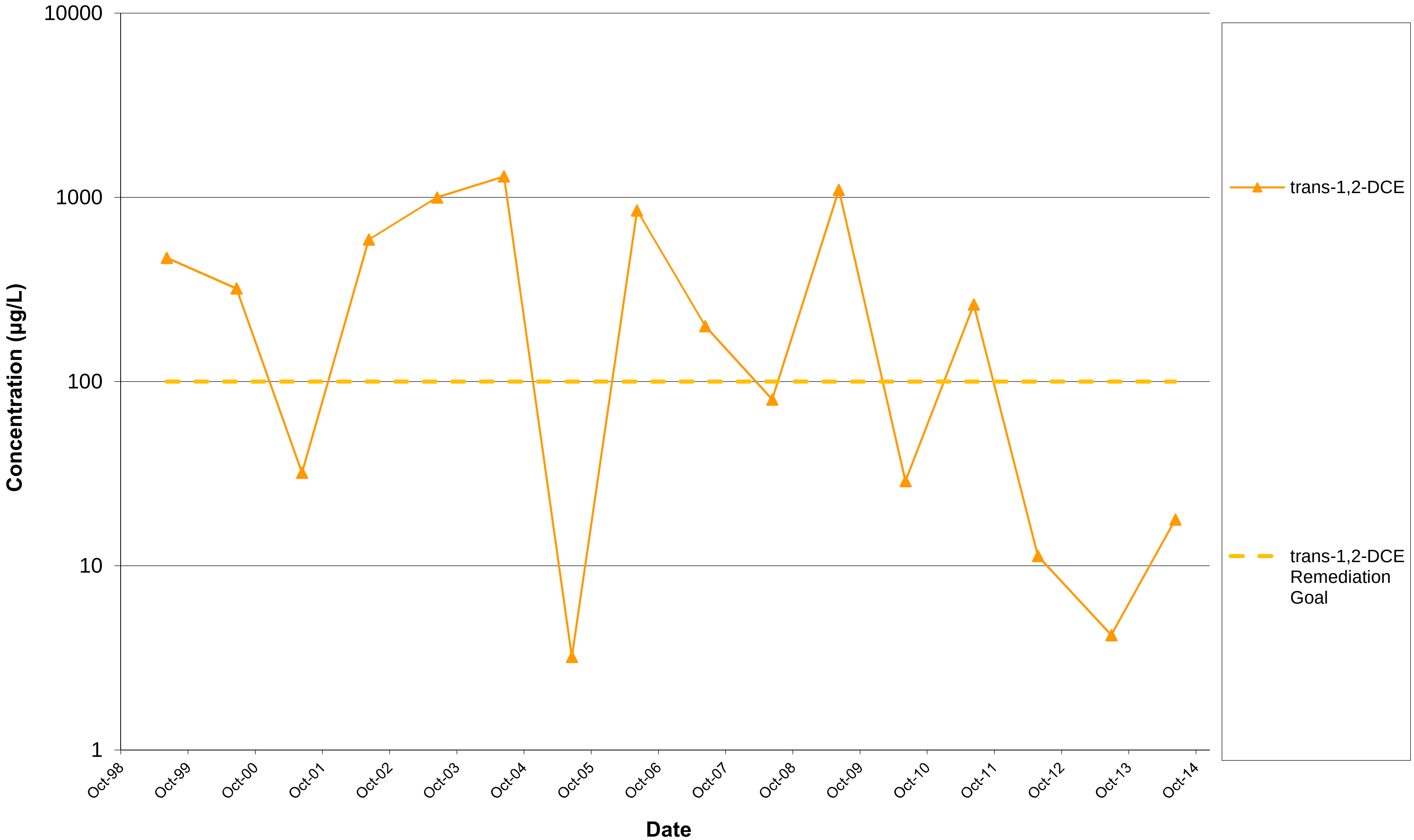


Figure D-9b. Area 1 South Plantation P1-9 VOC Trends.



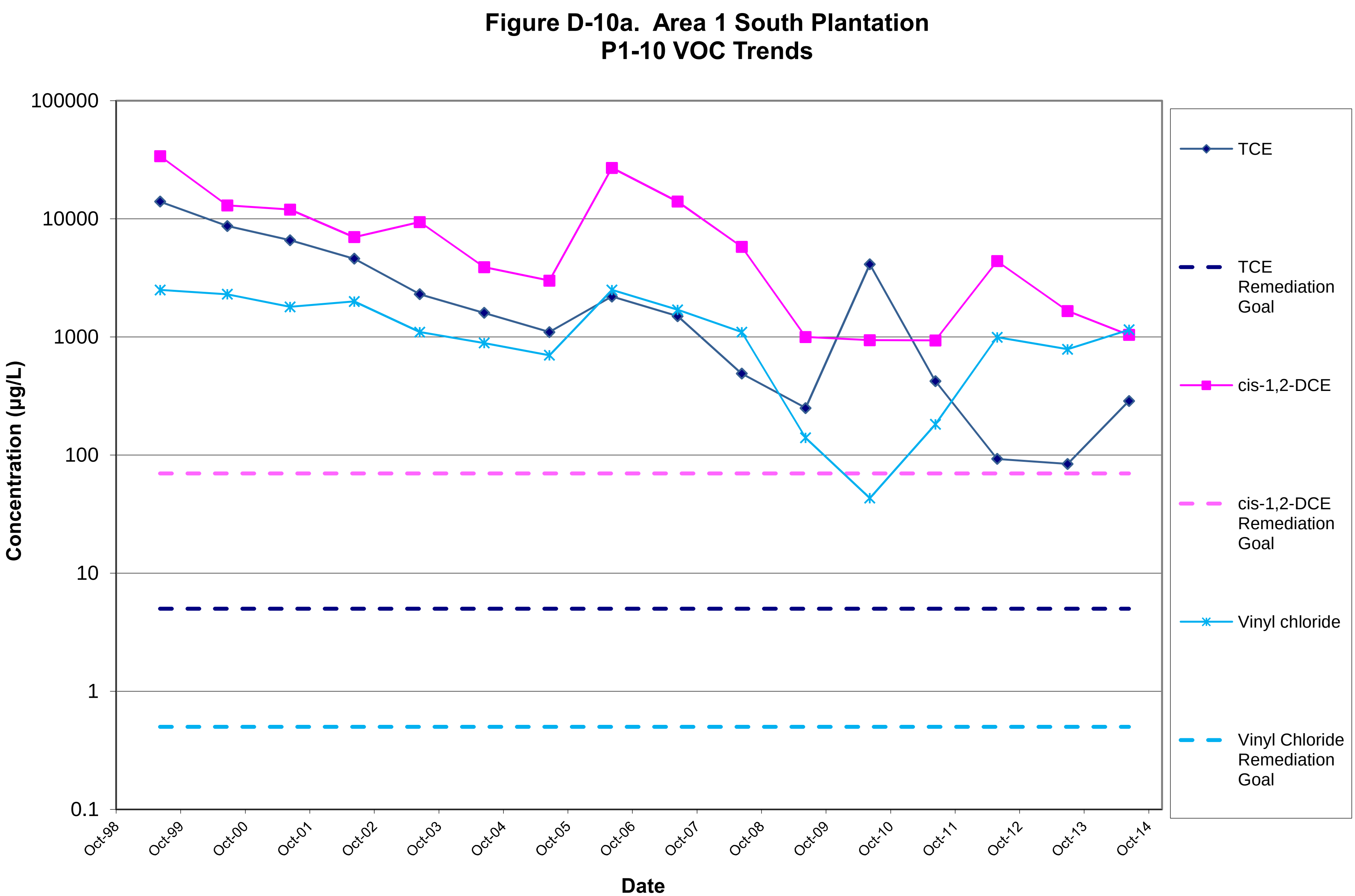


Figure D-10a. Area 1 South Plantation
P1-10 VOC Trends
100000
10000
1000
100
10
1
0.1
Concentration (µg/L)
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Date
TCE
TCE Remediation Goal
cis-1,2-DCE
cis-1,2-DCE Remediation Goal
Vinyl chloride
Vinyl Chloride Remediation Goal

Figure D-10b. Area 1 South Plantation
P1-10 VOC Trends

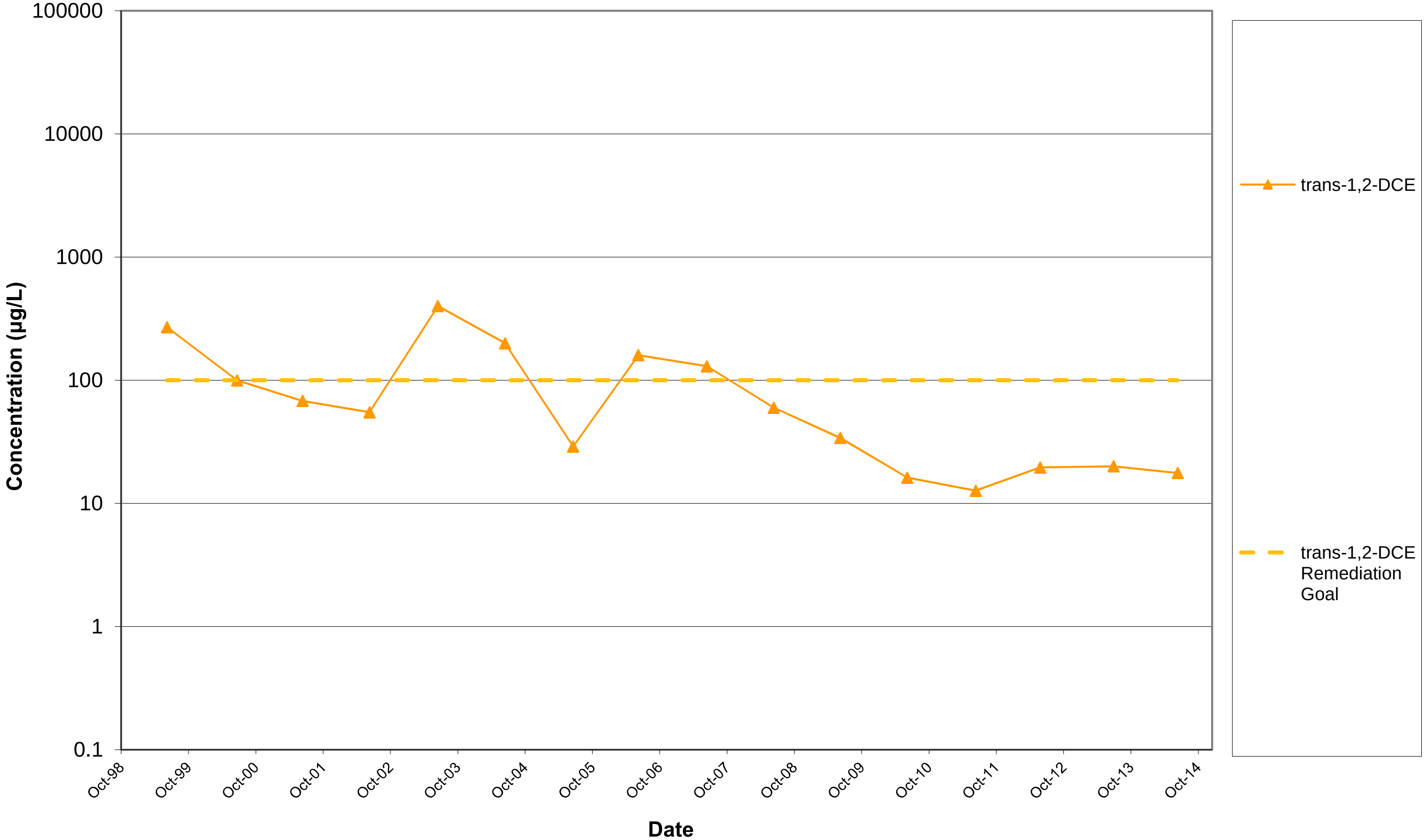


Figure D-11. Area 1 Central Landfill
MW1-17 VOC Trends

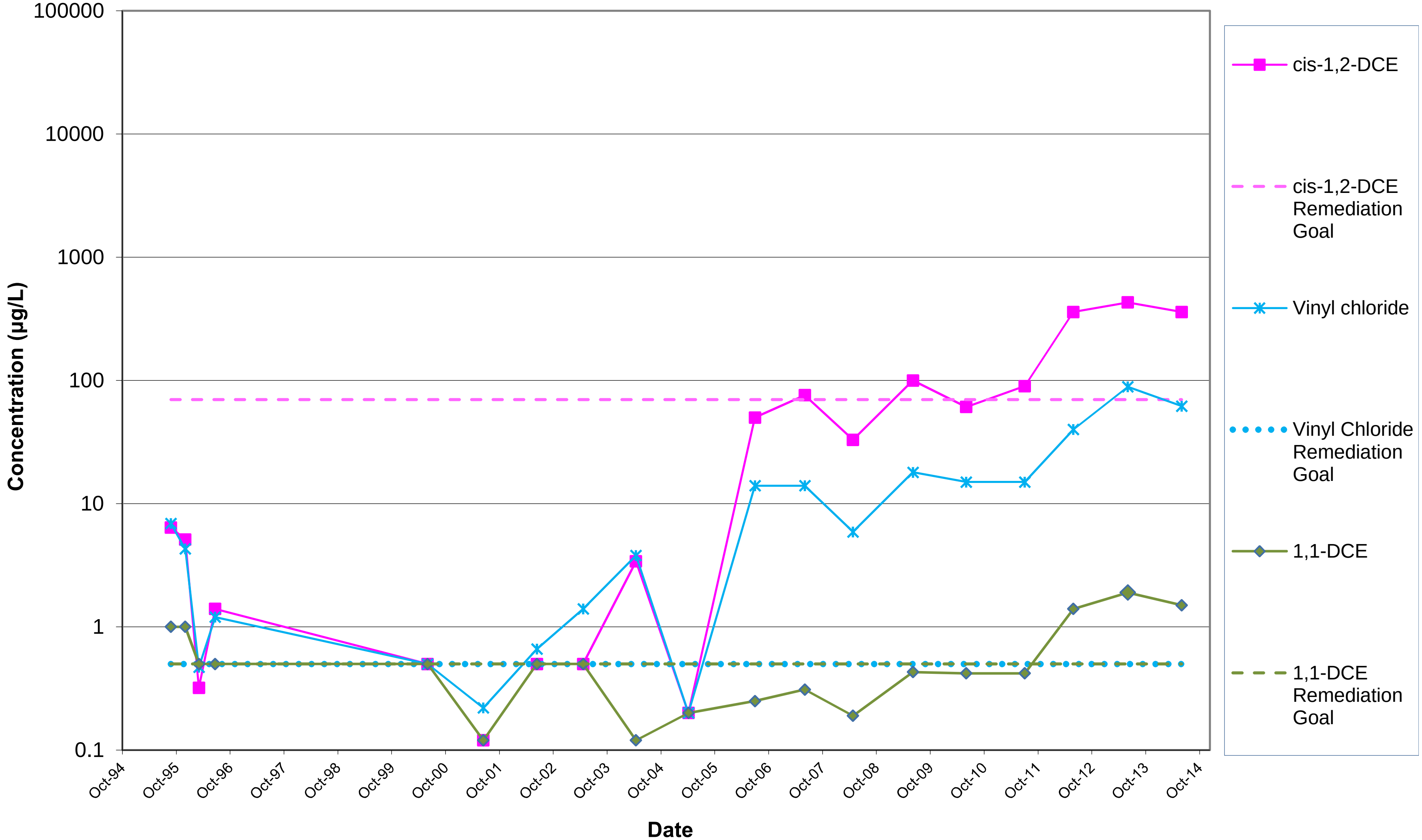


Figure D-12a. Area 1 Surface Water
MA12 VOC Trends

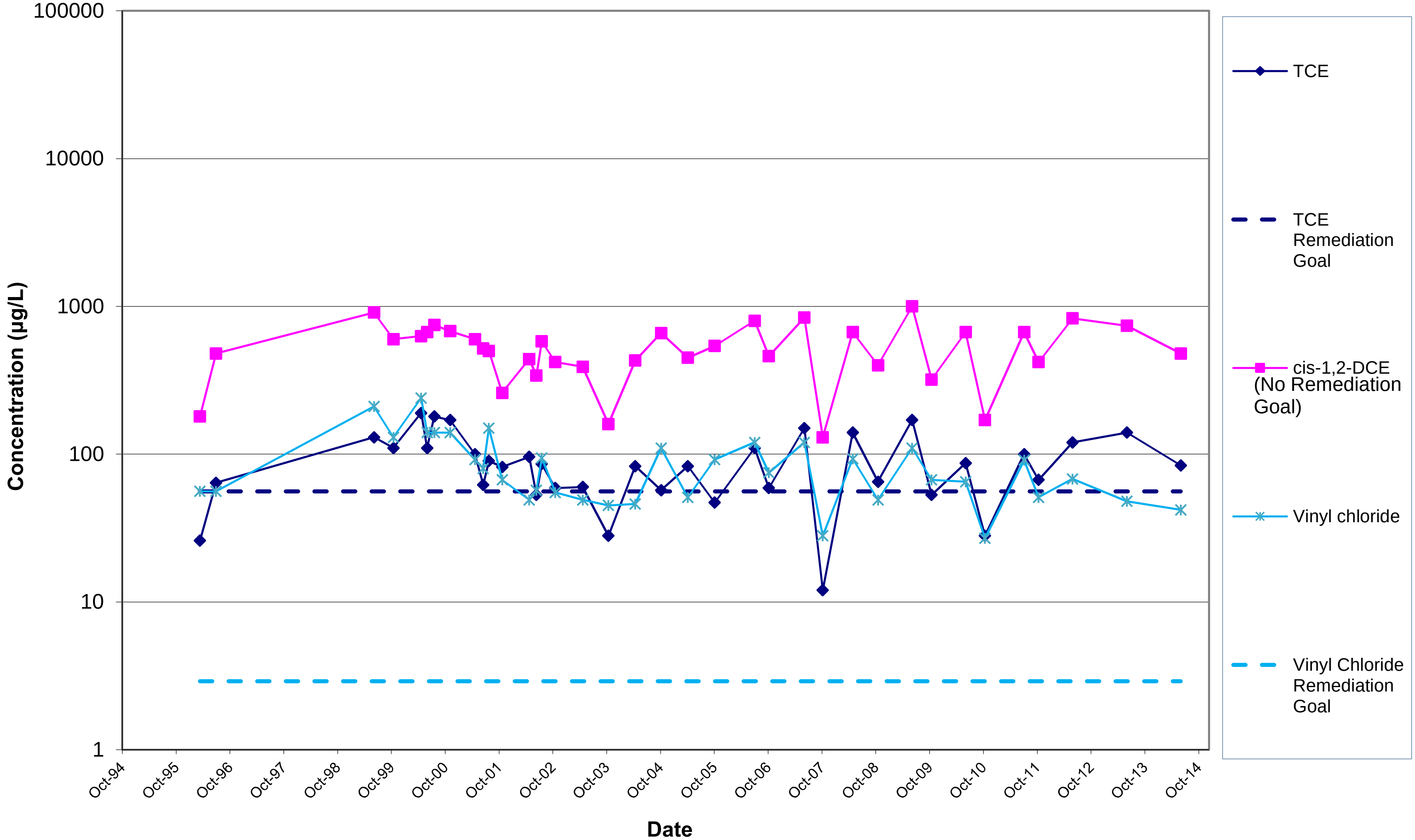


Figure D-12b. Area 1 Surface Water
MA12 VOC Trends

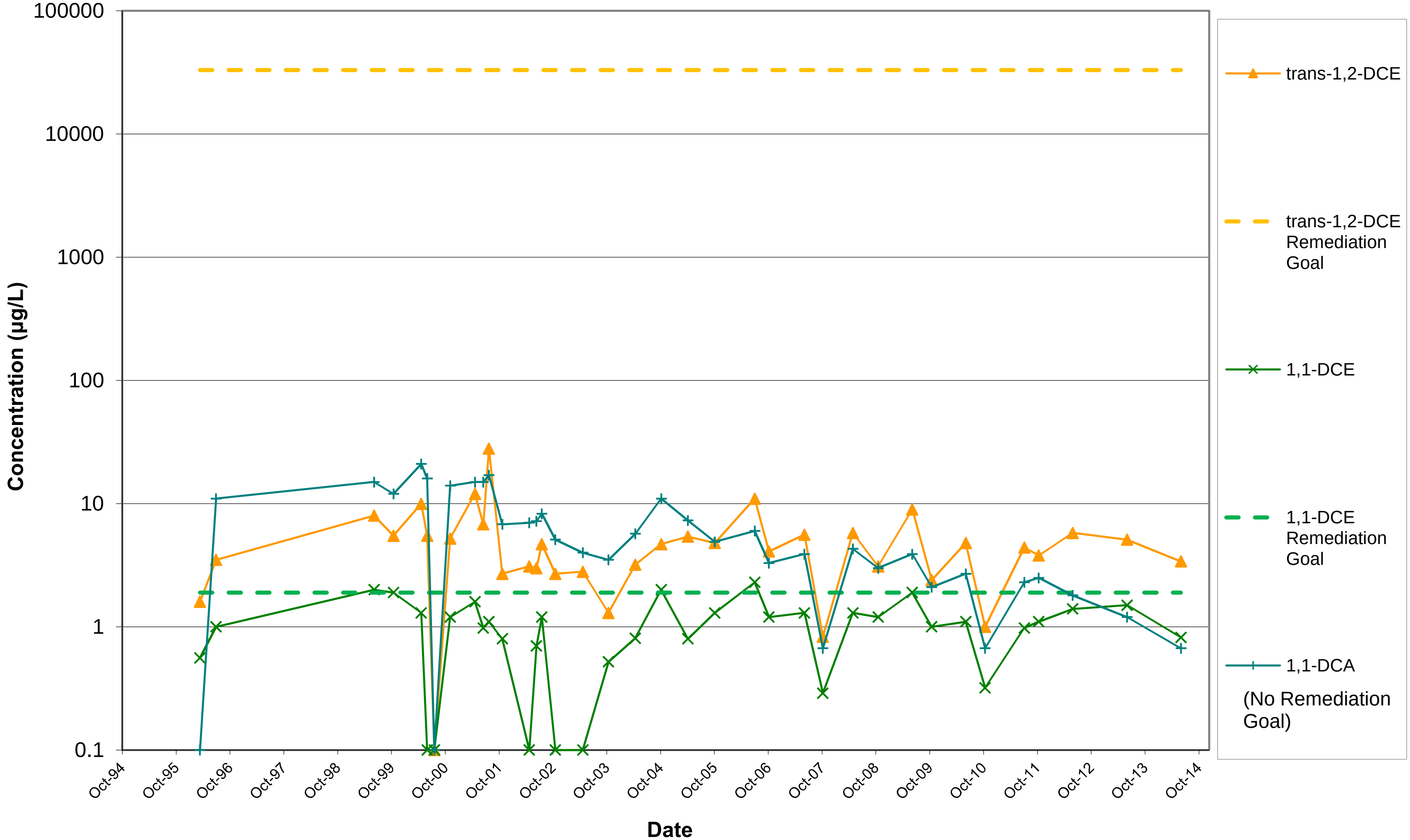


Figure D-13a. Area 1 Seep
SP1-1 VOC Trends

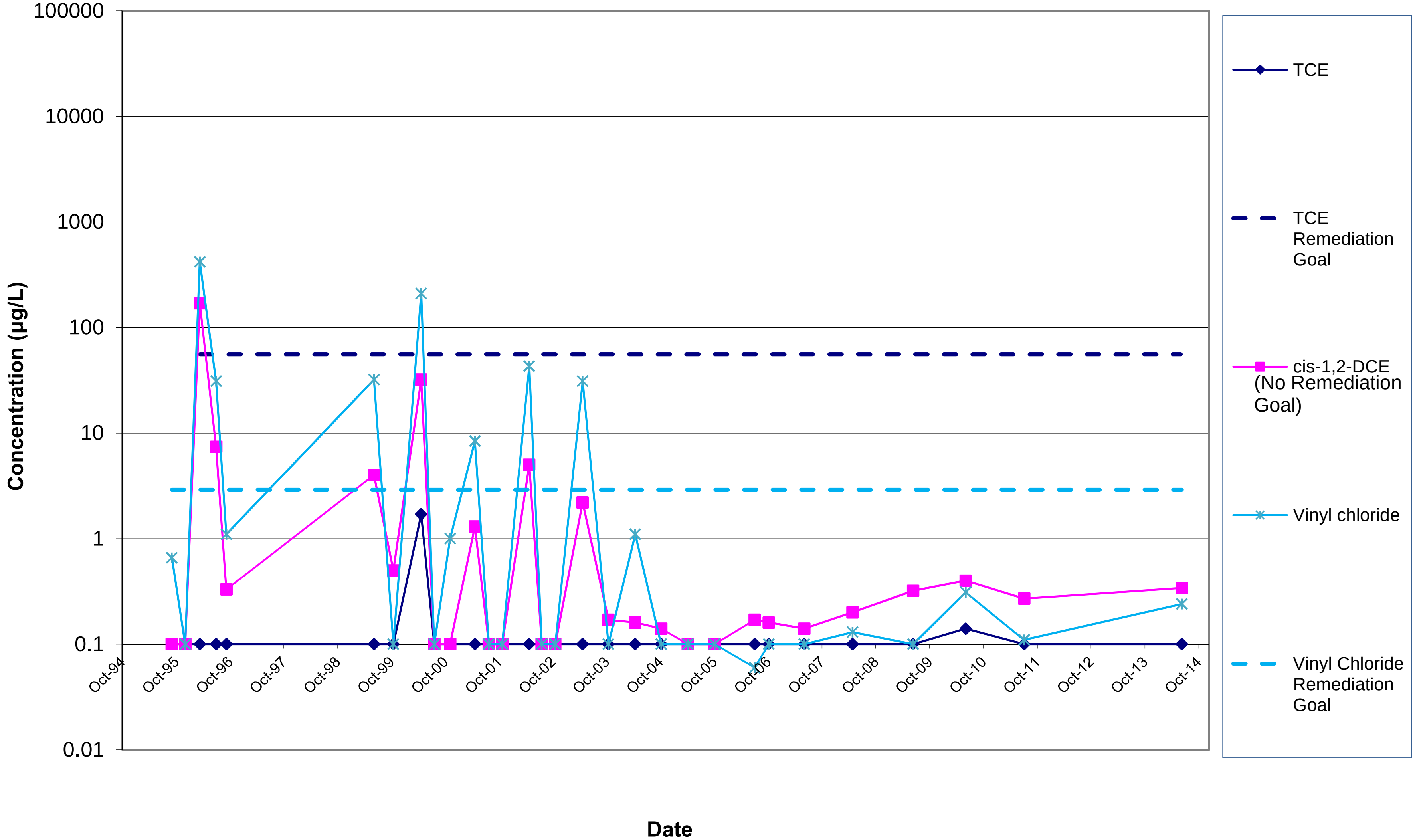


Figure D-13b. Area 1 Seep
SP1-1 Total PCB Trends

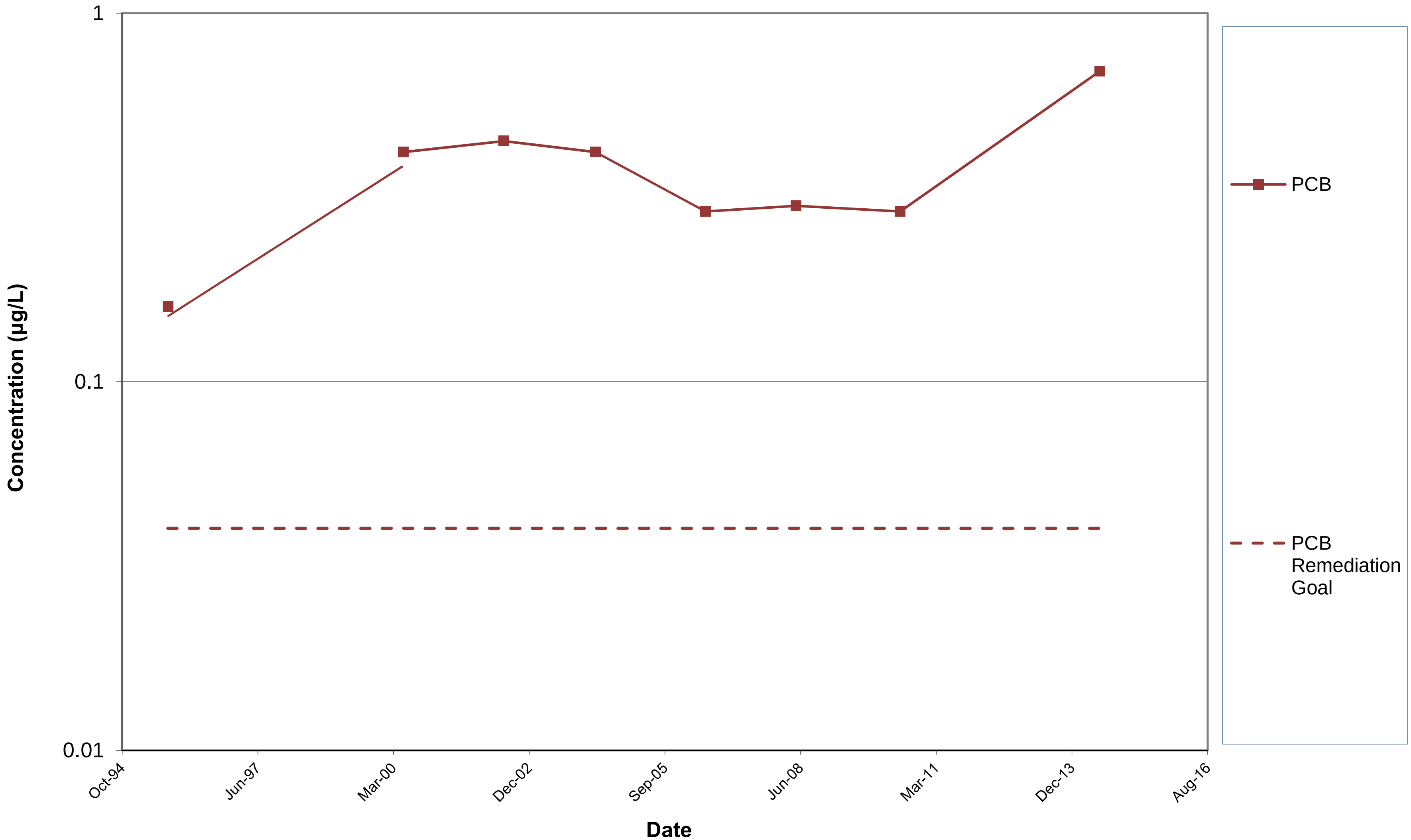


**Figure D-14. Area 1 Sediment
MA09, MA14, TF21 Total PCB Trends**

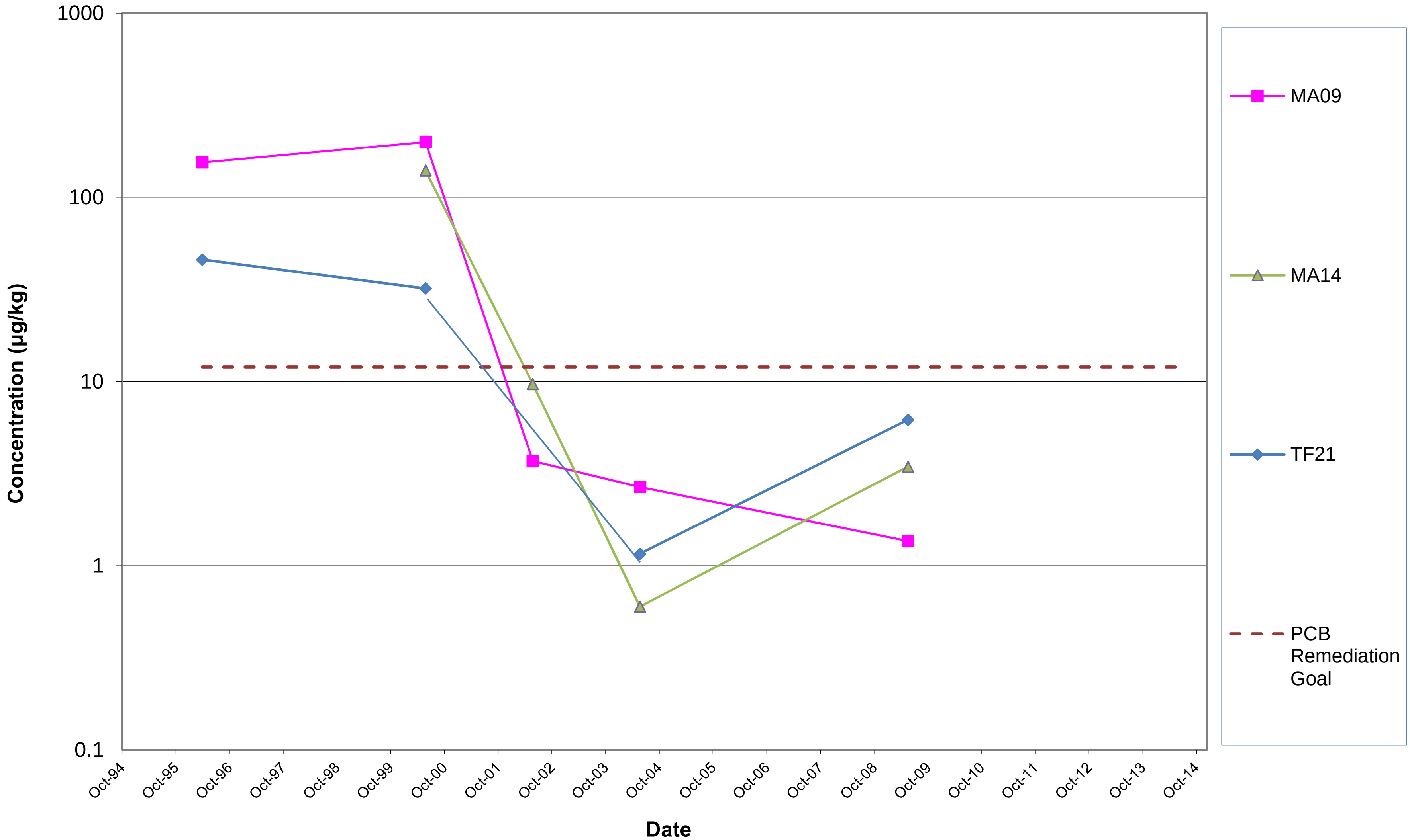


Figure D-15
2MW-1 Concentration Trend

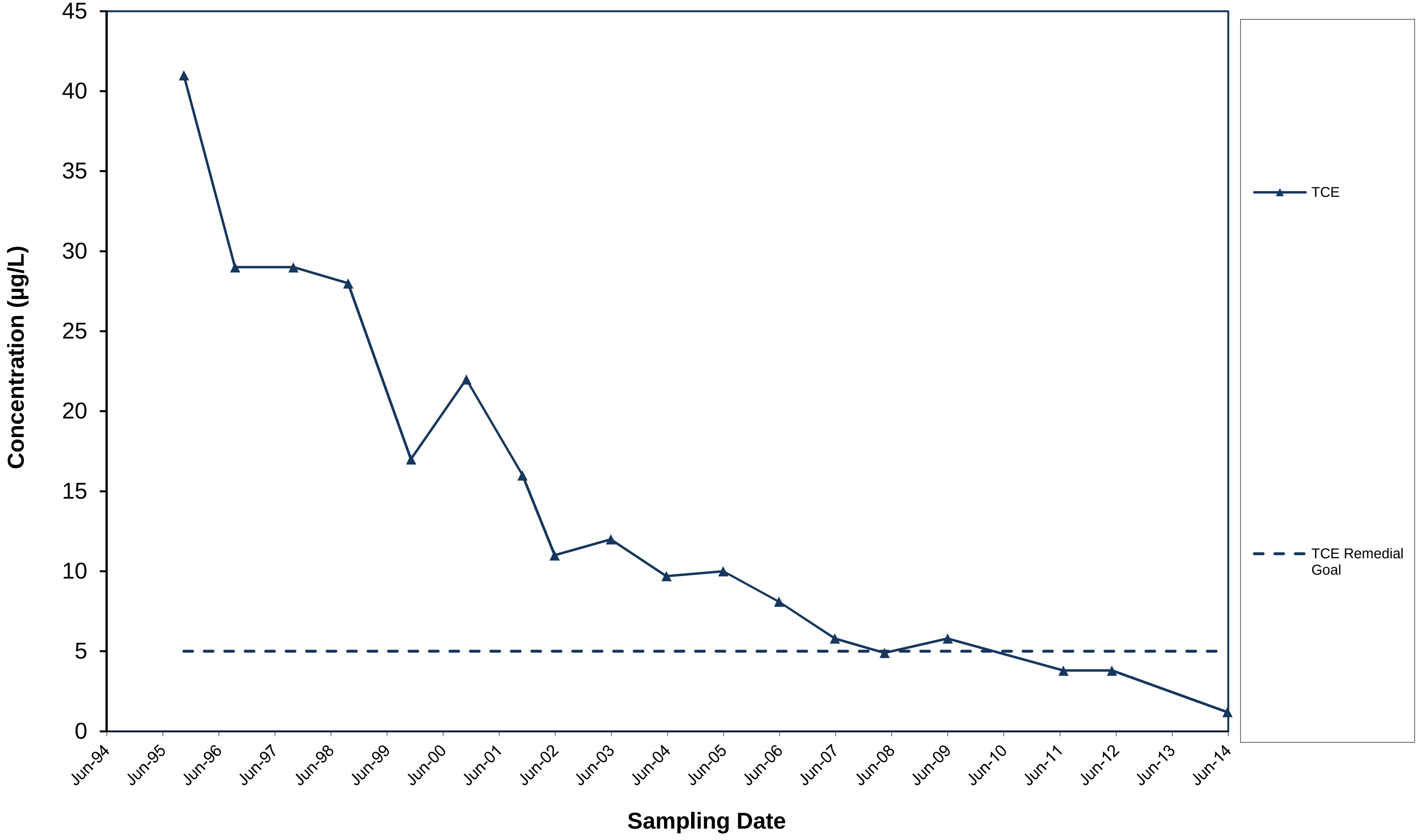


Figure D-16
2MW-6 Concentration Trends

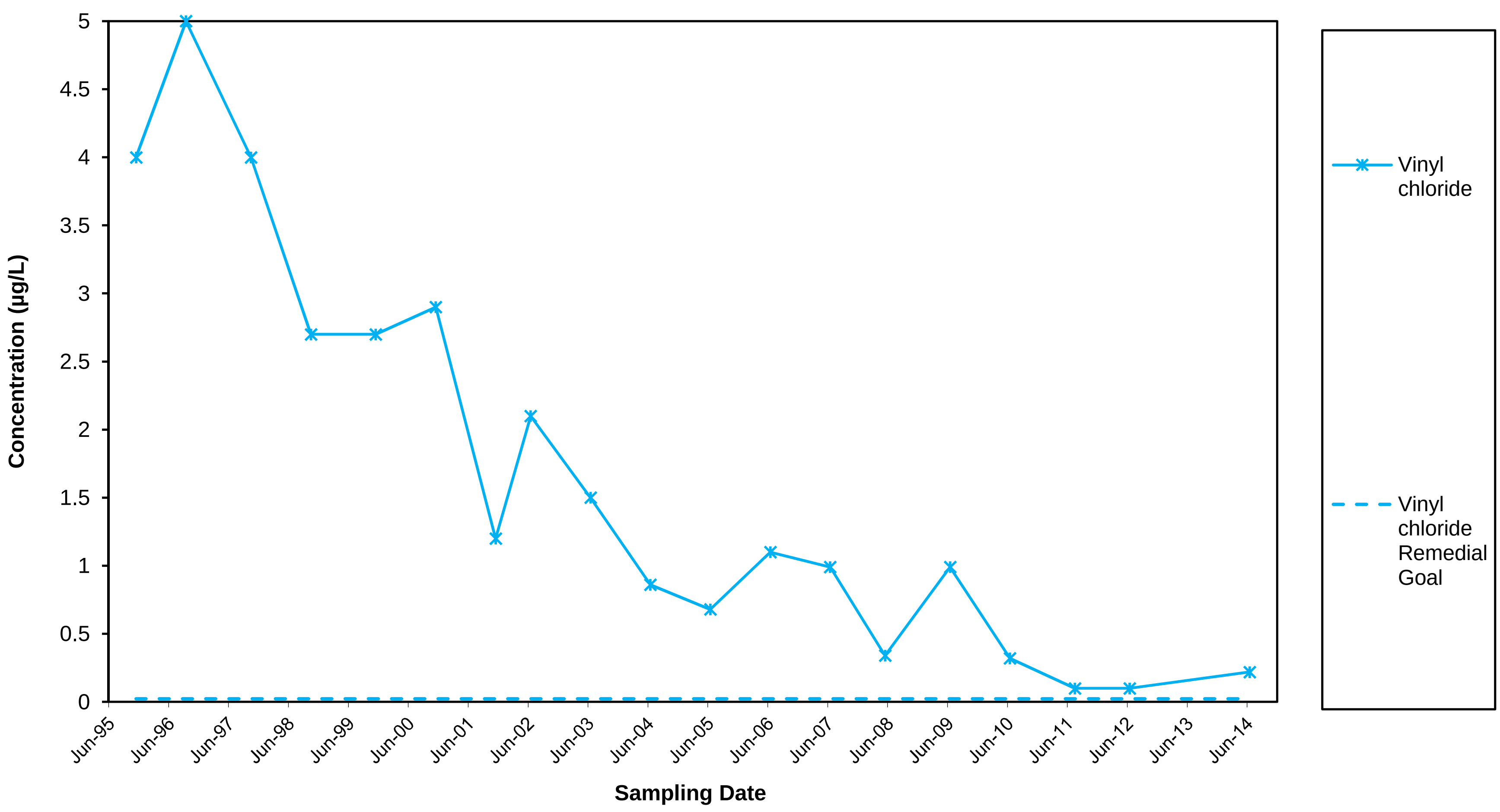


Figure D-17a. Area 8 MW8-8 VOC Trends

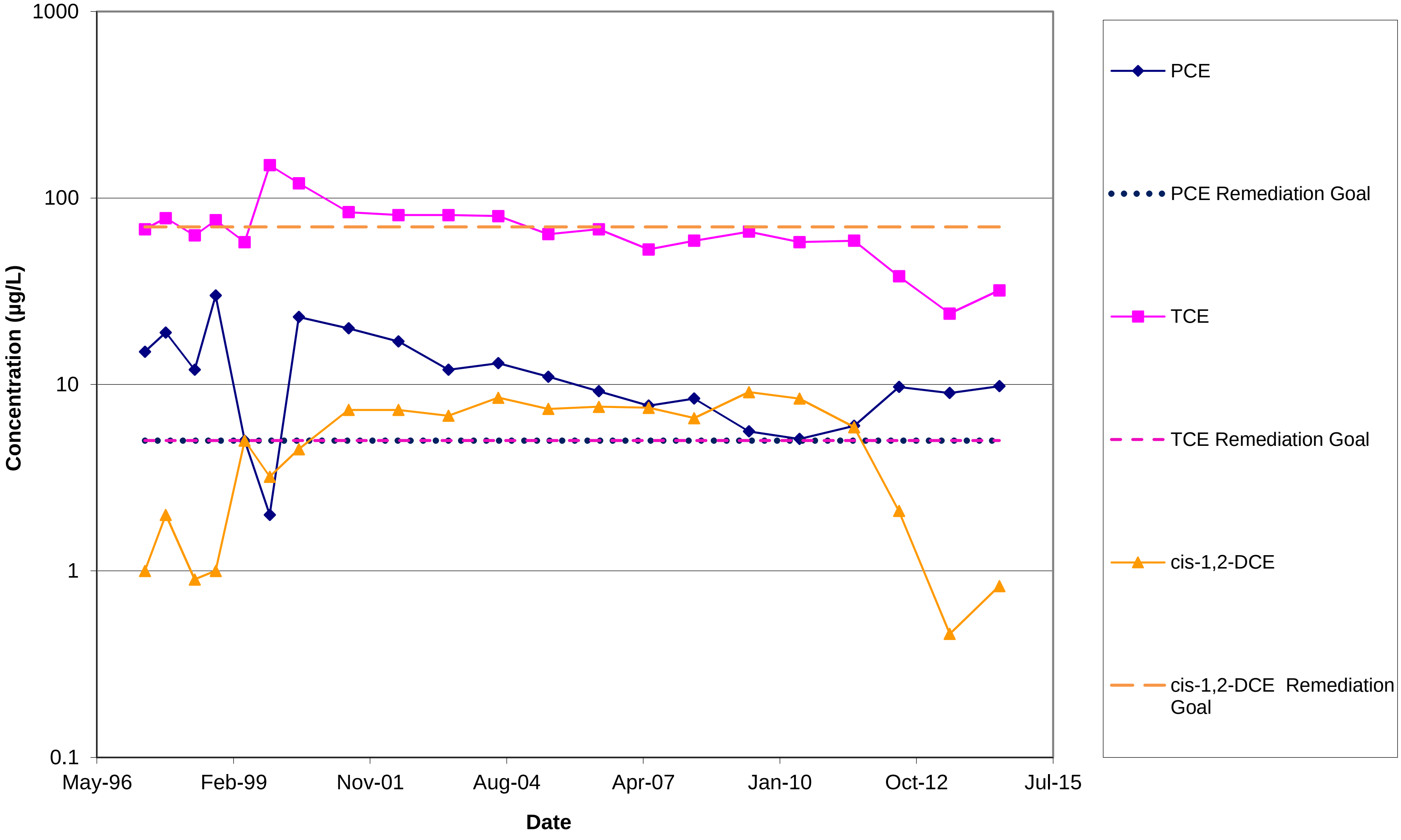


Figure D-17b. Area 8 MW8-8 Cd and Cr Concentration Trends

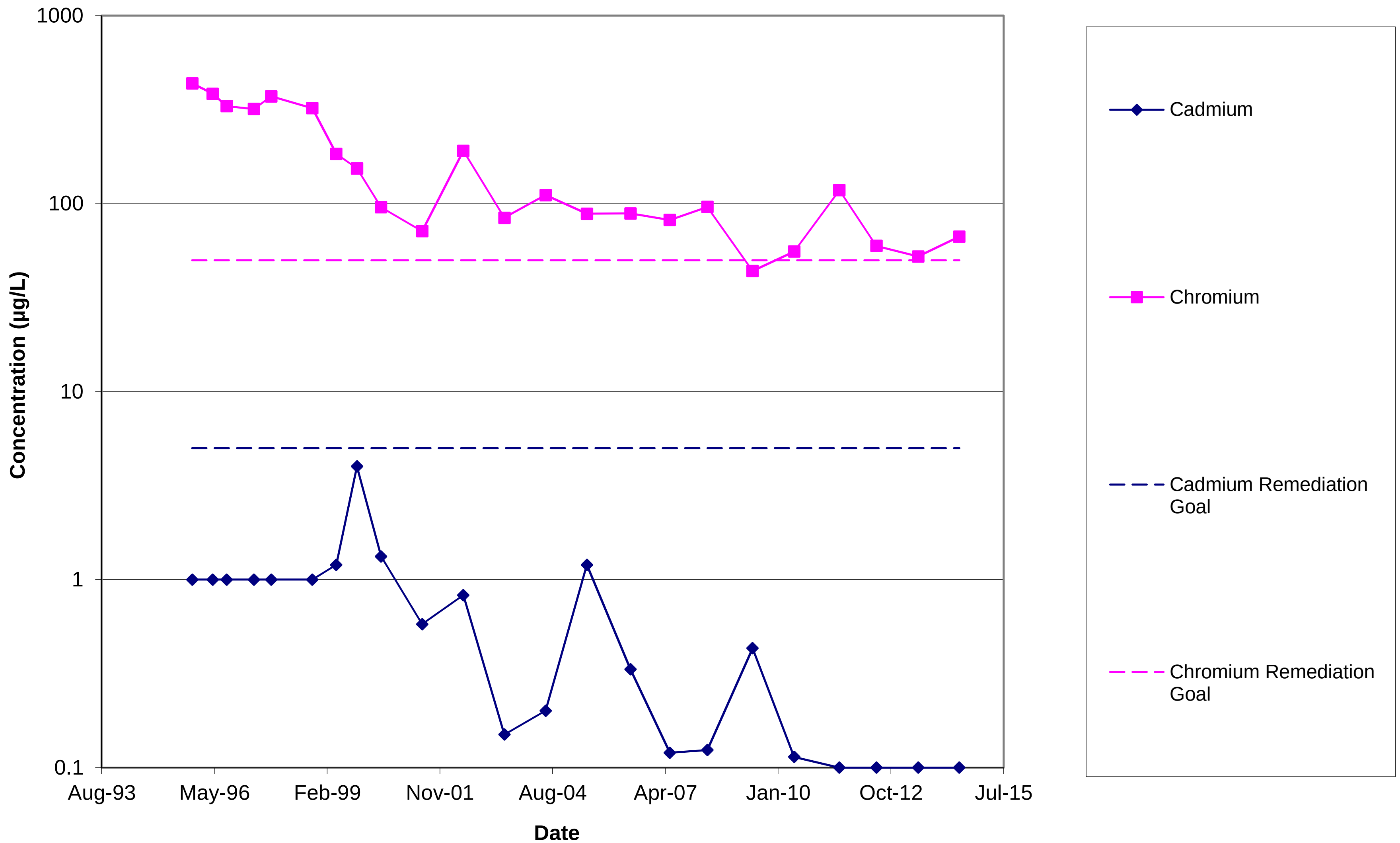


Figure D-18a. Area 8 MW8-9 VOC Trends

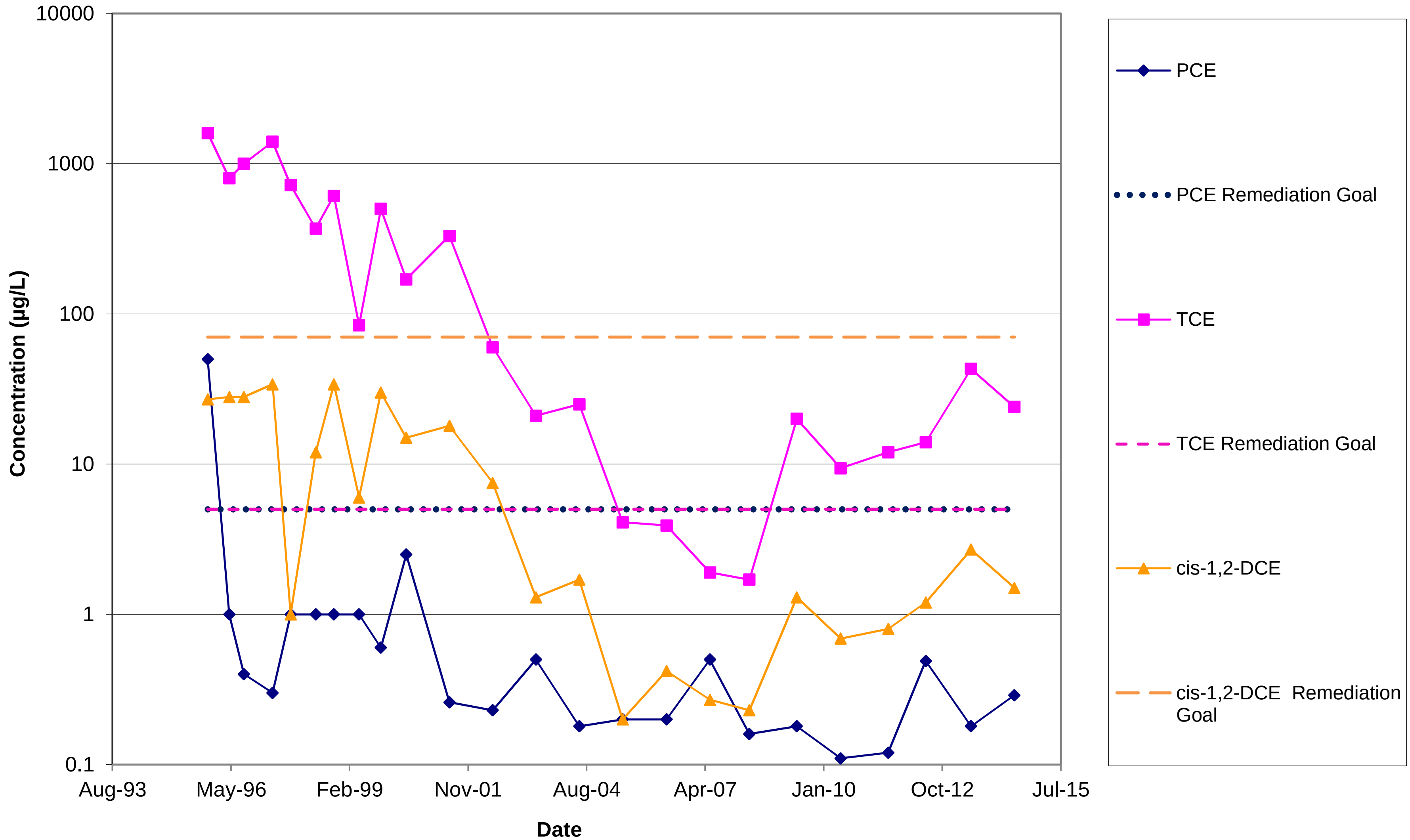


Figure D-18b. Area 8 MW8-9 Cd and Cr Concentration Trends

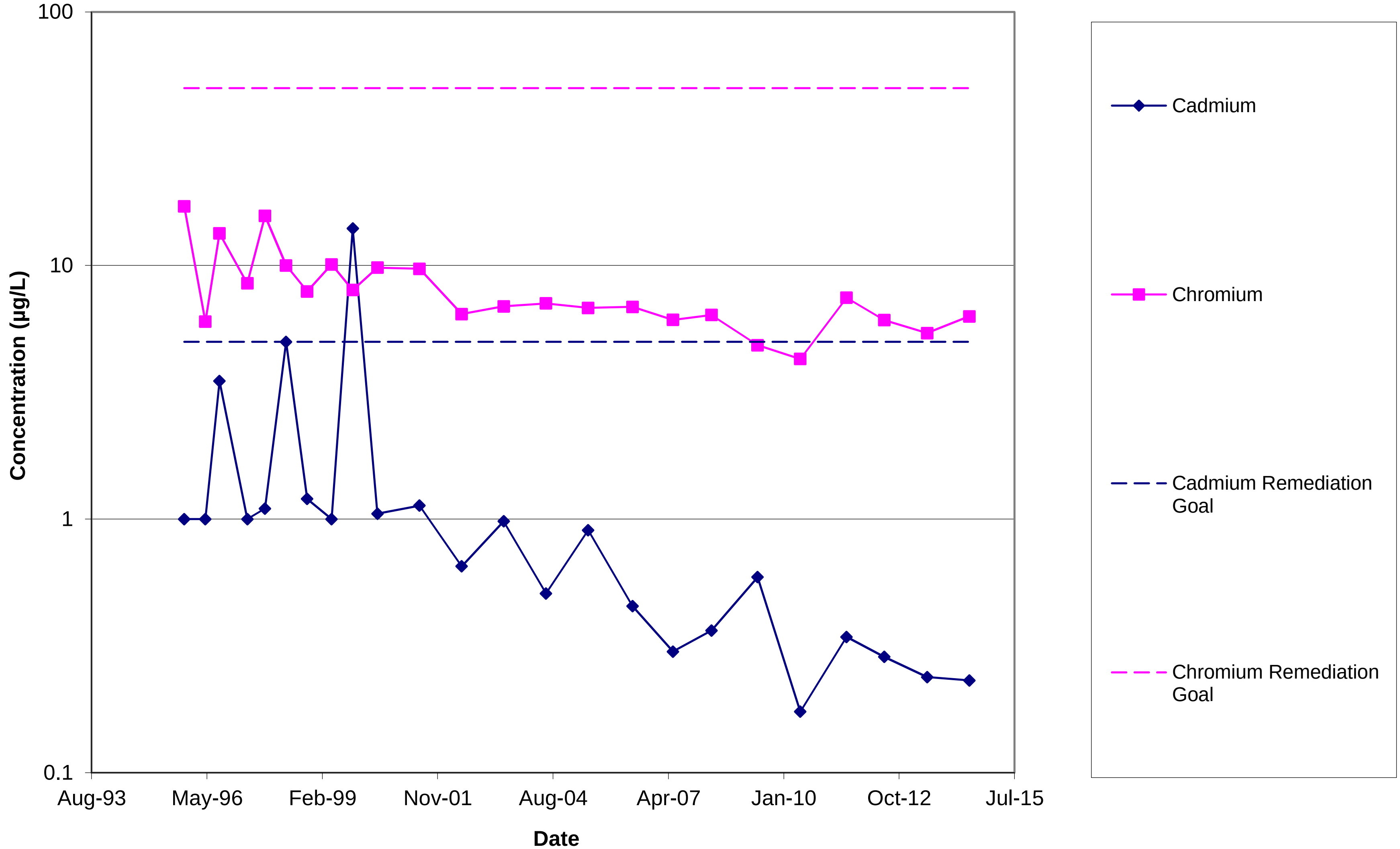


Figure D-19a. Area 8 MW8-11 VOC Trends

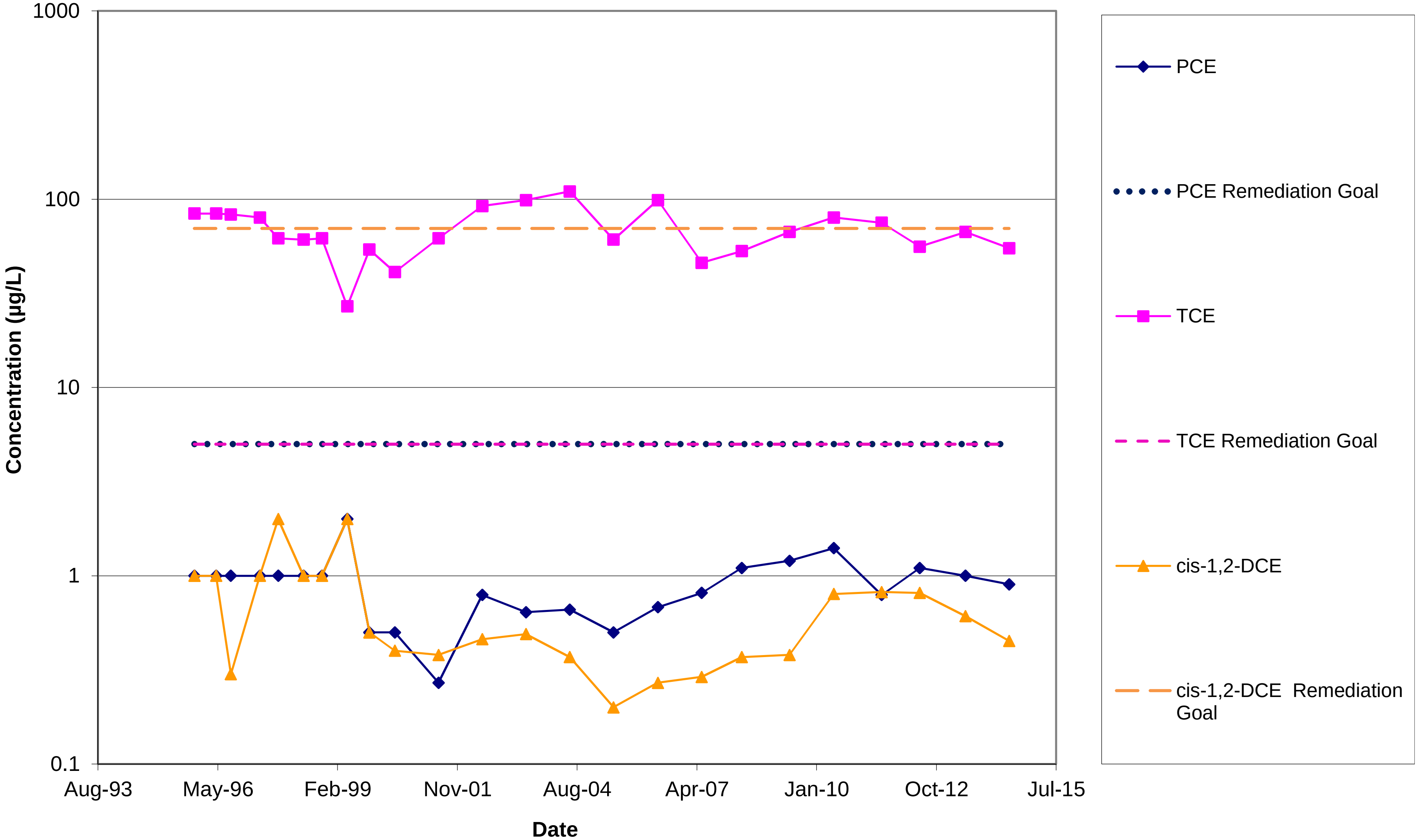


Figure D-19b. Area 8 MW8-11 Cd and Cr Concentration Trends

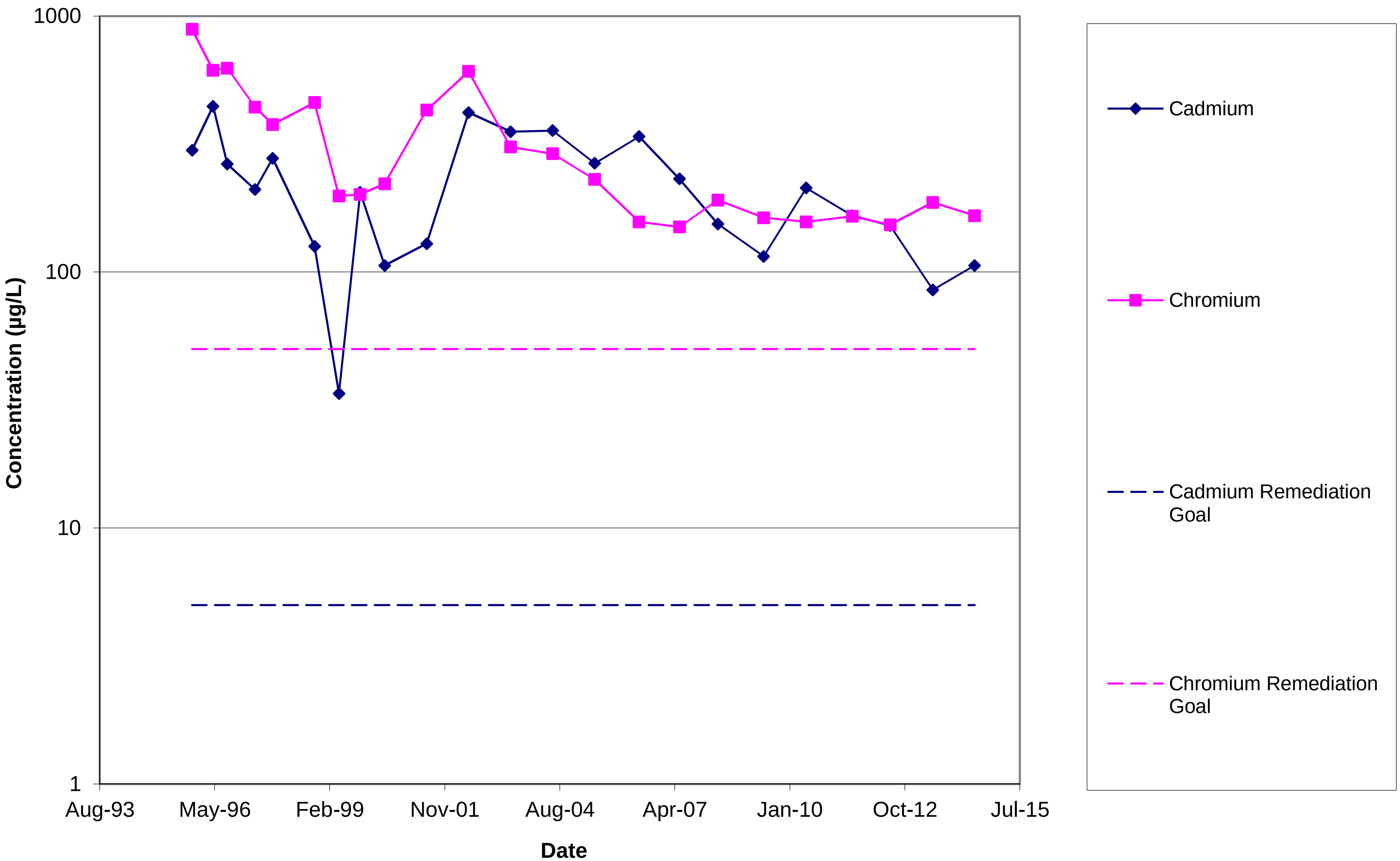


Figure D-20a. Area 8 MW8-12 VOC Trends

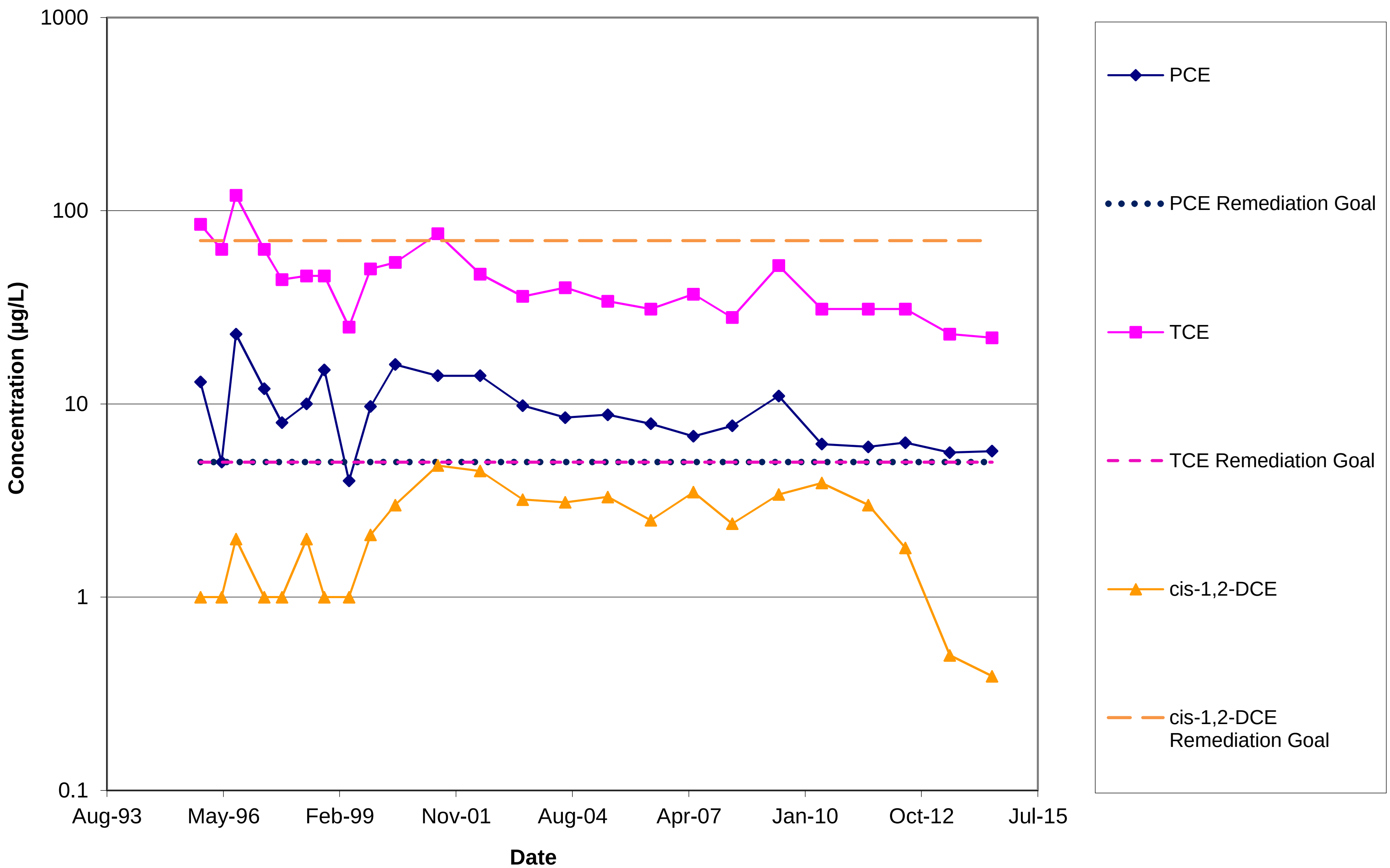


Figure D-20b. Area 8 MW8-12 Cd and Cr Concentration Trends

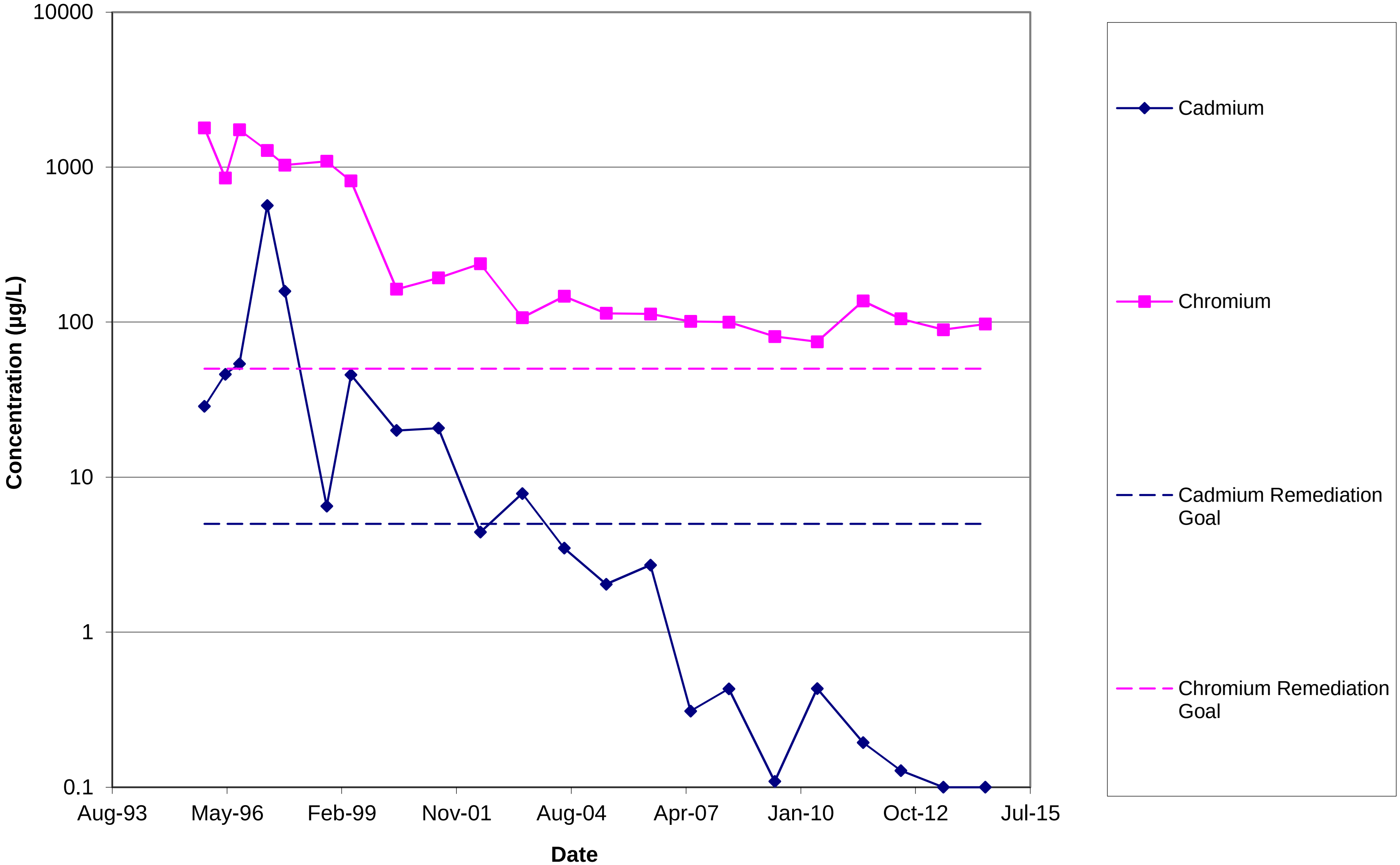


Figure D-21a. Area 8 MW8-16 VOC Trends

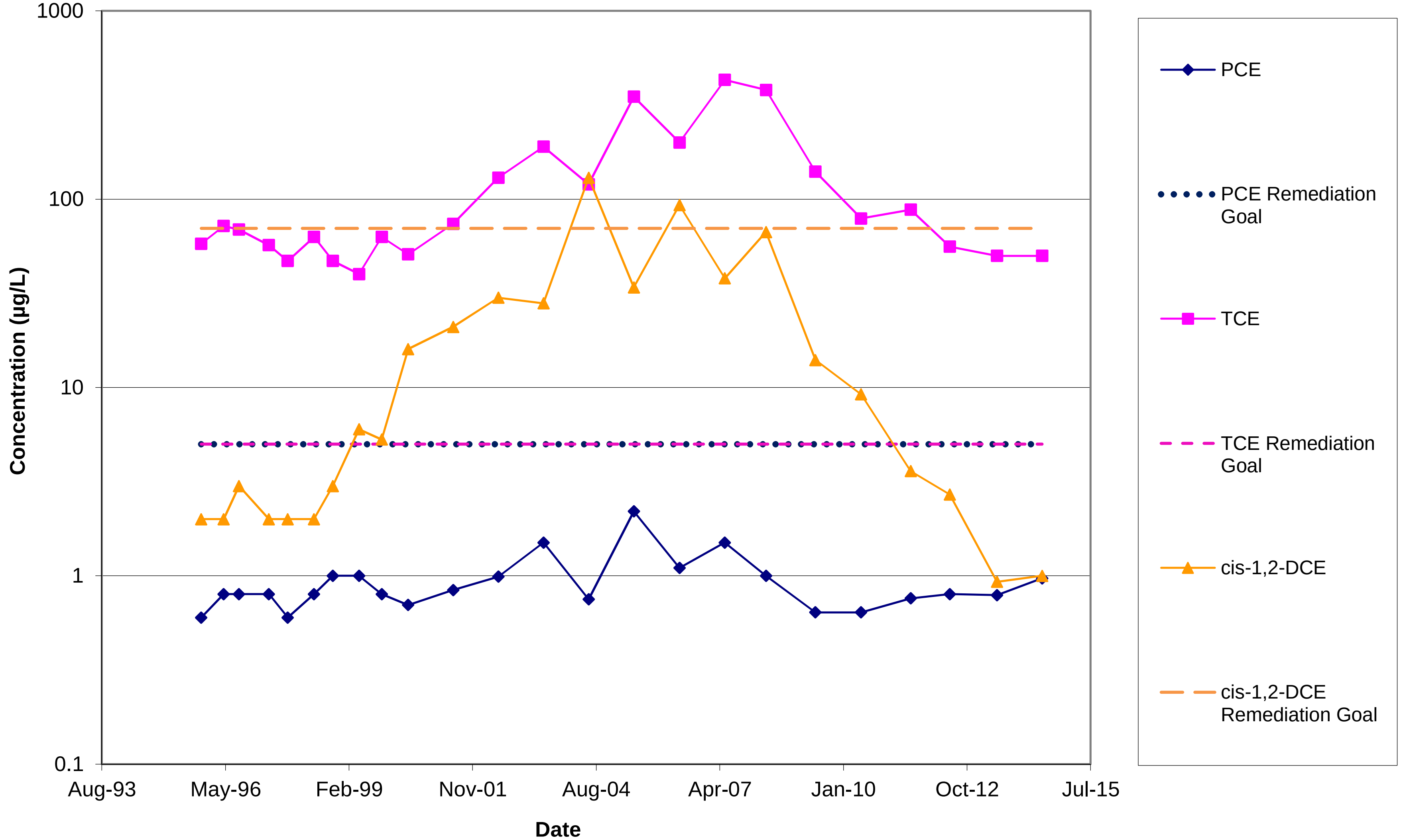


Figure D-21b. Area 8 MW8-14 Cd and Cr Concentration Trends

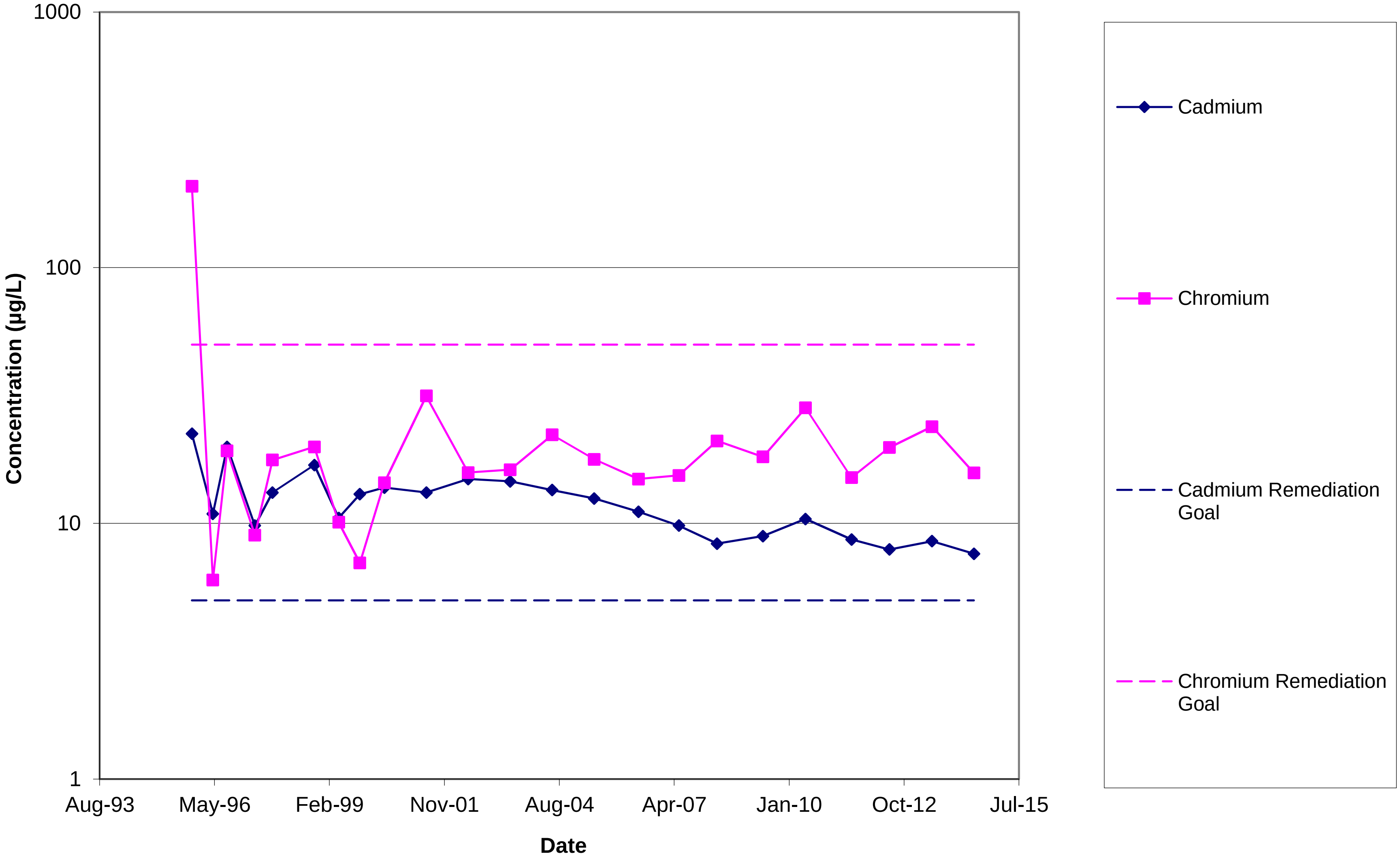


Figure D-22a. Area 8 Seep A VOC Trends

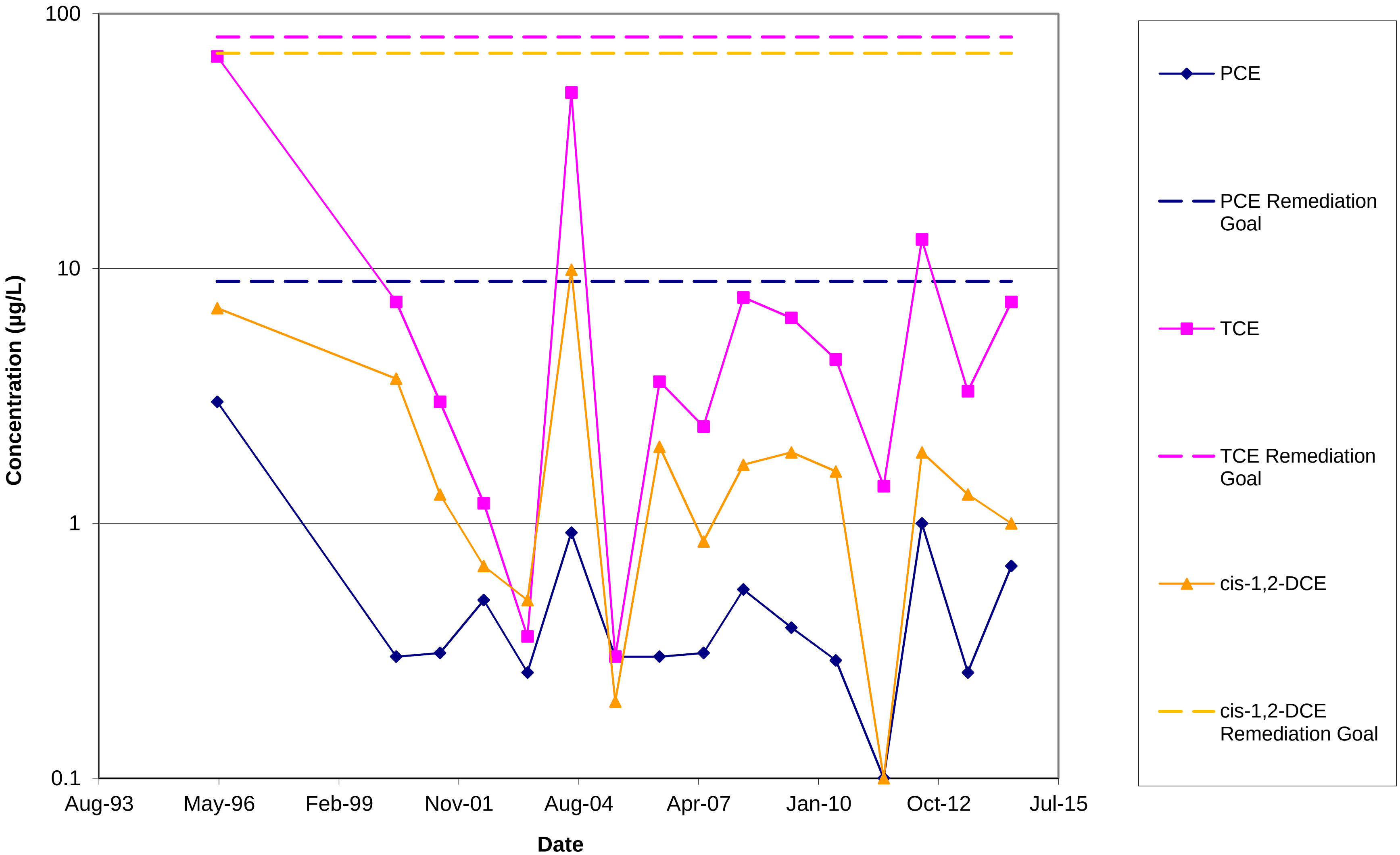


Figure D-22b. Area 8 Seep A Cd and Cr Concentration Trends

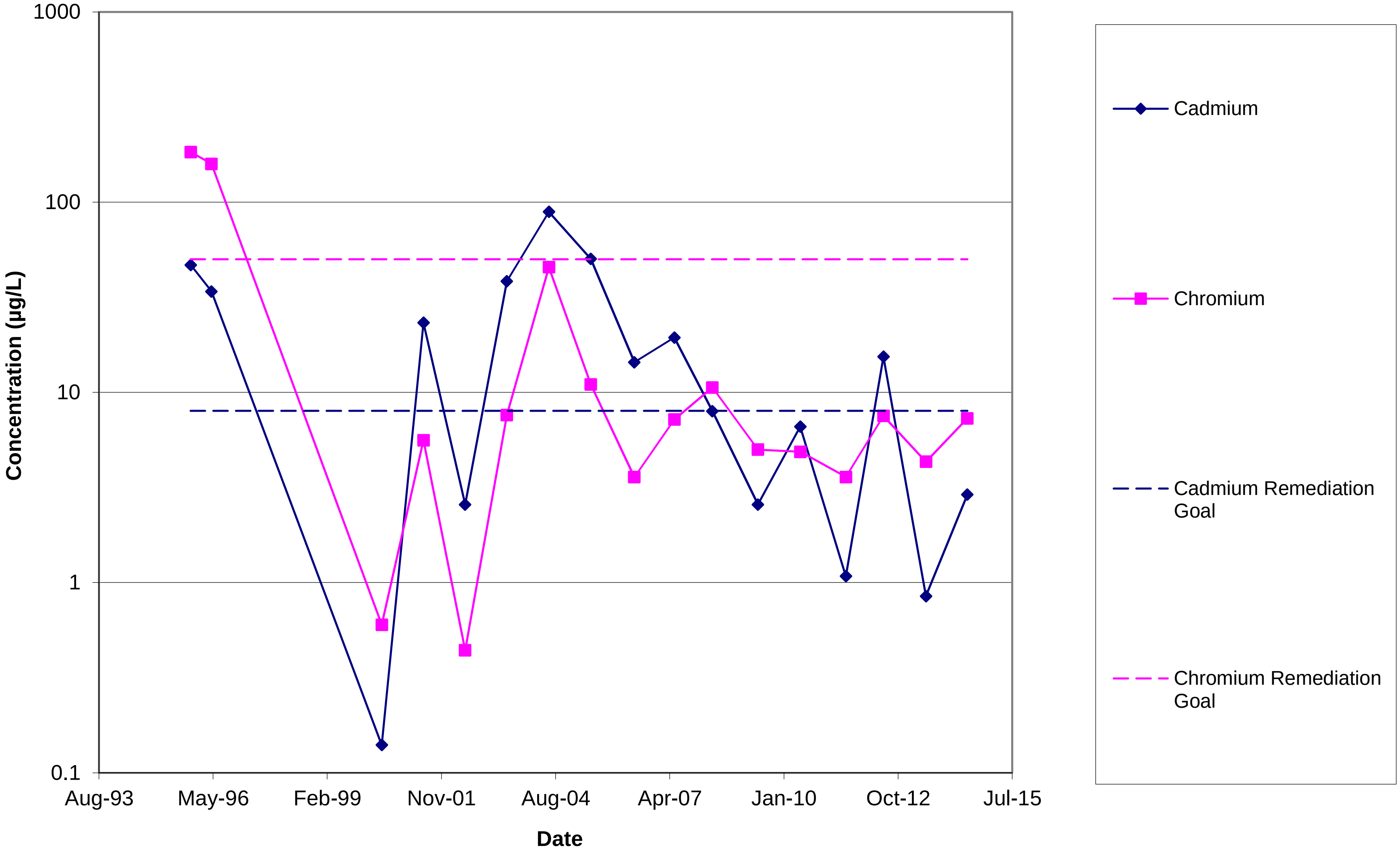


Figure D-23a. Area 8 Seep B VOC Trends

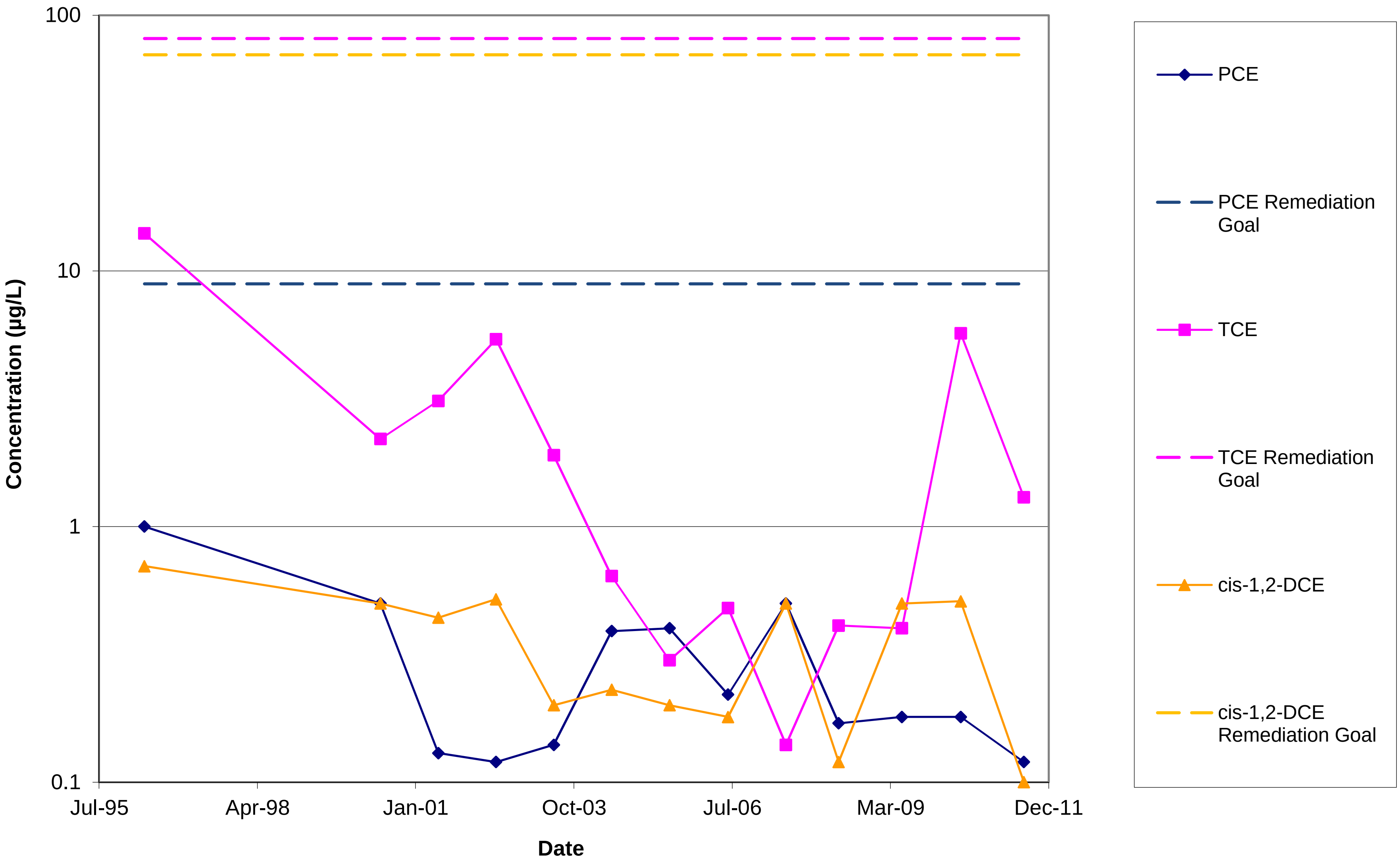


Figure D-23b. Area 8 Seep B Cd and Cr Concentration Trends

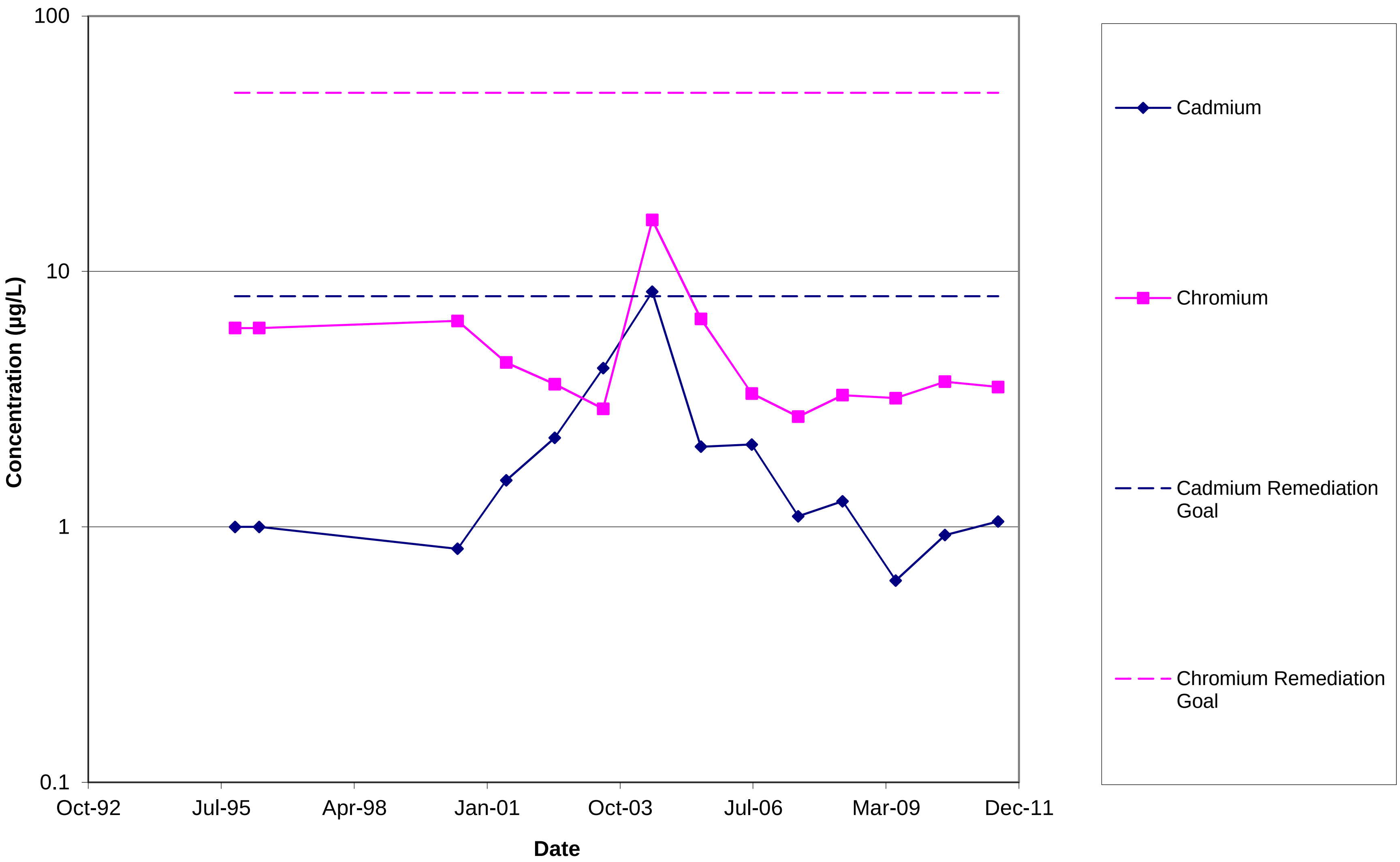


Figure D-24. Area 8 - MW8-8, MW8-11, MW8-12
1,4-Dioxane Concentration Trends

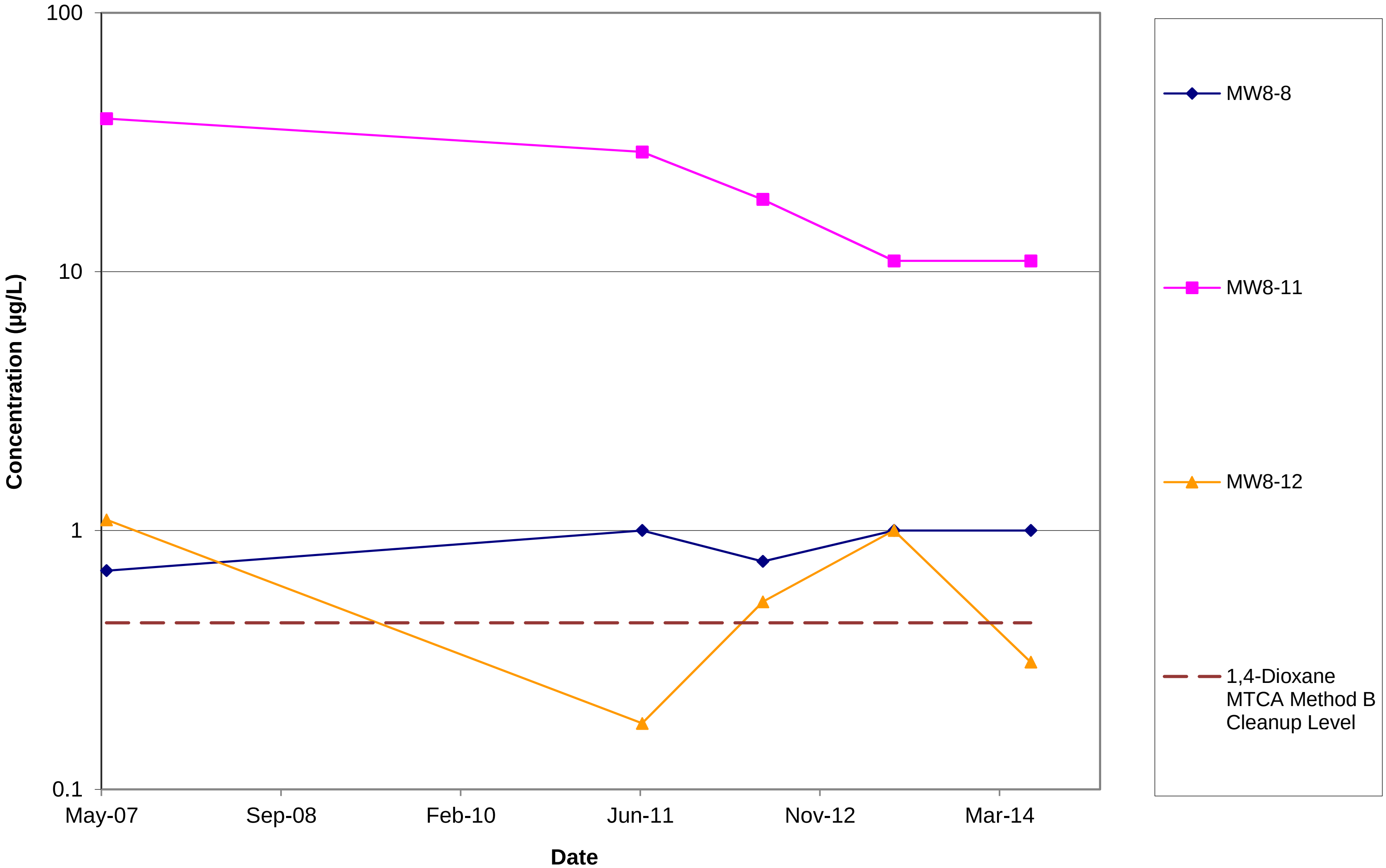


Figure D-25a. Area 8 MW8-8 VOC Trends (Last 10 Years)

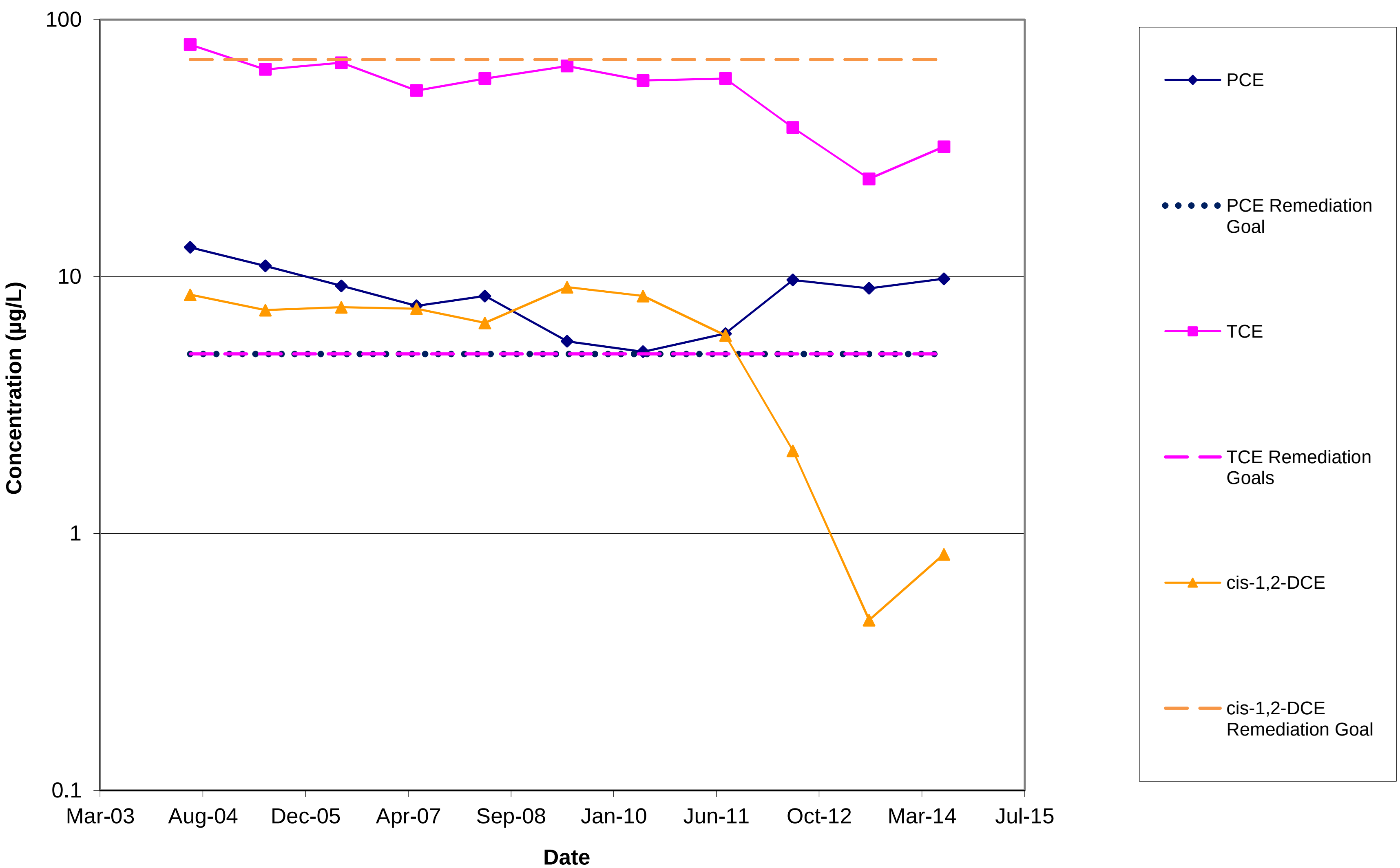


Figure D-25b. Area 8 MW8-8 Cd and Cr Concentration Trends (Last 10 Years)

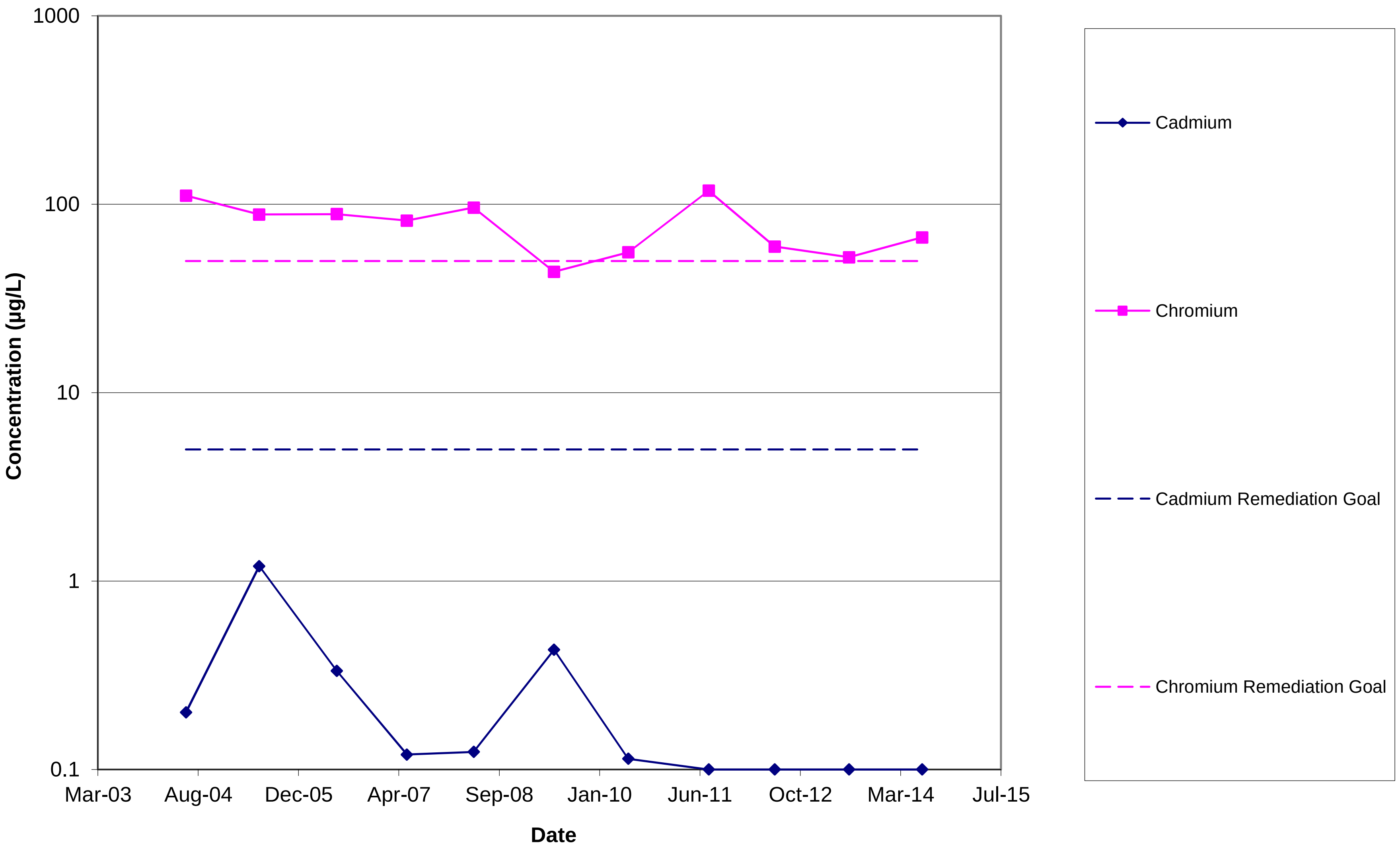


Figure D-26a. Area 8 MW8-9 VOC Trends (Last 10 Years)

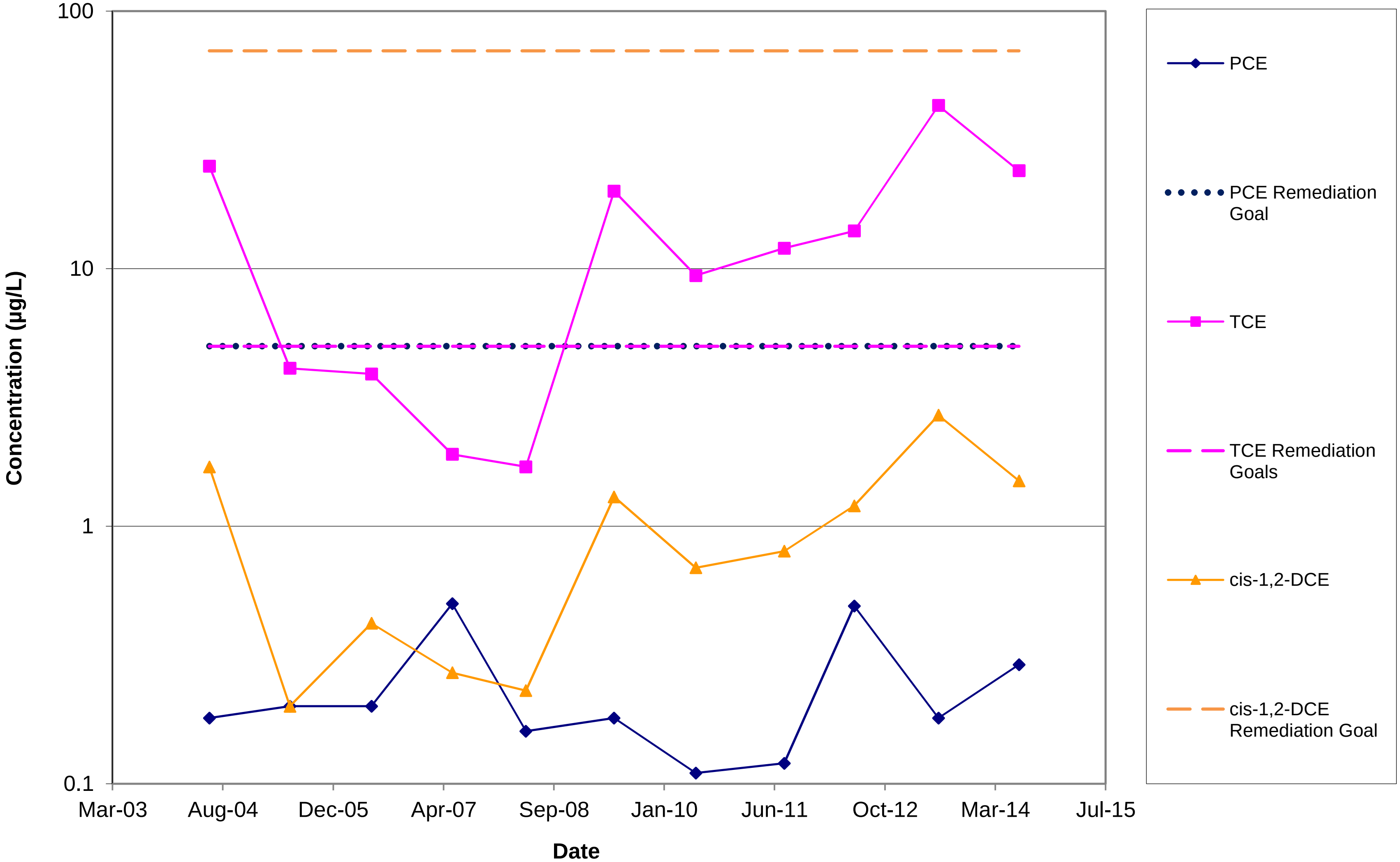


Figure D-26b. Area 8 MW8-9 Cd and Cr Concentration Trends (Last 10 Years)

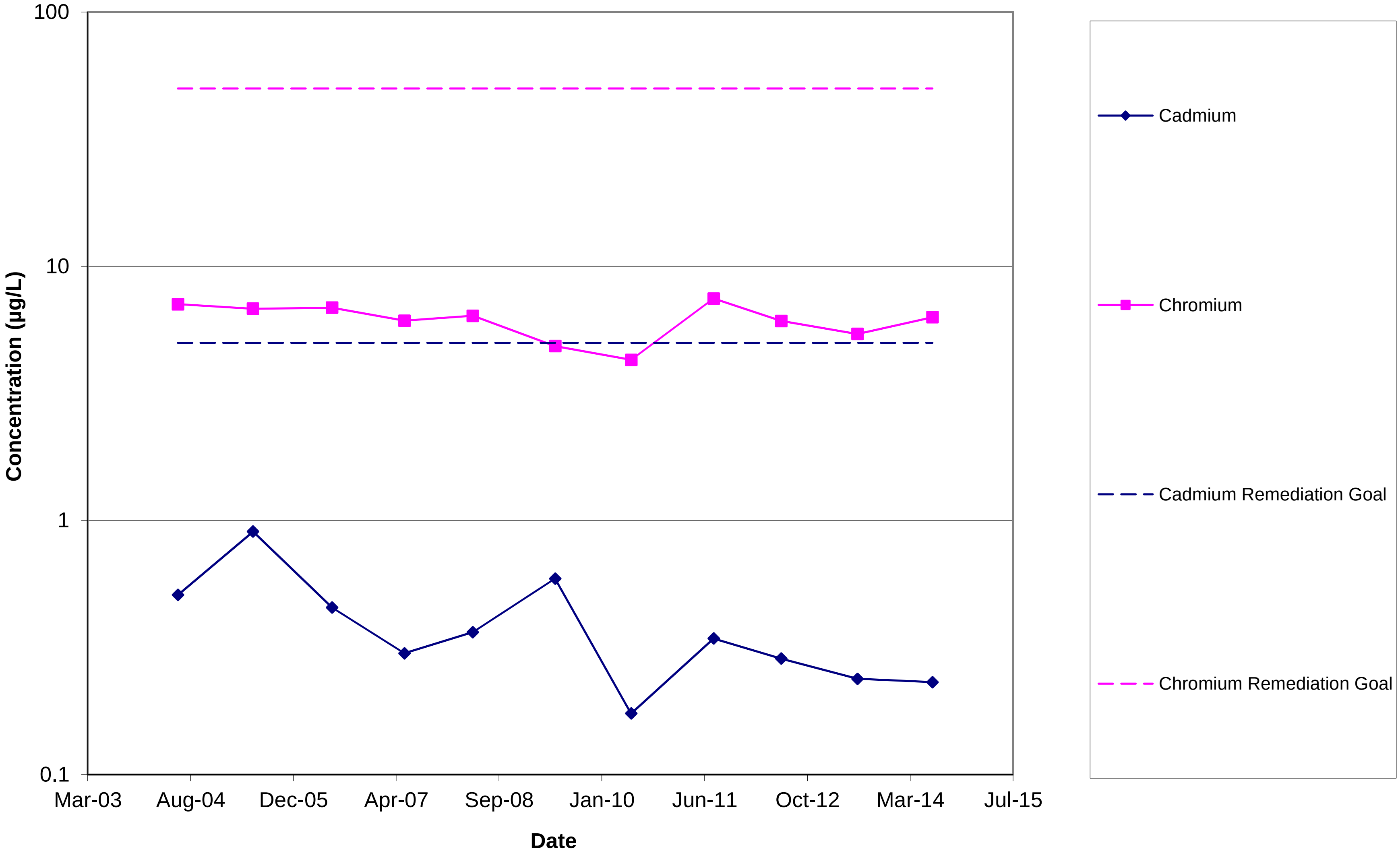


Figure D-27a. Area 8 MW8-11 VOC Trends (Last 10 Years)

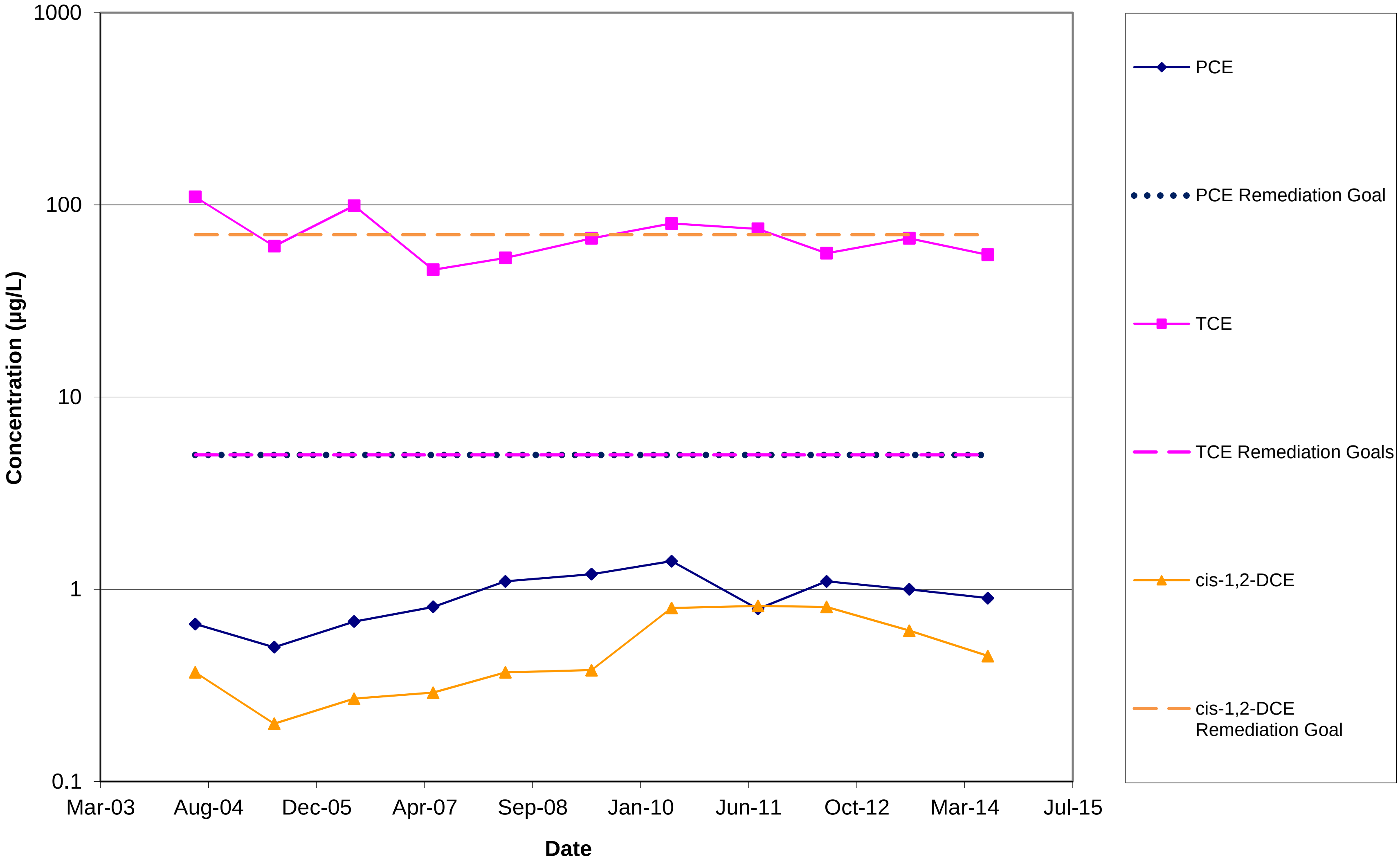
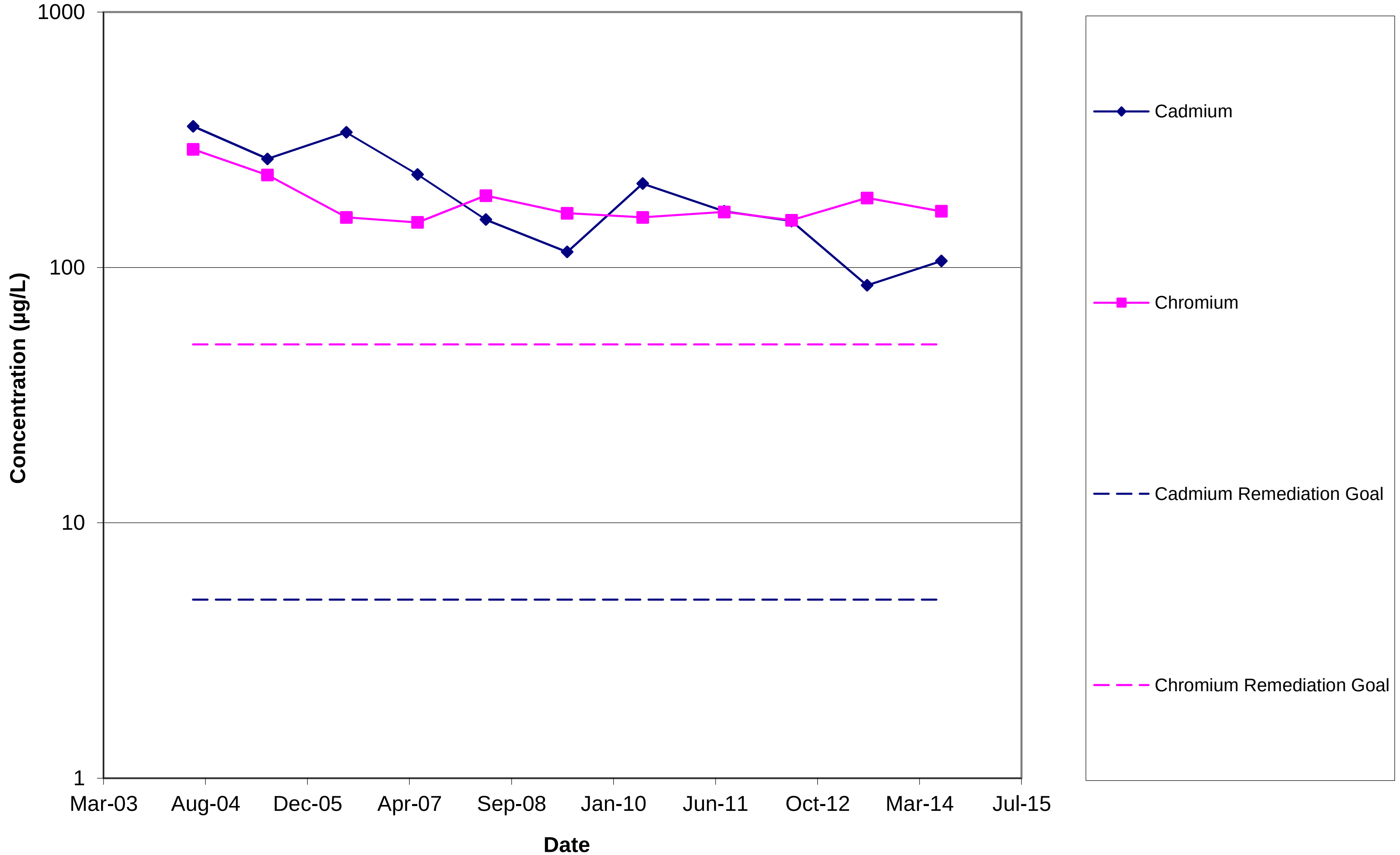


Figure D-27b. Area 8 MW8-11 Cd and Cr Concentration Trends (Last 10 Years)



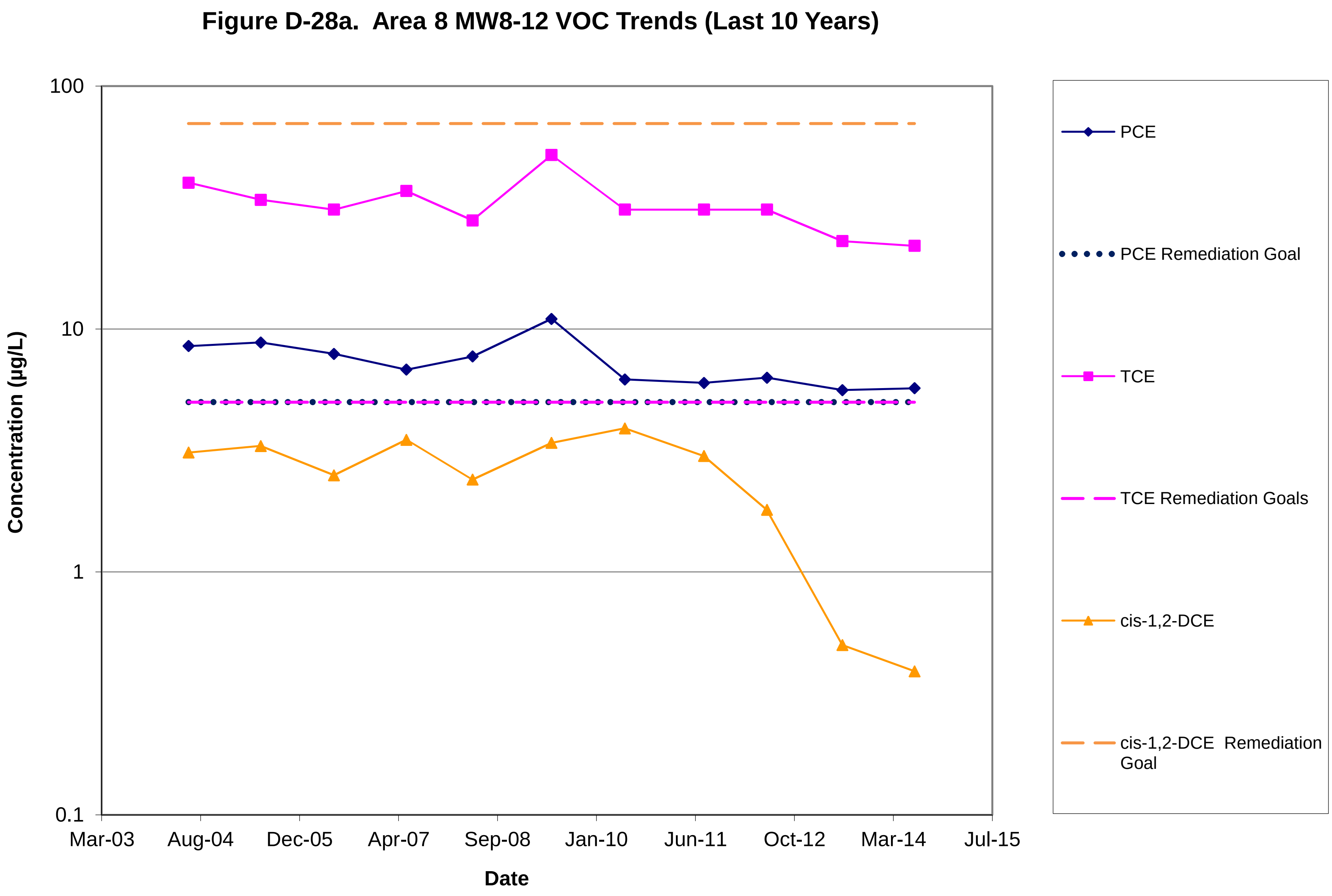


Figure D-28a. Area 8 MW8-12 VOC Trends (Last 10 Years)
100
10
1
0.1
Concentration (µg/L)
Mar-03
Aug-04
Dec-05
Apr-07
Sep-08
Jan-10
Jun-11
Oct-12
Mar-14
Jul-15
Date
PCE
PCE Remediation Goal
TCE
TCE Remediation Goals
cis-1,2-DCE
cis-1,2-DCE Remediation Goal

Figure D-28b. Area 8 MW8-12 Cd and Cr Concentration Trends (Last 10 Years)

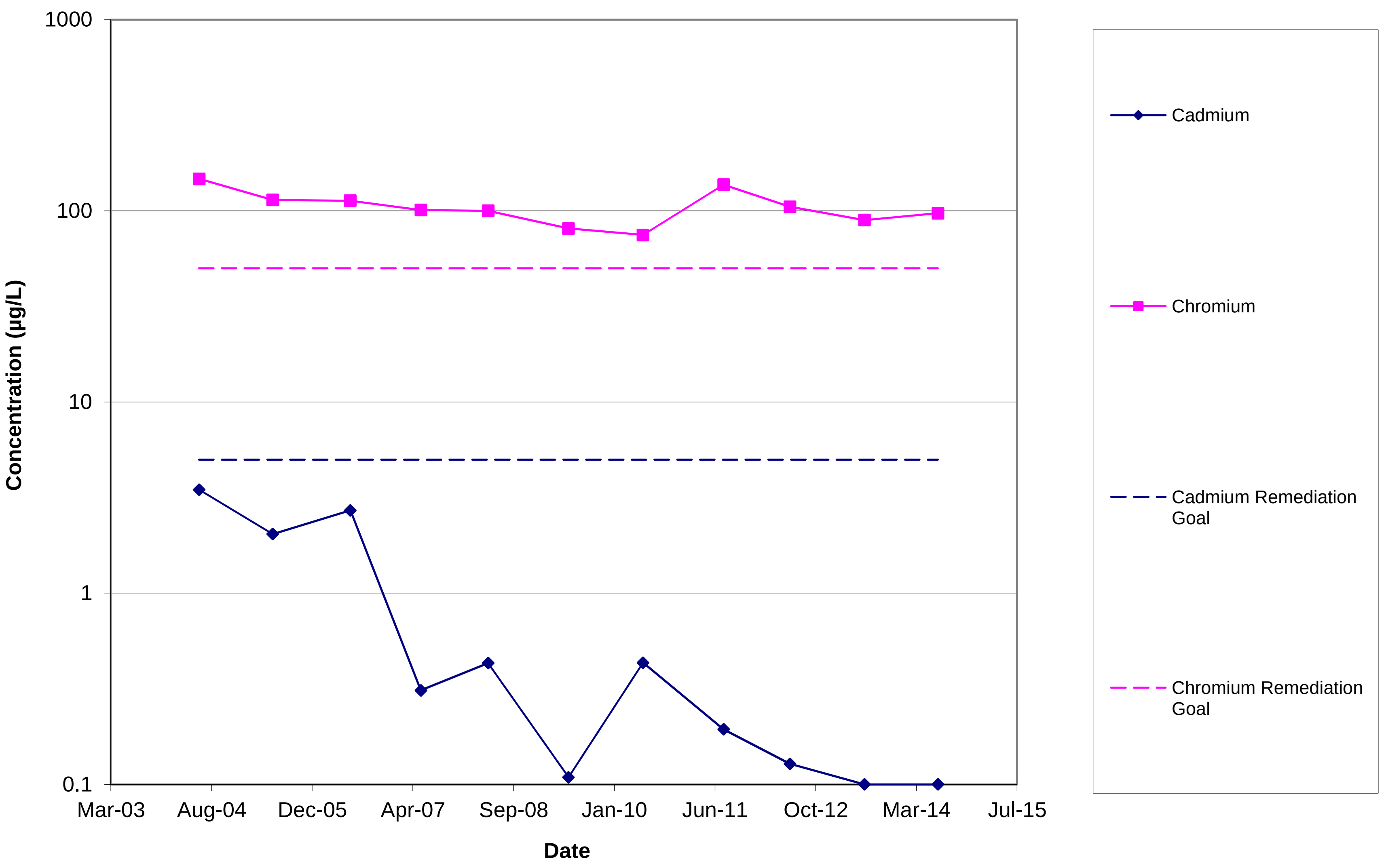


Figure D-29a. Area 8 MW8-16 VOC Trends (Last 10 Years)

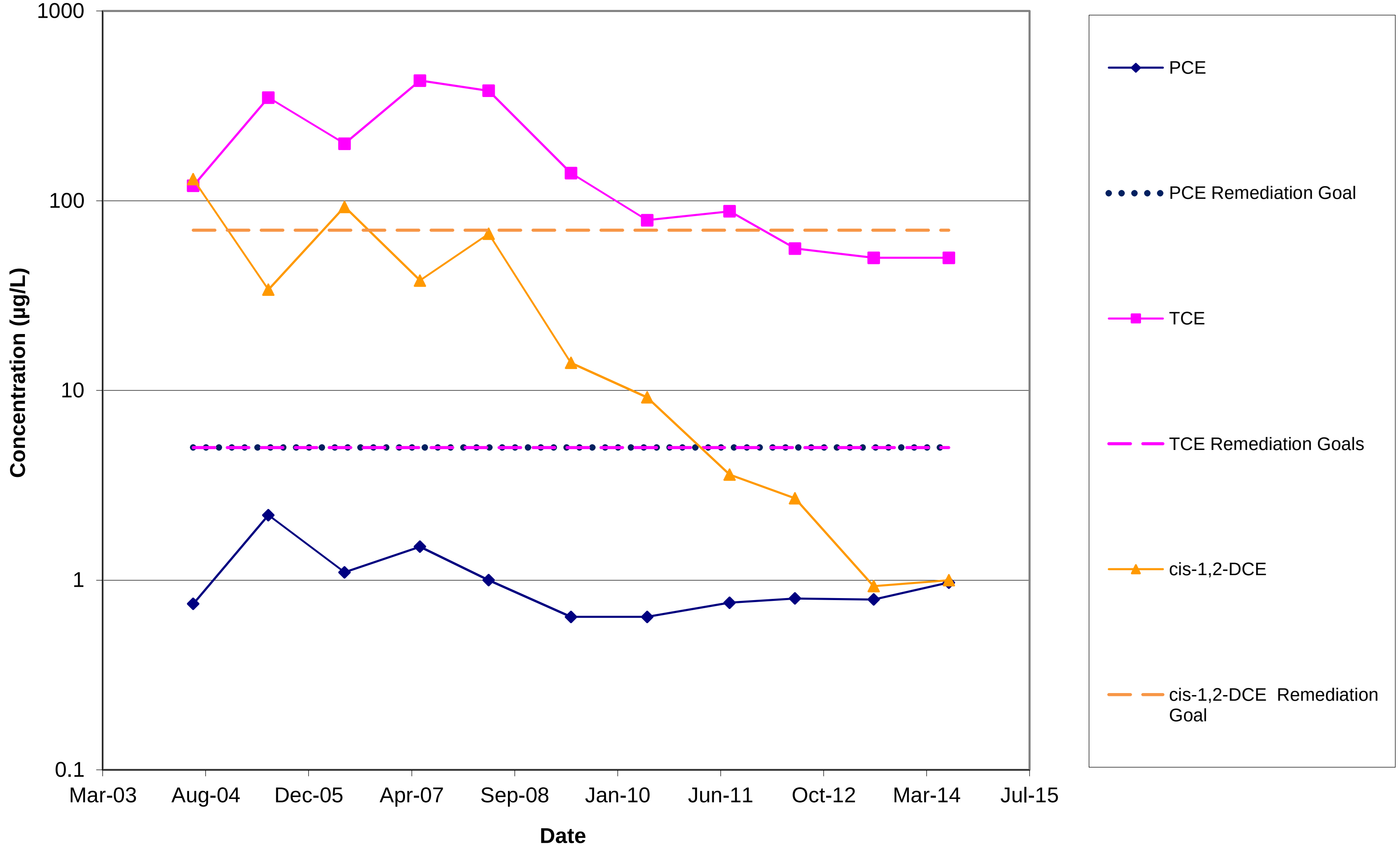


Figure D-29b. Area 8 MW8-14 Cd and Cr Concentration Trends (Last 10 Years)

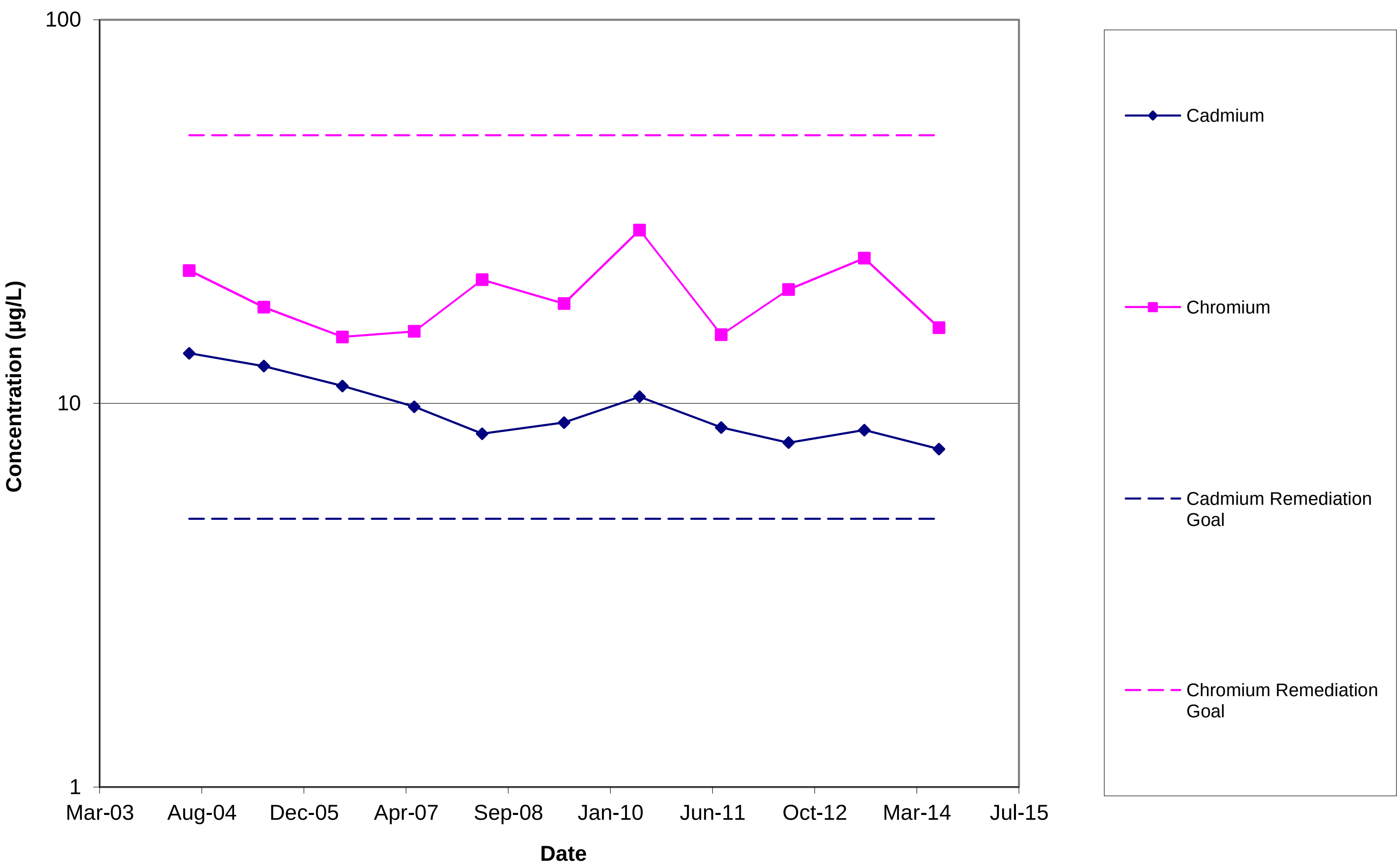


Figure D-30a. Area 8 Seep A VOC Trends (Last 10 Years)

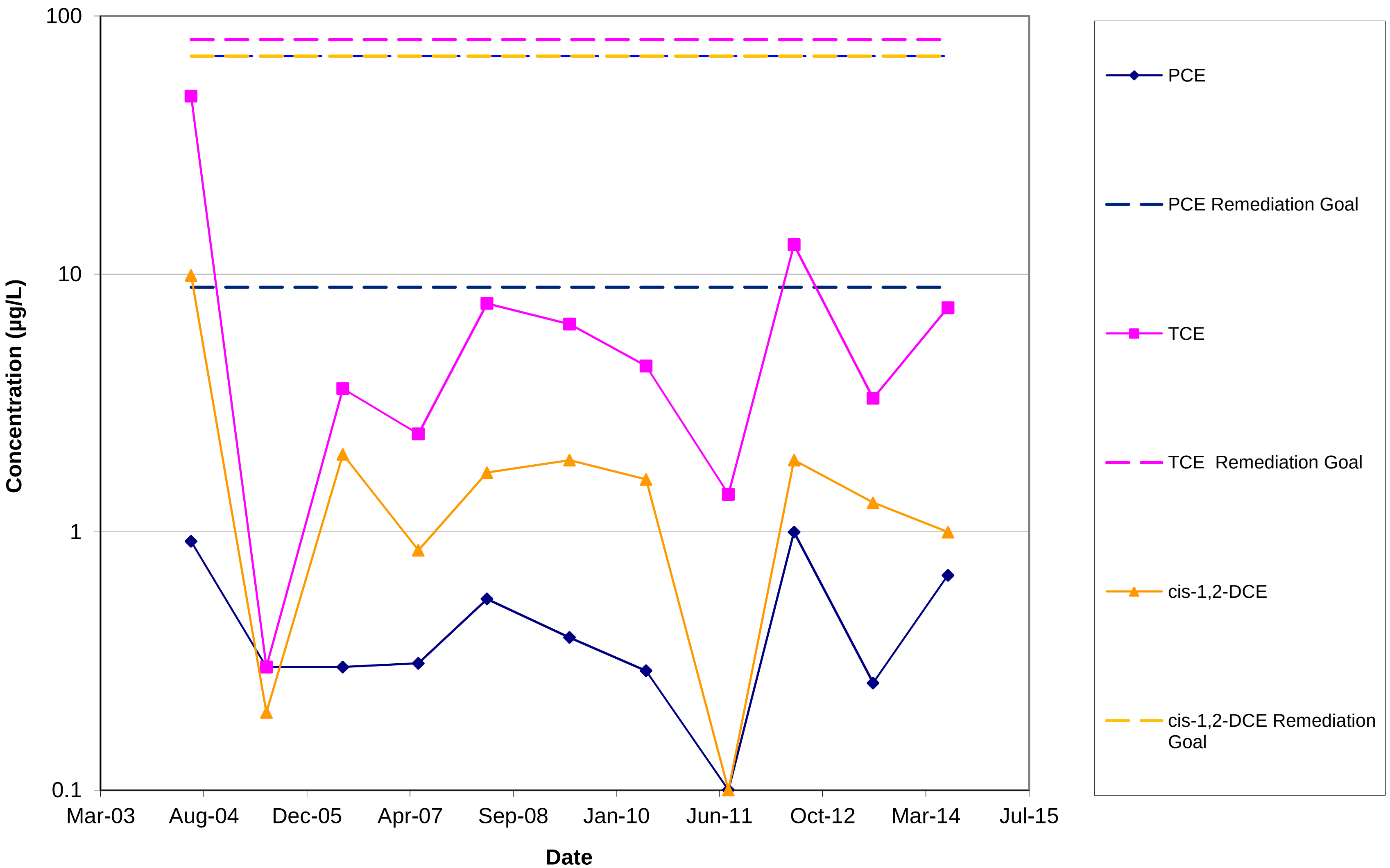


Figure D-30b. Area 8 Seep A Cd and Cr Concentration Trends (Last 10 Years)

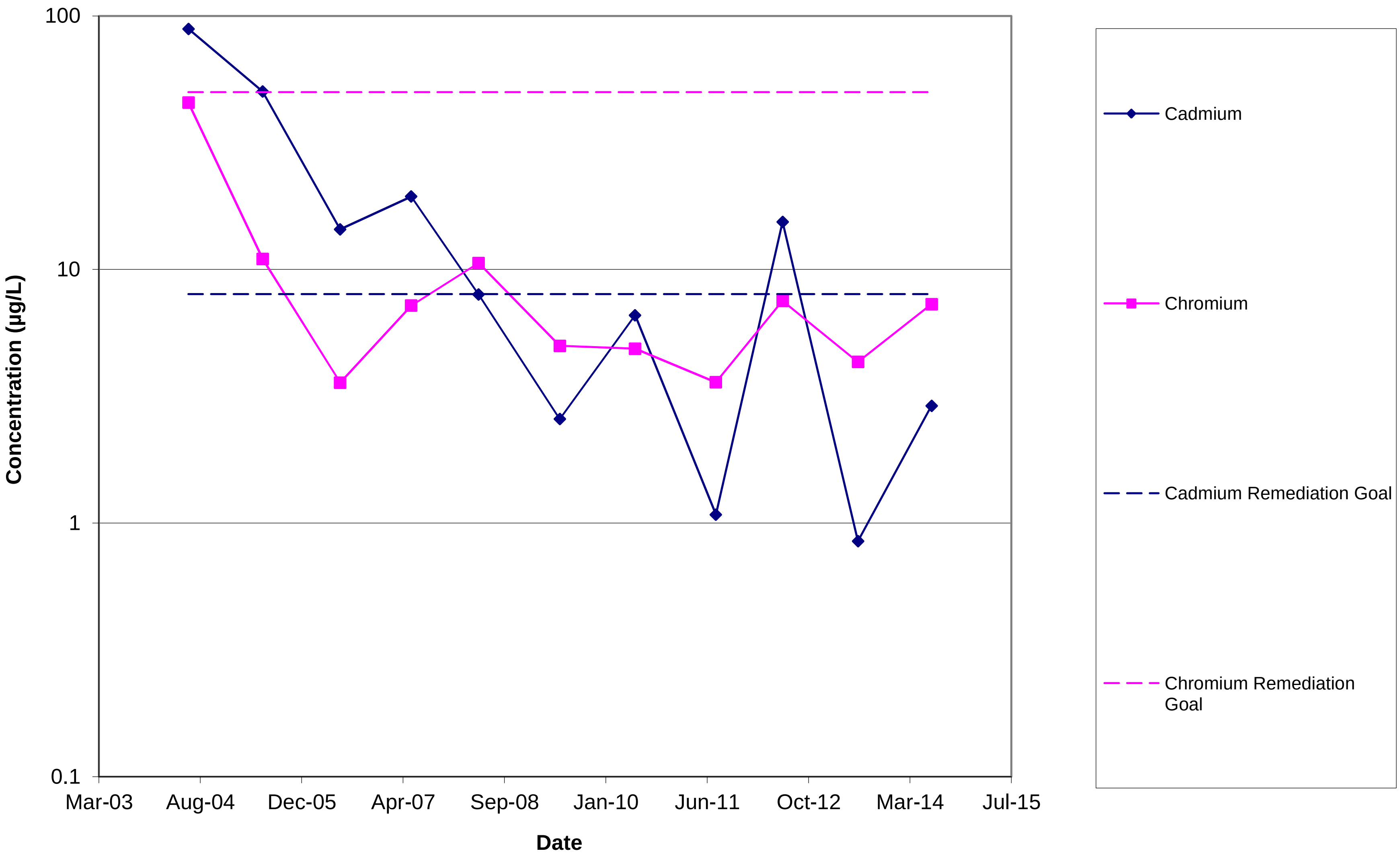


Figure D-31a. Area 8 Seep B VOC Trends (Last 10 Years)

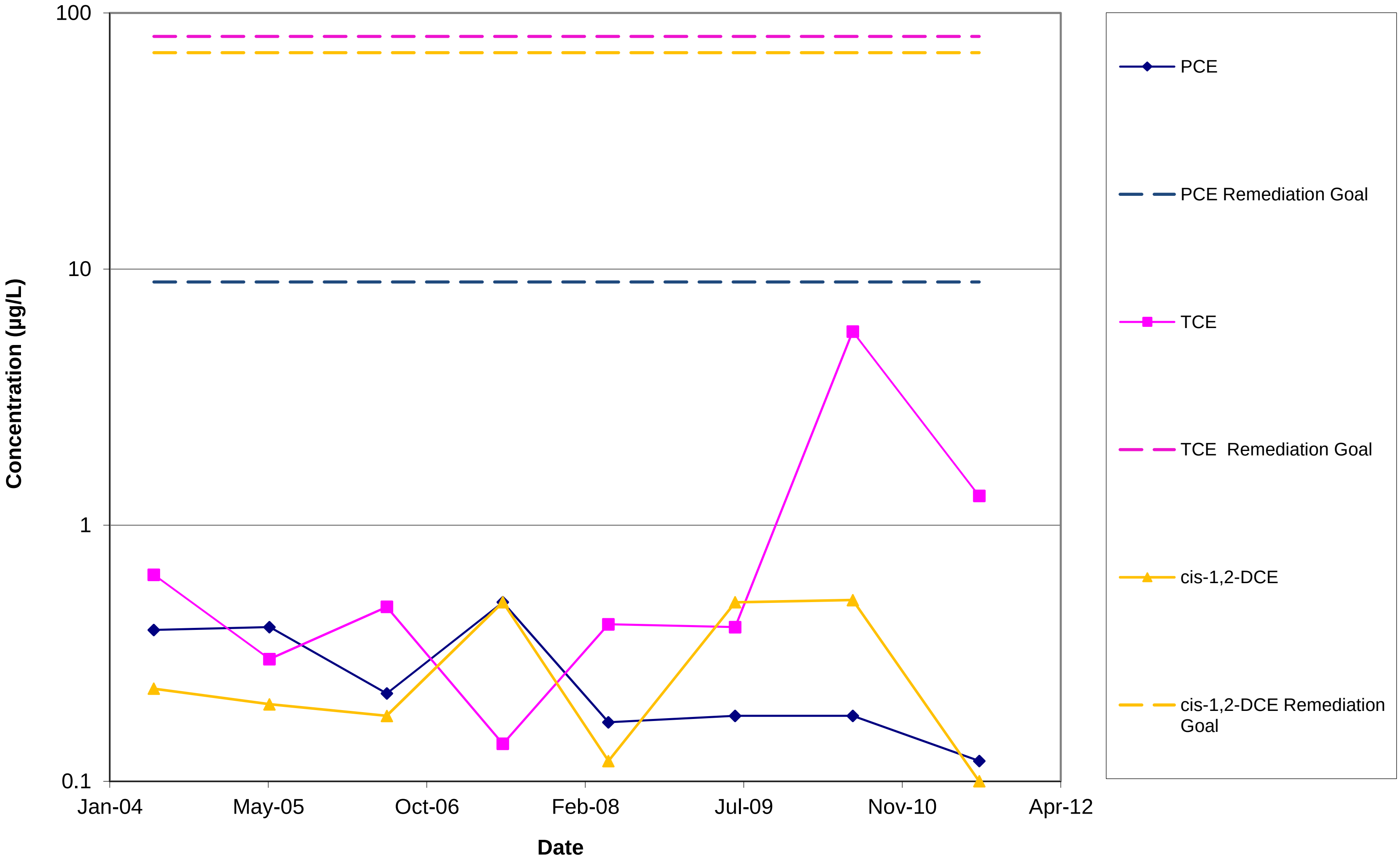
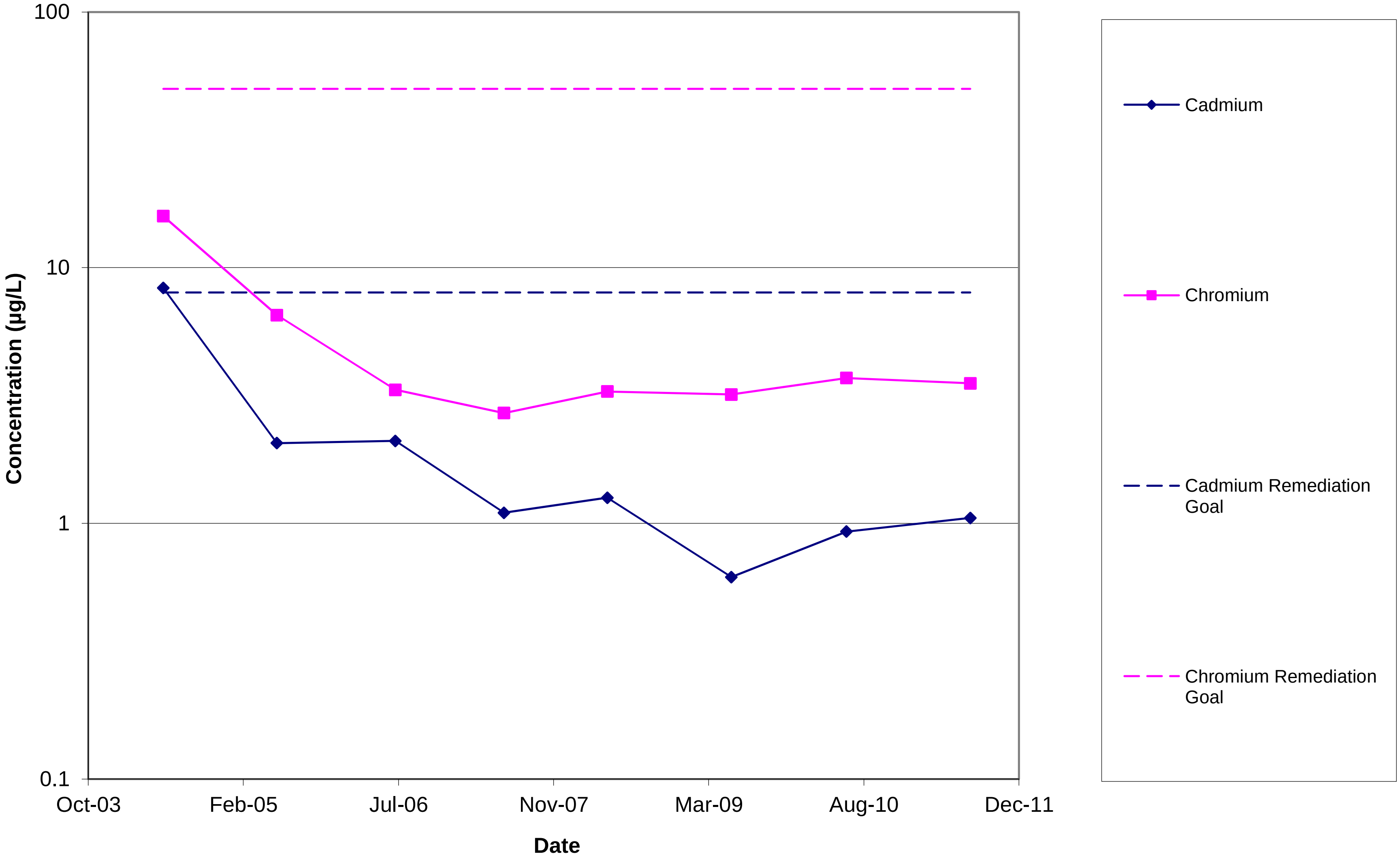


Figure D-31b. Area 8 Seep B Cd and Cr Concentration Trends (Last 10 Years)



APPENDIX E

Site Inspection Checklist

Site Inspection Checklist

I. SITE INFORMATION	
Site name: *NUWC, Division Keyport*	**Date of inspection:** 9/4/14
Location and Region: *Keyport, WA, Region 10*	**EPA ID:** *WA1170023419*
Agency, office, or company leading the five-year review: *US Navy, URS Corporation*	**Weather/temperature:** Sunny and pleasant, mid-60s

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☒ Other *Phytoremediation; Sediment and soil removal; tide gate upgrade; groundwater, sediment, and shellfish monitoring; contingent actions*
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Inspection team roster: ☒ Site map attached

- Carlotta Cellucci, NAVFAC NW
- John Blacklaw, Washington State Department of Ecology
- Michael Meyer, URS Corporation

II. INTERVIEWS (Check all that apply)

1. **Navy Staff**

Contact: Carlotta Cellucci **Title:** NAVFAC NW RPM **Date:** 12/5/14 **Phone no.:** 360-396-1518
Problems; suggestions; ☒ Report attached in Appendix F

Contact: Gary Simmons **Title:** NUWC Div. Keyport, Environmental Engineer
Date: 10/28/14 **Phone no.:** 360-315-8571
Problems; suggestions; ☒ Report attached in Appendix F

Contact: Reinout van Beynum **Title:** NUWC Div. Keyport, Sr. Environmental Engineer
Date: 10/28/14 **Phone no.:** 360-396-5435
Problems; suggestions; ☒ Report attached in Appendix F

2. **Regulatory and Tribal authorities and response agencies**

Agency: U.S. EPA
Contact: Dave Einan **Title:** Envir. Engineer/RPM **Date:** 12/12/14 **Phone no.:** 509-376-3883
Problems; suggestions; ☒ Report attached in Appendix F

Agency: Ecology
Contact: John Blacklaw **Title:** Cleanup Project Manager **Date:** 12/12/14 **Phone no.:** 360-407-6161
Problems; suggestions; ☒ Report attached in Appendix F

	Agency: Suquamish Tribe **Contact:** Denice Taylor **Title:** Environmental Scientist **Date:** 12/10/14 **Phone no.:** 360-394-8449 Problems; suggestions; ☒ Report attached in Appendix F ________________
3.	**Members of the public** **Contact:** Grant Holdcroft **Title:** Environmental Health Specialist, Kitsap Public Health District **Date:** December 2014 **Phone no.:** 360-337-5605 Problems; suggestions; ☒ Report attached in Appendix F ________________ **Contact:** Shirl Golden **Organization:** Keyport Improvement Club **Date:** December 2014 **Phone no.:** 360-779-1746 Problems; suggestions; ☒ Report attached in Appendix F________________
4.	**Other interviews** (optional) **Contact:** James Ruef **Title:** Task Manager / Quality Manager, Sealaska Environmental LLC **Date:** January 2015 **Phone no.:** 206-930-9623 Problems; suggestions; ☒ Report attached in Appendix F ________________
	III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)
1.	**O&M Records** ☒ O&M manual ☒ Readily available ☒ Up to date ☐ N/A ☒ As-built drawings ☒ Readily available ☒ Up to date ☐ N/A ☒ Maintenance logs ☒ Readily available ☒ Up to date ☐ N/A ☒ Health and Safety Plan ☒ Readily available ☒ Up to date ☐ N/A Remarks *On file at NAVFAC NW*
6.	**Institutional Controls Inspection Records** ☒ Readily available ☒ Up to date Remarks *Annual inspections conducted and reported to regulatory agencies*
	IV. O&M COSTS
1.	**O&M Organization** ☐ State in-house ☐ Contractor for State ☐ PRP in-house ☐ Contractor for PRP ☐ Federal Facility in-house ☒ Contractor for Federal Facility ☐ Other________________

2. **O&M Cost Records**
☒ Readily available ☒ Up to date
☒ Funding mechanism/agreement in place
Original O&M cost estimate $251,552 ☐ Breakdown attached

Total annual cost by year for review period if available

From (Date)	To (Date)	Total cost	
FY2010		*$299,077*	☐ Breakdown attached
FY2011		*$293,216*	☐ Breakdown attached
FY2012		*$259,321*	☐ Breakdown attached
FY2013		*$221,347*	☐ Breakdown attached
FY2014		*$263,023*	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: *None*

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. OU 1

1. **Access to landfill and plantations controlled?** ☒ Yes ☐ No
Remarks

2. **Groundwater wells installed?** ☐ Yes ☒ No
Remarks

3. **Any activities that could interfere with remedy or monitoring?** ☐ Yes ☒ No
Remarks

4. **Any permanent workers on landfill?** ☐ Yes ☒ No
Remarks

5. **Any digging in landfill without dig permit?** ☐ Yes ☒ No
Remarks

6. **Any disturbance to wetlands?** ☐ Yes ☒ No
Remarks

B. OU 2

1. **Access to Areas 2 and 8 controlled?** ☒ Yes ☐ No
Remarks

2. **Groundwater wells installed?** ☐ Yes ☒ No
Remarks

3. **Any digging without dig permit?** ☐ Yes ☒ No
Remarks

4. **Any residential development?** ☐ Yes ☒ No
Remarks

C. Site 23

1. **Asphalt paving at Site 23 still present?** ☒ Yes ☐ No
Remarks

2. **Groundwater wells installed?** ☐ Yes ☒ No
Remarks

3. **Any digging without dig permit?** ☐ Yes ☒ No
Remarks

4. **Any land use change?** ☐ Yes ☒ No
Remarks

D. Institutional Controls (ICs)

1. **Implementation and enforcement**
Site conditions imply ICs properly implemented ☒ Yes ☐ No
Site conditions imply ICs being fully enforced ☒ Yes ☐ No

Type of monitoring (*e.g.*, self-reporting, drive by) *Self*
Frequency *Annual*
Responsible party *NAVFAC NW*
Contact *Carlotta Cellucci* (Name) *RPM* (Title) *360.396.1518* (Phone no.)

Reporting is up-to-date ☒ Yes ☐ No

Specific requirements in decision documents have been met ☒ Yes ☐ No
Violations have been reported ☐ Yes ☒ No
Other problems or suggestions: ☐ Report attached

2.	**Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks______________________________	
	VI. REMEDY COMPONENTS	
A. Paved Landfill Surface		
1.	**Settlement** (Low spots) ☒ Location shown on site map ☐ Settlement not evident Areal extent__*See site map*_____ Depth____________ Remarks__*Settlement observed in south end of landfill area in vicinity north of south plantation.*	
2.	**Cracks** ☒ Location shown on site map ☐ Cracking not evident Lengths__*See site map*________ Widths__*<1 inch*____ Depths_*Not measurable*____ Remarks__*Numerous cracks in southern portion of landfill in vicinity north of south plantation. In portion paved in 2003, 8 narrow cracks observed along paving seams. Also cracking along swale adjacent to Bradley Road.*	
3.	**Erosion** ☐ Location shown on site map ☒ Erosion not evident Areal extent______________ Depth____________ Remarks______________________________	
4.	**Holes** ☒ Location shown on site map ☐ Holes not evident Areal extent__*12"*__________ Depth___*6"*_________ Remarks__*Hole, probably representing a piping failure into granular utility trench backfill, in southern portion of landfill in vicinity north of south plantation. Hole is in general vicinity of larger area of settlement.*	
5.	**Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress ☒ Trees/Shrubs (indicate size and locations on a diagram) Remarks *See phyotoremediation below*	
6.	**Alternative Cover (armored rock, concrete, etc.)** ☒ N/A Remarks______________________________	
7.	**Bulges** ☒ Location shown on site map ☐ Bulges not evident Areal extent___*10 ft x 20 ft*______ Height__*4 inches*_______ Remarks_*Tree roots south of irrigation shed causing bulging and cracking of asphalt.*	
8.	**Wet Areas/Water Damage** ☐ Wet areas/water damage not evident ☐ Wet areas ☐ Location shown on site map Areal extent______________ ☒ Ponding ☒ Location shown on site map Areal extent__*See site map*__ ☐ Seeps ☐ Location shown on site map Areal extent______________ ☐ Soft subgrade ☐ Location shown on site map Areal extent______________ Remarks__*Ponding south of irrigation shed along Bradley Road and in southern portion of landfill in area north of south plantation.*	
9.	**Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability Areal extent______________ Remarks______________________________	

10.	**Monitoring Wells** (within surface area of landfill) ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☒ Needs Maintenance ☐ N/A Remarks__*Concrete apron around wells needs to be resealed to asphalt.*
B. Surface Water Structures at Paved Landfill	
1.	**Siltation** ☐ Location shown on site map ☒ Siltation not evident Areal extent______________ Depth____________ Remarks____
2.	**Vegetative Growth** ☒ Location shown on site map ☐ N/A ☒ Vegetation does not impede flow Areal extent__*30 ft x 30 ft*_____ Type__*Alder*_____ Remarks_*Alder trees and other brush growing up through pentrations in the asphalt, primarily near old concrete foundations in southern portion of landfill.*
3.	**Erosion** ☐ Location shown on site map ☒ Erosion not evident Areal extent______________ Depth____________ Remarks____
4.	**Discharge Structure** ☒ Functioning ☐ N/A Remarks____
C. Phytoremediation	
1.	**Condition of Trees** ☐ Excellent health ☒ Some apparent health stress ☐ Severe stress observed Area of most stress___*Both plantations* Remarks: _*Leaf curl and burn observed and low leaf density compared to previous inspections.*
2.	Performance Monitoring Type of monitoring:_*Groundwater elevation and sampling*_____ Frequency _*Groundwater elevation currently collected once every 2 years; groundwater monitoring is annual in the south plantation and central landfill and once every 2 years in the north plantation* Remarks__*See text of 5-year review report*.____________________
3.	**Effectiveness** ☐ Data indicate effective uptake and metabolism of COCs ☐ Data indicate not effective ☒ Data inconclusive Remarks_*See text of 5-year review report*.____________________
D. Groundwater, Sediment, and Shellfish Monitoring	
1.	**Monitoring Wells** ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition ☒ All required wells located ☐ Needs Maintenance ☐ N/A Remarks__*Per monitoring reports.*____________________

2. **Monitoring**

Types of monitoring being conducted:

☒ Groundwater (OU 1 and OU 2) ☒ Sediment (OU 2 Area 8) ☒ Shellfish (OU 2 Area 8)

Frequency __*Varies – see text*______________________________

Remarks _*See text of 5-year review report*______________________________

3. **Data Trends**

Describe results and trends: *See text of 5-year review report*.__________________________

E. Other Remedy Components

1.	**Soil and Sediment excavations**	☒ Completed	☐ Not Completed
2.	**Contingent Remedial Action Plan**	☒ Completed	☐ Not Completed
3.	**Tide Gate Upgrade**	☒ Completed	☐ Not Completed

VII. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

_*See text of 5-year review report*______________________________

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

__*See text of 5-year review report*______________________________

C. Early Indicators of Potential Remedy Problems

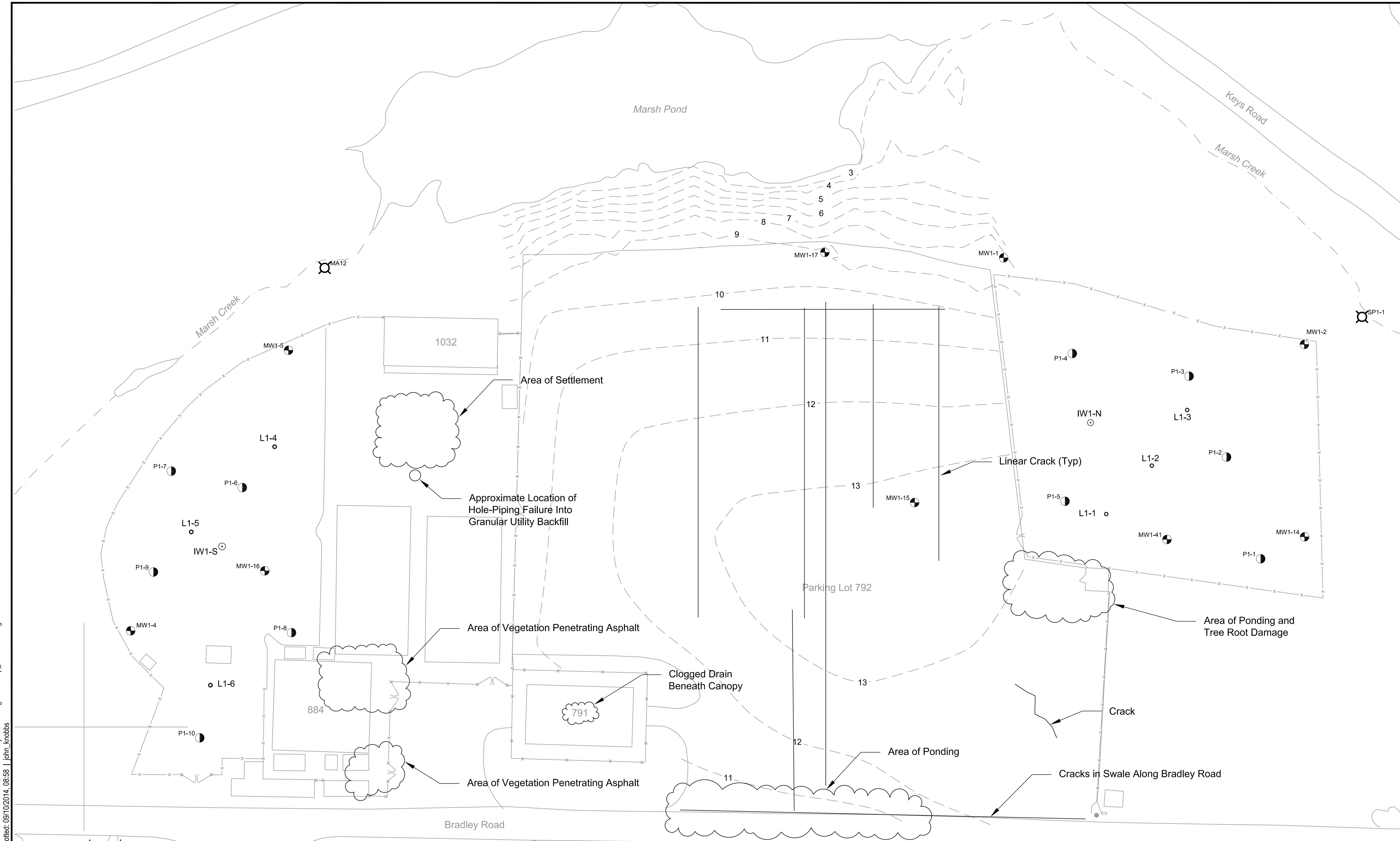
Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

___*See text of 5-year review report*_______________________________

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

__*See text of 5-year review report*______________________________



Legend:

- Piezometer
- Irrigation Well
- Monitoring Well
- Surface Water Sampling Station
- Lysimeter
- Topographic Contours (Ft NGVD 1929)

U.S. NAVY

Delivery Order 0081
Keyport, WA
FOURTH
5-YEAR REVIEW

0 30 60
SCALE IN FEET

Figure 2
Site Inspection Field Observation,
North Plantation and Central Landfill Area

APPENDIX F

Interview Responses

INTERVIEW RECORD FOR FOURTH FIVE-YEAR REVIEW
June 2009 through June 2014
Type 1 Interview – Navy Personnel
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Carlotta Cellucci
Title: Remedial Project Manager (RPM)
Organization: Naval Facilities Engineering Command, Northwest
Telephone: (360) 396-1518
E-mail: Carlotta.cellucci@navy.mil
Address: 1101 Tautog Circle
Silverdale, WA 98315

Contact made by: Heather Kabli, URS Corporation
Response type: Hard copy
Date: December 2, 2014

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Records of Decision (RODs) for Operable Units (OUs) 1 and 2 at Naval Base Kitsap (NBK) Keyport.

   Response: I have read both documents and am familiar with the contents of each.

2. Please describe your degree of familiarity with implementation of the remedies at these OUs and the monitoring and maintenance that has taken place since implementation of the remedies.

   Response: I was not with the Navy during implementation of the remedies, but am familiar with current monitoring and maintenance activities.

3. Please also describe your involvement with regard to review and comment on these actions since June 2009.

   Response: I have been the RPM for Keyport since August 9, 2013 and have reviewed all documents produced since that time. I was not involved in the project prior to that time.

4. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the primary remedy components are:

   - Phytoremediation at the former landfill using hybrid poplar trees – **The plantations are impeding migration of contaminants and reducing contaminant concentrations in concert with natural bioremediation processes.**
   - Removal of PCB-contaminated sediments from the marsh – **The removal was completed and was successful.**
   - Upgrade of the tide gate – **The tide gate is operating well and continues to detour inundation of the landfill by marine tidal waters.**
   - Upgrade and maintenance of the landfill cover – **The landfill cover was upgraded when the plantations were installed over 10 years ago. Additional upgrade and maintenance of the landfill cap is currently required.**
   - Long-term monitoring – **LTM has continued to produce usable data.**
   - Contingent actions for off-base domestic wells – **No contingent actions have been necessary, since no contamination has been detected in off-base wells.**
   - Institutional controls – **Use restrictions have been effective.**

   Response: Responses added above.

5. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the primary remedy components are:

   - Institutional controls and groundwater monitoring at Area 2 – **Results have shown steadily decreasing trends and degradation of parent compounds to daughter products. Institutional controls have been successful.**
   - Excavation and off-site disposal of vadose-zone soil at Area 8 – **Excavation of contaminated soils at Area 8 has reduced the potential for contamination of the adjoining bay.**
   - Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8. – **LTM appears to have shown the expected "bump" in contaminant levels and additional investigation and risk assessment are needed to ensure that groundwater controls are not necessary. Overall the monitoring and institutional controls have been successful at Area 8.**

   Response: Responses added above.

6. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Based on the monitoring data and the risk assessment performed to date, do you believe that additional groundwater control actions or further investigation are warranted?

   Response: Although former investigations and risk assessment have shown that there is no risk at Area 8, based on disagreement by stakeholders regarding the risk assessment methods used, additional investigation and risk assessment are needed to satisfy all stakeholders that no risk to human health or the environment exists at Area 8.

7. Are you aware of any violations of the institutional controls requirements at either of the OUs that could impact the protectiveness of this component of the remedies (e.g., unauthorized excavation, unauthorized use of groundwater)?

   Response: No

8. To the best of your knowledge, are regular inspections of the institutional controls remedy components being conducted and documented?

   Response: Yes

9. To the best of your knowledge, has the on-going environmental monitoring performed at both the OUs since June 2009 been sufficiently thorough and frequent to meet the goals of the RODs? Have the monitoring data been timely and of acceptable quality?

   Response: Yes. Yes.

10. Do you know of any significant operation and maintenance difficulties with the phytoremediation or tide gate components of the OU 1 remedy that could have impacted the protectiveness of these components of the remedy?

    Response: No; however, it is not clear whether the oil/water separator and drainage swale installed during implementation of the remedial action are being maintained.

11. The phytoremediation component of the OU 1 remedy is not operating as anticipated in the southern portion of the former landfill. The Navy has recently begun performing additional investigation to evaluate possible actions to shorten the restoration timeframe and improve the remedy

performance. What is your impression of the progress towards reassessing this component of the remedy?

Response: I think progress has been good. The investigation results have been helpful and have allowed for re-scoping of the planned Phase II investigation.

12. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

    Response: The USGS has found that intrinsic bioremediation is actively degrading the contaminants of concern at Area 1. Since no current risk to human health or the environment exists at Area 1, I believe that bioremediation is effective.

13. Are you aware of any community concerns regarding implementation of the remedies either OU? If so, please give details.

    Response: No.

14. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at NBK Keyport?

    Response: No.

INTERVIEW RECORD FOR FOURTH FIVE-YEAR REVIEW
June 2009 through June 2014
Type 1 Interview – Navy Personnel
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Gary Simmons
Title: Environmental Engineer
Organization: NUWC Div. Keyport
Telephone: 360-315-8571
E-mail: gary.d.simmons@navy.mil
Address: Naval Undersea Warfare Center Division, Keyport
610 Dowell Street
Keyport, WA 98345

Contact made by: Heather Kabli, URS Corporation
Response type: letter
Date: 10/28/14

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Records of Decision (RODs) for Operable Units (OUs) 1 and 2 at Naval Base Kitsap (NBK) Keyport.

   Response: NONE

2. Please describe your degree of familiarity with implementation of the remedies at these OUs and the monitoring and maintenance that has taken place since implementation of the remedies.

   Response: Had a very limited role in providing contractor oversight in maintenance of the phytoremediation and the construction of the landfill cover as a NTR for NAVFAC NW

3. Please also describe your involvement with regard to review and comment on these actions since June 2009.

   Response: NONE

4. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the primary remedy components are:
   - Phytoremediation at the former landfill using hybrid poplar trees
   - Removal of PCB-contaminated sediments from the marsh
   - Upgrade of the tide gate

- Upgrade and maintenance of the landfill cover
- Long-term monitoring
- Contingent actions for off-base domestic wells
- Institutional controls

Response: Haven't been actively involved in dealing with the effectiveness of the remedy.

5. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the primary remedy components are:
   - Institutional controls and groundwater monitoring at Area 2
   - Excavation and off-site disposal of vadose-zone soil at Area 8
   - Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

   Response: NONE

6. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Based on the monitoring data and the risk assessment performed to date, do you believe that additional groundwater control actions or further investigation are warranted?

   Response: NONE

7. Are you aware of any violations of the institutional controls requirements at either of the OUs that could impact the protectiveness of this component of the remedies (e.g., unauthorized excavation, unauthorized use of groundwater)?

   Response: NONE

8. To the best of your knowledge, are regular inspections of the institutional controls remedy components being conducted and documented?

   Response: NONE

9. To the best of your knowledge, has the on-going environmental monitoring performed at both the OUs since June 2009 been sufficiently thorough and frequent to meet the goals of the RODs? Have the monitoring data been timely and of acceptable quality?

   Response: NONE

10. Do you know of any significant operation and maintenance difficulties with the phytoremediation or tide gate components of the OU 1 remedy that could have impacted the protectiveness of these components of the remedy?

Response: NONE

11. The phytoremediation component of the OU 1 remedy is not operating as anticipated in the southern portion of the former landfill. The Navy has recently begun performing additional investigation to evaluate possible actions to shorten the restoration timeframe and improve the remedy performance. What is your impression of the progress towards reassessing this component of the remedy?

Response: NONE

12. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

Response: NONE

13. Are you aware of any community concerns regarding implementation of the remedies either OU? If so, please give details.

Response: NONE

14. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at NBK Keyport?

Response: NONE

INTERVIEW RECORD FOR FOURTH FIVE-YEAR REVIEW
June 2009 through June 2014
Type 1 Interview – Navy Personnel
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Reinout van Beynum
Title: Sr. Envir. Engr
Organization: NWWC, Keyport
Telephone: 360-396-5435
E-mail: reinout.vanbeynum@navy.mil
Address: 610 Dowell St
C/1023 Bldg 1051
Keyport, WA 98345
Contact made by: **Heather Kabli, URS Corporation**
Response type:
Date:

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Records of Decision (RODs) for Operable Units (OUs) 1 and 2 at Naval Base Kitsap (NBK) Keyport.

   Response: Fairly familiar - I was involved with the development and reviewed them but that was 15 years ago

2. Please describe your degree of familiarity with implementation of the remedies at these OUs and the monitoring and maintenance that has taken place since implementation of the remedies.

   Response: I know what has been accomplished but have not reviewed any monitoring results

3. Please also describe your involvement with regard to review and comment on these actions since June 2009.

   Response: No involvement since about 1999

4. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the primary remedy components are:
   - Phytoremediation at the former landfill using hybrid poplar trees
   - Removal of PCB-contaminated sediments from the marsh
   - Upgrade of the tide gate

- Upgrade and maintenance of the landfill cover
- Long-term monitoring
- Contingent actions for off-base domestic wells
- Institutional controls

Response: From what I've heard, it is all working as expected - some of what I've just read is a surprise

5. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the primary remedy components are:
   - Institutional controls and groundwater monitoring at Area 2
   - Excavation and off-site disposal of vadose-zone soil at Area 8
   - Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

   Response: same as #4

6. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Based on the monitoring data and the risk assessment performed to date, do you believe that additional groundwater control actions or further investigation are warranted?

   Response: further investigation to gather more data so a scientifically justifyable control action can be determined

7. Are you aware of any violations of the institutional controls requirements at either of the OUs that could impact the protectiveness of this component of the remedies (e.g., unauthorized excavation, unauthorized use of groundwater)?

   Response: No, and I should know because making sure violations do not occur is part of my job

8. To the best of your knowledge, are regular inspections of the institutional controls remedy components being conducted and documented?

   Response: yes, by the RPM

9. To the best of your knowledge, has the on-going environmental monitoring performed at both the OUs since June 2009 been sufficiently thorough and frequent to meet the goals of the RODs? Have the monitoring data been timely and of acceptable quality?

   Response: To the best of my knowledge, yes - but RPM records should reflect this

10. Do you know of any significant operation and maintenance difficulties with the phytoremediation or tide gate components of the OU 1 remedy that could have impacted the protectiveness of these components of the remedy?

Response: No

11. The phytoremediation component of the OU 1 remedy is not operating as anticipated in the southern portion of the former landfill. The Navy has recently begun performing additional investigation to evaluate possible actions to shorten the restoration timeframe and improve the remedy performance. What is your impression of the progress towards reassessing this component of the remedy?

Response: I have not been involved and have seen neither the data (test results) or possible actions

12. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

Response: I have not seen the USGS studies so cannot comment

13. Are you aware of any community concerns regarding implementation of the remedies either OU? If so, please give details.

Response: No

14. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at NBK Keyport?

Response: No

INTERVIEW RECORD FOR FOURTH FIVE-YEAR REVIEW
June 2009 through June 2014
Type 2 Interview – Regulatory Agency
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: John Blacklaw, P.E. John Blacklaw
Title: Cleanup Project Manager
Organization: Washington Department of Ecology
Telephone: (360)407-6161
E-mail: john.blacklaw@ecy.wa.gov
Address: 300 Desmond Dr. SE, Lacey, WA 98503

Contact made by: Heather Kabli, URS Corporation
Response type:
Date: December 12, 2014

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Records of Decision (RODs) for Operable Units (OUs) 1 and 2 at Naval Base Kitsap (NBK) Keyport.

   Response: Very familiar.

2. Please describe your degree of familiarity with implementation of the remedies at these OUs and the monitoring and maintenance that has taken place since implementation of the remedies.

   Response: For OU2, Area 8: Very familiar.

3. Please also describe your involvement with regard to review and comment on these actions since June 2009.

   Response: I have represented Ecology on this site since January 2012.

4. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the remedy primary components are:
   - Phytoremediation at the former landfill using hybrid poplar trees
   - Removal of PCB-contaminated sediments from the marsh

- Upgrade of the tide gate
- Upgrade and maintenance of the landfill cover
- Long-term monitoring
- Contingent actions for off-base domestic wells
- Institutional controls

Response: It is generally accepted by the stakeholders that phytoremediation and intrinsic bioremediation are intimately connected, operating together and are not adequately effective to reduce the groundwater concentrations of TCE and daughter products in the south plantation area or to adequately limit release to the marshy area, stream or pond on the south and west side of the landfill.

The tide gate appears to be functioning well.

The landfill cover has several deficiencies identified in the Ecology inspection report for the 5-year review that should be addressed.

Other remedy features appear adequate, although there is inefficiency in that several different contractors are performing monitoring activities that are not fully separate or coordinated. In addition, the USGS is doing monitoring in the marsh, stream and pond area without regulatory agency (Ecology) reviewed sampling and analysis plans (SAPs) and the results are not subject to regulatory review as required by the Federal Facility Agreement. Without these oversights, the USGS work lacks credibility and standing.

5. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the primary remedy components are:
   - Institutional controls and groundwater monitoring at Area 2
   - Excavation and off-site disposal of vadose-zone soil at Area 8
   - Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

   Response: The remaining issue at OU 2 is a sediment evaluation to determine the extent of contamination and to determine health-based and environmental risk factors. Background also needs to be established. If new information is found, the remedy at OU 2 Area 8 may need to be upgraded.

6. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Are you satisfied with the progress to date towards meeting this ROD requirement?

Response: Progress to date has been slow and difficult due to differing concerns of the stakeholders. Recent progress has been good.

7. Do you feel well informed about the remediation activities and progress at NBK Keyport? Please elaborate.

   Response: Information is generally available within reasonable timeframes on this project. Improvement is always possible and welcome.

8. To the best of your knowledge, since June 2009 have there been any new scientific findings that relate to potential site risks that might call into question the protectiveness of the remedies?

   Response: Yes (in three areas).

   1. In OU 1 Landfill, preliminary recent sampling results from tree coring and geo-technical evaluation indicate that the TCE plume in the south plantation is more extensive than previously thought. Additional sampling will need to be made to fill data gaps and to understand the nature and extent of the contamination in this area. Remedy upgrade may then be needed to address the findings.

   2. In OU 2 Area 8 Sediment Evaluation Area, there is existing recent monitoring data that shows several locations where contaminants exceed state sediment standards. This area is being further characterized to evaluate the nature and extent of this contamination and to develop human-health and ecological risk factors. Background is also being evaluated. New information at this site may justify upgrade of the existing remedy.

   3. At the Keyport Lagoon, not a current operable unit, monitoring results from an evaluation of this site for a possible mitigation site found exceedances. This new information justifies further investigation to determine the nature and extent of this contamination and if this area needs to be cleaned up.

9. What is your overall impression of the on-going effectiveness of the institutional controls components of the remedies?

   Response: Adequate.

10. The phytoremediation component of the OU 1 remedy is not operating as anticipated in the southern portion of the former landfill. The Navy has recently begun performing additional investigation to evaluate possible actions to shorten the restoration timeframe and improve the remedy

performance. What is your impression of the progress towards reassessing this component of the remedy?

Response: This topic has been frought with disagreement and delay for some time. However, recent progress is encouraging.

11. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

    Response: First, the USGS, for some unknown reason, has refused to allow pear review or input other than from their management and scientists. This precludes Ecology, the Navy, EPA, the Suquamish Tribe or any other oversight stakeholders from review and approval of sampling and analysis plans (SAPS) or to critically review reports and documents authored by the USGS. This is contrary requirements in the Federal Facility Agreement between, Ecology, EPA and the Navy.

    In reading these reports and documents, it is evident that site performance is the result of the combined benefits of phytoremediation and what is called intrinsic bioremediation. The idea of a fall back is not correct. That would only be to take away the trees.

    The current status of the south plantation is that concentrations of TCE and daughter products are very high and not diminishing well and not likely to meet any reasonable remediation timeframe. Contamination continues to exceed standards in the adjacent marshy, stream and pond area. Further study is needed to determine the nature and extent of this contamination source and to support potential remedy upgrades, should they be needed.

12. Since June 2009, have there been any complaints, violations, or other incidents related to NBK Keyport installation restoration issues that required a response by your office? If so, please provide details of the events and results of the responses.

    Response: There have been no complaints, violations or incidents reported to the Ecology offices regarding this site.

13. To the best of your knowledge, has the on-going program of environmental monitoring at NBK Keyport been sufficiently thorough and frequent to meet the goals of the RODs?

Response: There are considerable monetary and staff resources being expended at this site by the Navy and the stockholders. Deficiencies are being addressed.

14. Are you aware of any community concerns regarding implementation of the remedies at NBK Keyport? If so, please give details.

    Response: The community was involved in the development of the original remedy schemes at this site. They were apparently quite interested that the remedy approach would not adversely impact the marsh, stream and pond flow patterns. Community has since been very limited, except for the continuing involvement of the Suquamish Tribe.

15. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at NBK Keyport?

    Response: Not at this time. Several reports are pending at many of the Keyport sites that may result in additional comments. Ecology reserves an opportunity to update this interview should it be necessary to do so.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47600 • Olympia, WA 98504-7600 • 360-407-6000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

December 12, 2014

Carlotta Cellucci, R.G., Remedial Project Manager
Naval Facilities Engineering Command Northwest
1101 Tautog Circle, Suite 203
Silverdale, WA 98315-1101

RE: Washington State Department of Ecology Inspection Report for Keyport Five-Year Review, for Naval Base Kitsap, Keyport, dated December 12, 2014

Dear Ms. Cellucci:

The Department of Ecology has reviewed reference documents, met with the stakeholders and the Navy on numerous occasions, and visited and inspected the Keyport facility and operable units during the review period. Ecology has also performed independent evaluation of some of the site facilities, based on monitoring data supplied in the reference reports.

The Navy is in the process of preparing the Fourth Five-Year Review Report and has asked Ecology and the other stakeholders to prepare interview forms for inclusion in the report. Ecology also offered to participate in a site inspection in support of the review process.

A site visit and inspection of the Keyport facilities occurred on September 4, 2014. Carlotta Cellucci, R.G. (NAVFAC NW), Michael Meyer, R.G. (URS), and John Blacklaw, P.E. (Ecology) were present. Each participant took their own notes and evaluated the areas of the site independently. There was collaboration and discussion during the inspection work. That inspection is the subject of this inspection report.

The attached inspection report was prepared by Ecology and represents the status and evaluation conclusions based on the information previously known as stated above and the conditions encountered at the site on the date of the inspection. Photographs were not taken due to security protocols.

Please let me know at John.Blacklaw@Ecy.Wa.Gov or (360) 407-6161, if you have any questions on the attached inspection report.

Sincerely,

John R. Blacklaw

John Blacklaw, P.E., Cleanup Project Manager

Cc: Denice Taylor, Environmental Scientist, The Suquamish Tribe
Dave Einan, P.E., RPM, EPA
Susannah Edwards, Sediment Specialist, Ecology

Distribution List

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Attachment: Washington State Department of Ecology Inspection Report for Keyport Five-Year Review, for Naval Base Kitsap, Keyport, dated December 12, 2014

A site visit to the facility was arranged and performed on September 4, 2014.

Site Visit: Carlotta Cellucci (NAVFAC NW), Michael Meyer (URS) and John Blacklaw (Ecology) attended the site visit. The participants met and drove around the site and stopped at key observation points. The participants shared questions and answers about the facility during the site tour. Four operable units (OU 1 – landfill, OU 2 Area 2 – drum storage, OU 2, Area 8 – sediment evaluation site, and Site 23 – building/parking lot) and the Keyport Lagoon were visited.

This Navy facility performs underseas warfare operations in support of the West Coast fleet. Past and current practices include research, development and production of equipment that entails metal work, plating, painting and assembly practices. These practices resulted in production of solvents, plating process chemicals, and painting supplies. The production areas have had releases and the landfill area is a disposal area for waste materials.

OU 1 – Landfill: This is an area of about 9 acres in total on the west side of the facility where landfill waste materials were disposed over several decades. This area was remediated in the late 1990s by grading the area, installing clean fill and adding an asphalt cover. The north and south ends of the landfill were planted with trees for the purpose of phytoremediation (where the trees remove water (by evapo-transpiration) from the subsurface and chemically convert waste chemicals that may be entrained by metabolic processes in the tree and/or by release as vapors from the leaves of the trees. There was also a drainage system installed in the cover at some locations that assist with removing surface water from the landfill cover area. The remedy was defines as phytoremediation with trees supported by intrinsic bioremediation. In addition, near field off-site wells are monitored and plans are in place to provide any such wells that may become contaminated with clean sources of drinking water. There is also an element for institutional controls at the facility.

Observations during the inspection identified some small cracks in the asphalt cover that may need to be filled to prevent leakage. There is also an area near the north plantation where the surface has become undulating. It was not immediately clear if the cause was settling or from tree roots. This area needs further investigation, and corrections made to bring this area back to design grade. There is also an area of shallow ponding on the east side of the site that shows signs of settlement that may need correction. There is also an area near the roadway entrance from Bradley Road that shows significant ponding.

The surface has some type of under-surface drain lines with grates at the surface. On the east side of the site, there is a grate that appears to have been covered, clogged and overflowed into the adjacent pond. The grate appears to be undersized and may need maintenance for clogging.

There is an area on the west side of the site that has a grate and a vegetated ditch running toward the south. The ditch is about 2 feet deep and is filled with heavy brush. This ditch supplies an under-surface pipe drainage system to carries surface water to the south of the south plantation where it enters the swampy area at the headwaters of the small creak. Ecology's opinion is that this drainage area should be performed on the surface of an appropriately graded asphalt cover and not in pipes or ditches that can supply input water to the underlying waste by leakage. All drainage from the asphalt cover should be directed away from the landfill and especially away from the plantation areas where any leakage from the drainage system could be immediately infiltrated to the soil around the trees.

There are oil water separators in vaults, one the west side of the site and two on the east side. It is not clear by observation where the sources for these vaults come from. Drainage designs were not reviewed during the inspection. However, this is a site in western Washington that gets significant rainfall events in the winter months and drainage is important to the functioning of the landfill cover. It is recommended that drainage in all types and locations at this site is evaluated for any potential improvements and that underground pipes and ditches are removed as expeditiously as possible to limit that infiltration pathway.

Building 791 is an open structure with a metal roof and concrete floor graded to a drainage grate in the middle that is plugged and ponding. It's not clear where this drain goes. There is a paved area between the main cover area and the south plantation where the asphalt cover is not as well placed or maintained. There are larger gaps and installed concrete pads, ponding areas, grates, and storm water piping below grade. There is a building (1032) with an open front metal roofed area with concrete slab floor. There is a lot of unused, stored material. This material has degraded to what appears to be unusable condition and should be removed from the area.

From discussions during the inspection, storage of materials is allowed by the language of the ROD. This suggests that the landfill cover area will therefore be exposed to driving with heavy trucks to move these materials. This is not a good practice on an asphalt landfill cover. It would be an improvement if storage materials are not allowed and vehicle weights and use is highly controlled to limit damage to the cover materials and function.

There is a large temporary building just north of the south plantation with stored building materials inside (rolled insulation and wood trusses). This material appears to be old, may lack an appropriate use and may have limited value. It should be removed and kept elsewhere, if really needed by the Navy, or disposed of.

There is a curbed area, and a system of grates and underground storm water lines from the area north of the south plantation across the east side of the plantation to the swampy area south of the plantation. It would be best that this drainage system does not cross the plantation area, where leakage would cause infiltration.

There is a fenced in area on the east side of the site just north of the south plantation, where there is a ditch and drainage area that has become overgrown with brush and small trees. This is an obvious infiltration area that should be eliminated.

Both the north and south plantation trees appear well formed and productive. Trees are quite uniform is size. There does not appear to be any deficiency in tree growth. The trees in the south plantation showed bore holes about 3 feet high from the ground surface on the north side where cores had been removed for chemical analysis. There were several trees near the creek that had also been cored.

Stored material on the landfill and in the various buildings was mostly old-looking and appears to have been stored beyond its useful life and purpose. The Navy should either remove and store any useful material elsewhere or dispose of any useless materials.

The tide gate that controls backflow from the bay into the stream and small lake on the west side of the landfill was inspected. It was found to be functioning as intended. The flow during low tide was maybe 1 to 2 gpm from the south drainage and none from the north. The outlet side of the tide gate was not accessible and was not inspected.

The small pond and wetland area on the west side of the landfill was observed from access from the west. There is a wooden walkway that is in disrepair. It was not unsafe, but will become so if not maintained in the near future. The walkway is being used but is no longer a friendly amenity to the marsh and pond. There is a need to get to the sampling locations in the stream area upstream of the pond near the south plantation. The walkway is the likely approach. If this walkway becomes unfeasible, another path will need to be developed. This area is idyllic for the ducks and other wildlife in the area.

There are several bunkers west of the landfill site. Some have drainage that appears to be toward the marshy area. It's possible that some of this drainage could be diverted away from the marshy area toward drainage to the west. This area should be evaluated to see if minor drainage improvements could be installed.

On the east side of the landfill is Bradley Road with a right-of way ditched area between the road and landfill. This area has a shallow ditch that directs intercepted surface flows to the south. The natural groundwater gradient is from east to west in this area. It would be feasible to install a piped or French drain system in the ditch area along Bradley road that would intercept both surface water and groundwater flow and direct it south. If this was done, it would limit the washing effect of the groundwater flow on the waste in the landfill. This would then reduce the flux rate of contaminants released from the landfill into the stream, pond and marshy area on the south and west side of the landfill. This would be a logical and cost-effective remedy improvement option if ongoing evaluations of chemical transport mechanisms require it. If a remedy improvement becomes necessary, this drainage method should be included in available options, along with any other methods that would limit release of contaminants from the landfill waste materials to the environment. Such a deep drainage system would also intercept any potentially dangerous vapors from moving from the waste to the east and into the buildings east of Bradley road (an additional bonus).

OU 2 Area 2 – Drum Storage Area: This area is immediately south of the landfill area about a quarter of a mile up an access road. This area is uphill with an elevation of 100 to 200 feet above the marshy area and flows directly toward the marsh. This area has been remediated and concentrations of contaminants in groundwater have decreased in this area.

This area has three buildings (1078, 1017 and 1018). The area is not shipshape. There is deferred maintenance of the facilities and quantities of stored materials appear unusable. This area should be cleaned up to make it more accessible for whatever the area may be useful for and to facility environmental sampling when it is needed. There is brush, with unused and what appears to be waste materials. Monitoring points were observed to be functional, but with limited access. The site has institutional controls in place.

Keyport Lagoon: The Keyport Lagoon was observed from the outfall area during low tide. The small dam controls the lagoon elevation to about 4 feet above mean tide. This allows that there is some saltwater backflow into the lagoon during highest tides and limited flushing during low tides. The dam and bridge appears to be in adequate condition. There is a recreational area on the north side of the lagoon where people can enjoy the beach area.

During low tide, there was some small flow over the weir dam with a naturally formed channel out to the bay. There was also evidence of seeps in the area indicating that there was subsurface flow in the area likely bypassing the dam.

This area was monitored as part of a possible mitigation project and contaminants were found above state standards.

OU 2 Area 8 – Sediment Evaluation Area: OU 2 Area 8 is the old plating shop area. It was remediated about 15 years ago. The plating building was demolished and removed. Contaminated soils were also removed. The site was regarded and an asphalt parking lot was installed. Contaminants that leaked from the original site leaked in a drainage vault toward the beach and sediments. Sediment monitoring over the past several years found several sampling locations with exceedances to state sediment benthic standards. This area is now subject to additional monitoring to establish the extent of contamination and to support a human-health and ecological risk evaluation. Local background will also be established to support possible implementation of improved remedies in the area. A sampling and analysis plan (SAP) is being developed and monitoring is planned for 2015.

Observations during the inspection identified a prolific beach of mostly small stone and cobble surface with clams and shell covering many areas. There was some discarded building rubble in some locations that should be picked up and removed. There are at least 2 large (greater than 12-inch diameter) outfall pipes up-gradient of the contaminated beach area. Follow up on these outfalls indicates that they are surface water and utility outfalls from the adjacent building, roadway and parking areas. Specific piping schematics were not reviewed during the inspection. There is an installed concrete barrier between the old plating shop area and the beach that will divert contaminants to the south and north. The north diversion has not been monitored. Existing monitoring has found contamination in the south diversion. A biological assessment has recently been performed on the beach. Results are not yet available.

The beach was inspected during a rising tide. The evidence of seep areas on the beach was good enough to identify some specific locations and some broader areas where the beach was wet with active seepage. There is one area to the south of the evaluation area. It has not been monitored recently for contaminants. The seeps appear to be the result of confining zones (likely clay) that daylight on the beach across the entire area. It is not clear if there are discontinuities or if there are irregularities that support the point and small area seepage areas, and not a widely disperse seepage area. It is possible that seepage may be occurring below tidal influence, where it would be hard to identify. Maybe this seepage pattern will become evident after additional monitoring is completed.

The outfalls could very well be emitting some quantity of the same contaminants of concern (COCs) as those found in the sediments that could confound the results of sampling. Outfalls will therefore need to be characterized and even remediated, if warranted.

Site 23 – Building and Parking Lot: This site was investigated historically. It is located near building 15. Nothing of note was observed at this site and no documentation or monitoring information was available during the inspection.

INTERVIEW RECORD FOR FOURTH FIVE-YEAR REVIEW
June 2009 through June 2014
Type 2 Interview – Regulatory Agency
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Susannah Edwards
Title: Sediment Specialist
Organization: Washington Department of Ecology
Telephone: (360)407-6798
E-mail: susannah.edwards@ecy.wa.gov
Address: 300 Desmond Dr. SE, Lacey, WA 98503

Contact made by: Heather Kabli, URS Corporation
Response type:
Date:

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Records of Decision (RODs) for Operable Units (OUs) 1 and 2 at Naval Base Kitsap (NBK) Keyport.

   Response: I was assigned to OU2, Area 8 in October 2013, to provide technical support to the Ecology Project Manager on sediment issues. I am familiar with sections of the ROD that deal with OU2, Area 8, including the remedial investigation, remedial actions, remedial goals, and long term monitoring data.

   I am not involved in OU1.

2. Please describe your degree of familiarity with implementation of the remedies at these OUs and the monitoring and maintenance that has taken place since implementation of the remedies.

   Response: For OU2, Area 8: See response to question 1.

3. Please also describe your involvement with regard to review and comment on these actions since June 2009.

   Response: I became involved in OU2, Area 8 in October 2013. I reviewed and commented on the Spring 2013 Area 8 long-term monitoring report. During 2014 I was involved in technical workgroups and project team discussions to develop a quality assurance project plan (QAPP) for determining nature and extent of contamination at Area 8 and to evaluate risk to human health and ecological receptors.

4. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the remedy primary components are:

- Phytoremediation at the former landfill using hybrid poplar trees
- Removal of PCB-contaminated sediments from the marsh
- Upgrade of the tide gate
- Upgrade and maintenance of the landfill cover
- Long-term monitoring
- Contingent actions for off-base domestic wells
- Institutional controls

Response: I am not involved in OU1.

5. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the primary remedy components are:

- Institutional controls and groundwater monitoring at Area 2
- Excavation and off-site disposal of vadose-zone soil at Area 8
- Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

Response: Long-term monitoring data of sediments in Area 8 show that certain chemicals of concern (COCs), including but not limited to cadmium, appear to be accumulating in the sediments. While institutional controls have been effective in limiting human exposure to these sediments, further evaluation is needed to determine impacts to the sediments and biological receptors from the continued discharge of contaminants from Area 8 groundwater to Liberty Bay. Sediment sampling events in 2008 and 2012 measured concentrations of cadmium at several stations exceeding the Sediment Management Standards cleanup screening level chemical criteria for benthic community health.

Additionally, in 2013, the Agency for Toxic Substances and Disease Registry published a health consultation for OU2, Area 8 (*Naval Base Kitsap, Keyport, Operable Unit 2 Area8 Shellfish Evaluation, 2013,* ATSDR). This study evaluated clam tissue data collected by the Navy from 1996 to 2008. The study found that "Pacific Littleneck clam samples from seep areas near Area 8 exceeded human health-based screening levels for several heavy metals and could present a health hazard to subsistence and recreational shellfish consumers."

6. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Are you satisfied with the progress to date towards meeting this ROD requirement?

   Response: Ecology did not agree with the inputs/findings of previous Navy human health and ecological risk evaluations. However, the Navy is currently planning to conduct additional risk evaluations. I appreciate the collaborative process through which the development of the latest QAPP, which will be used to further assess risk to human health and environmental receptors, has been discussed with the State. I would like to note that at the time of responding to interview questions I have not seen the first draft of the QAPP.

7. Do you feel well informed about the remediation activities and progress at NBK Keyport? Please elaborate.

   Response: Yes, I generally feel well informed about progress at OU2, Area 8. The Navy has sought feedback from Ecology on its sampling and analysis plan for collecting additional necessary data for Area 8 (see response to #6).

8. To the best of your knowledge, since June 2009 have there been any new scientific findings that relate to potential site risks that might call into question the protectiveness of the remedies?

   Response: See response to question 5.

9. What is your overall impression of the on-going effectiveness of the institutional controls components of the remedies?

   Response: OU2 , Area 8: While institutional controls prevent public beach access, contaminants accumulating in the sediments or tissue of organisms in this area have the potential to be transported beyond the area of limited access.

10. The phytoremediation component of the OU 1 remedy is not operating as anticipated in the southern portion of the former landfill. The Navy has recently begun performing additional investigation to evaluate possible actions to shorten the restoration timeframe and improve the remedy performance. What is your impression of the progress towards reassessing this component of the remedy?

    Response: I am not involved in OU1.

11. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

    Response: I am not involved in OU1.

12. Since June 2009, have there been any complaints, violations, or other incidents related to NBK Keyport installation restoration issues that required a response by your office? If so, please provide details of the events and results of the responses.

    Response: None that I am aware of.

13. To the best of your knowledge, has the on-going program of environmental monitoring at NBK Keyport been sufficiently thorough and frequent to meet the goals of the RODs?

    Response: For OU2, Area 8: The extent of sampling locations was increased upon recommendations from the third 5-year review, to capture sediment data deeper in the intertidal and subtidal beach area. In recent years multiple stations have exceeded the Sediment Management Standards (SMS) benthic invertebrate chemical criteria for at least one chemical of concern. These stations are located on the Northern end of the sampling area. The Navy is currently working toward an expanded sampling area to capture the extent of these exceedances. Additionally, one of the recommendations made in the ATSDR report referenced in question 8 is to sample at varying times of year to capture seasonal variation in concentration and toxicity.

14. Are you aware of any community concerns regarding implementation of the remedies at NBK Keyport? If so, please give details.

    Response: I am not aware of community concerns.

15. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at NBK Keyport?

    Response: Upon review of the findings of the upcoming human health and ecological risk assessments, as well as the findings, recommendations and follow-up actions of the FOURTH FIVE-YEAR REVIEW, Ecology may have additional comments, concerns, and suggestions regarding the protectiveness of cleanup measures, and request to update this interview sheet.

INTERVIEW RECORD FOR FOURTH FIVE-YEAR REVIEW
June 2009 through June 2014
Type 2 Interview – Regulatory Agency
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Dave Einan
Title: Environmental Engineer/RPM
Organization: EPA Region 10
Telephone: 509-376-3883
E-mail: einan.david@epa.gov
Address: 309 Bradley Blvd, Ste 115
Richland, WA 99452

Contact made by: Heather Kabli, URS Corporation
Response type:
Date: December 12, 2014

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Records of Decision (RODs) for Operable Units (OUs) 1 and 2 at Naval Base Kitsap (NBK) Keyport.

   Response: I have only been EPA's project manager for the Keyport sites since December 2013. Consequently, I am not as familiar as I'd like to be.

2. Please describe your degree of familiarity with implementation of the remedies at these OUs and the monitoring and maintenance that has taken place since implementation of the remedies.

   Response: I have only been EPA's project manager for the Keyport sites since December 2013. Consequently, I am not as familiar as I'd like to be.

3. Please also describe your involvement with regard to review and comment on these actions since June 2009.

   Response: There hasn't been much to be reviewed in the last year, but I am responsible for future reviews.

4. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the remedy primary components are:

   - Phytoremediation at the former landfill using hybrid poplar trees

- Removal of PCB-contaminated sediments from the marsh
- Upgrade of the tide gate
- Upgrade and maintenance of the landfill cover
- Long-term monitoring
- Contingent actions for off-base domestic wells
- Institutional controls

Response: Most components have been effective. As to the phytoremediation, given the data we have, I would say that it is inconclusive, particularly regarding the southern portion of the landfill. There are some downgradient exceedances. Whether it is due to a lack of effectiveness or errors in the conceptual site model (e.g., an unknown source), we can't yet tell. The Navy's additional planned work should address this.

5. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the primary remedy components are:

- Institutional controls and groundwater monitoring at Area 2
- Excavation and off-site disposal of vadose-zone soil at Area 8
- Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

Response: Again, most components have been effective. The Navy is doing additional sediment and shellfish sampling, followed by revising the risk assessment to address concerns and that work is proceeding appropriately.

6. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Are you satisfied with the progress to date towards meeting this ROD requirement?

Response: Please see the response to Question 5.

7. Do you feel well informed about the remediation activities and progress at NBK Keyport? Please elaborate.

Response: Yes.

8. To the best of your knowledge, since June 2009 have there been any new scientific findings that relate to potential site risks that might call into question the protectiveness of the remedies?

Response: None

9. What is your overall impression of the on-going effectiveness of the institutional controls components of the remedies?

   Response: None

10. The phytoremediation component of the OU 1 remedy is not operating as anticipated in the southern portion of the former landfill. The Navy has recently begun performing additional investigation to evaluate possible actions to shorten the restoration timeframe and improve the remedy performance. What is your impression of the progress towards reassessing this component of the remedy?

    Response: Please see the response to Question 4.

11. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

    Response: Please see the response to Question 4.

12. Since June 2009, have there been any complaints, violations, or other incidents related to NBK Keyport installation restoration issues that required a response by your office? If so, please provide details of the events and results of the responses.

    Response: Not in my tenure, but that has been since December 2013.

13. To the best of your knowledge, has the on-going program of environmental monitoring at NBK Keyport been sufficiently thorough and frequent to meet the goals of the RODs?

    Response: None

14. Are you aware of any community concerns regarding implementation of the remedies at NBK Keyport? If so, please give details.

    Response: I am not aware of any concerns.

15. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at NBK Keyport?

    Response: Not right now.

INTERVIEW RECORD FOR FOURTH FIVE-YEAR REVIEW
June 2009 through June 2014
Type 2 Interview – Regulatory Agency
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Grant Holdcroft
Title: Environmental Health Specialist
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Bremerton, WA 98337

Contact made by: Heather Kabli, URS Corporation
Response type:
Date:

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Records of Decision (RODs) for Operable Units (OUs) 1 and 2 at Naval Base Kitsap (NBK) Keyport.

   Response: I read thru the RODs at one time. I am more familiar with OU-1, as the Health District has some regulatory responsibilities at landfills.

2. Please describe your degree of familiarity with implementation of the remedies at these OUs and the monitoring and maintenance that has taken place since implementation of the remedies.

   Response: I am somewhat familiar with the remedies and the monitoring and maintenance. I have read the RODs and the 5 year reviews since the remedies were implemented. I have inspected the landfill at OU-1 with a representative of the US Navy's NAVFAC/NW, and discussed the remedy at OU-1 with him.

3. Please also describe your involvement with regard to review and comment on these actions since June 2009.

   Response: I have reviewed the documents related to OU-1, inspected the landfill at OU-1, and met with a representative of the US Navy's NAVFAC/NW at the landfill.

4. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the remedy primary components are:

   - Phytoremediation at the former landfill using hybrid poplar trees
   - Removal of PCB-contaminated sediments from the marsh
   - Upgrade of the tide gate
   - Upgrade and maintenance of the landfill cover
   - Long-term monitoring
   - Contingent actions for off-base domestic wells
   - Institutional controls

   Response: Based solely on the 2010 5 yr review – Apparently, the phytoremediation is not working in the intended manner. Data from the seep at SP1-1 indicates that contaminants continue to enter surface water. Likely, from the landfill. The removal of PCB contaminated sediments may have been effective. However, continued releases of PCBs may negate the benefits of that removal. The tide gate upgrade has apparently protected the landfill from erosion. The landfill cover and maintenance has been effective. The long-term monitoring has been critical to assessment of the various remedies. To the best of my knowledge the contingent actions for the wells has been effective. The institutional controls appear to be effective.

5. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the primary remedy components are:

   - Institutional controls and groundwater monitoring at Area 2
   - Excavation and off-site disposal of vadose-zone soil at Area 8
   - Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

   Response: Based on the information given in the Site Specific Information and the 2010 5 yr review, the area 2 remedy is working and the area 8 needs review.

6. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Are you satisfied with the progress to date towards meeting this ROD requirement?

   Response: Yes. Continue to move forward.

7. Do you feel well informed about the remediation activities and progress at NBK Keyport? Please elaborate.

Response: Better than the last 5 year review, in 2010. It would be helpful to look at recent data from the monitoring at the site prior to the interview. In addition, the Health District has not been included in discussions on additional investigations or secondary remedies. The Health District respectfully requests being involved in any discussion regarding OU1 and the landfill.

8. To the best of your knowledge, since June 2009 have there been any new scientific findings that relate to potential site risks that might call into question the protectiveness of the remedies?

   Response: No. But, the Health District has not received any materials related to this site since the last interview for a 5 yr review in 2009.

9. What is your overall impression of the on-going effectiveness of the institutional controls components of the remedies?

   Response: Mostly effective.

10. The phytoremediation component of the OU 1 remedy is not operating as anticipated in the southern portion of the former landfill. The Navy has recently begun performing additional investigation to evaluate possible actions to shorten the restoration timeframe and improve the remedy performance. What is your impression of the progress towards reassessing this component of the remedy?

    Response: I understand that a round of sampling took place in August of 2014. The Health District would like to look at the data when available and be involved in the discussions on the next steps to address the results. My impression is that progress is slow and steady.

11. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

    Response: I have not seen any of the USGS intrinsic bioremediation studies. The Health District would appreciate receiving and reviewing the studies.

12. Since June 2009, have there been any complaints, violations, or other incidents related to NBK Keyport installation restoration issues that required a response by your office? If so, please provide details of the events and results of the responses.

    Response: No. Not to our knowledge.

13. To the best of your knowledge, has the on-going program of environmental monitoring at NBK Keyport been sufficiently thorough and frequent to meet the goals of the RODs?

    Response: Yes. The monitoring program has identified areas of concern that are being addressed thru further sampling and possibly further remedies.

14. Are you aware of any community concerns regarding implementation of the remedies at NBK Keyport? If so, please give details.

    Response: No.

15. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at NBK Keyport?

    Response: The Health District has concerns and would like to see steps taken to:

    1) Further reduce or eliminate releases of COCs to surface and groundwater at the site;

    2) Ensure shellfish closure areas are adequate to protect public health, and;

    3) (If not already done) Investigate the elevation of groundwater in the landfill area to ensure that waste in the landfill is not submerged in groundwater or tidally influenced groundwater.

INTERVIEW RECORD FOR FOURTH FIVE-YEAR REVIEW
June 2009 through June 2014
Type 3 Interview – Community Member
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Shirl Golden
Title:
Organization: Keyport Improvement Club
Telephone: 779-1746
E-mail:
Address: P.O. box 378
Keyport WA
98345
Contact made by: Heather Kabli, URS Corporation
Response type:
Date:

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Records of Decision (RODs) for Operable Units (OUs) 1 and 2 at Naval Base Kitsap (NBK) Keyport.

   Response: I was on the RAB

2. Please describe your degree of familiarity with implementation of the remedies at these OUs and the monitoring and maintenance that has taken place since implementation of the remedies.

   Response:

3. Please also describe your involvement with regard to review and comment on these actions since June 2009.

   Response:

4. What is your overall impression of the on-going protectiveness of the remedies at NBK Keyport?

   Response: I am glad investigations are still taking place. They strike me as being thorough.

5. Do you feel well informed about the remediation activities and progress at NBK Keyport? Please elaborate.

   Response: this has been my first communicati

6. What effects on the community have you observed as a result of on-going remedy implementation?

   Response:

7. Are you aware of any community concerns regarding implementation of the remedies? If so, please give details.

   Response:

8. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at NBK Keyport?

   Response:

9. Please provide the newspaper, website, or Facebook page you use to obtain local information.

   Response: the Kitsap Sun.

INTERVIEW RECORD FOR FOURTH FIVE-YEAR REVIEW
June 2009 through June 2014
Type 5 Interview – Tribal Stakeholder
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Denice Taylor
Title: Environmental Scientist
Organization: Suquamish Tribe
Telephone: 360-394-8449
E-mail: dtaylor@suquamish.nsn.us
Address: Suquamish Tribe
Fisheries Department
PO Box 498
18490 Suquamish Way
Suquamish, WA 98392

Contact made by: Heather Kabli, URS Corporation
Response type:
Date: December 10, 2014

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Records of Decision (RODs) for Operable Units (OUs) 1 and 2 at Naval Base Kitsap (NBK) Keyport.

   Response: I have been the Suquamish Tribe's project manager for the Keyport sites since October 2002. I participate on the OU 1 and Area 8 project teams and am familiar with the RODs, the remedies and monitoring and maintenance that have taken place since implementation of the remedies.

2. Please describe your degree of familiarity with implementation of the remedies at these OUs and the monitoring and maintenance that has taken place since implementation of the remedies.

   Response: See response to Question 1.

3. Please also describe your involvement with regard to review and comment on these actions since June 2009.

   Response: As the project manager for the Suquamish Tribe, I participate on the project teams for both OU 1 and OU 2/Area 8. I was involved in the Third Five Year

Review (finalized December 2010), and routinely review and comment on reports, work plans and sampling plans.

4. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the primary remedy components are:

- Phytoremediation at the former landfill using hybrid poplar trees
- Removal of PCB-contaminated sediments from the marsh
- Upgrade of the tide gate
- Upgrade and maintenance of the landfill cover
- Long-term monitoring
- Contingent actions for off-base domestic wells
- Institutional controls

Response: As described in Question 10, phytoremediation using hybrid poplar trees has not functioned as intended by the ROD in the southern portion of the landfill. Long-term monitoring data confirm that VOC concentrations in groundwater and in the closest surface water sample (MA12) consistently exceed remediation goals and regulatory criteria. Although exposure routes are being controlled and monitored, the Tribe does not believe that phytoremediation, even in conjunction with intrinsic bioremediation, is protective of human health and the environment in the long-term.

The Tribe supports the Navy's current efforts to further characterize remaining or residual sources of contamination in the southern portion of the landfill and will continue to actively participate in the review of new data and the development of appropriate site management strategies. It is possible that other remedy components, including maintenance of the landfill cover and long-term monitoring, may be modified through that process.

5. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the primary remedy components are:

- Institutional controls and groundwater monitoring at Area 2
- Excavation and off-site disposal of vadose-zone soil at Area 8
- Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

Response: Long-term monitoring demonstrates that site-related contaminants are continuing to impact sediments and clams offshore of Area 8. The Tribe supports the Navy's current efforts to further evaluate the nature and extent of contamination and potential risks to human health and the environment.

6. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Are you satisfied with the progress to date towards meeting this ROD requirement?

   Response: See the response to Question 5. The risk assessments performed for the previous 5YRs did not adequately address the concerns of the Suquamish Tribe regarding potential impacts to human health and the environment. The Tribe is actively involved in the Navy's current efforts to determine what actions may be necessary to achieve the RAOs for Area 8.

7. Do you feel well informed about the remediation activities and progress at NBK Keyport? Please elaborate.

   Response: Yes. The current project manager is committed to ensuring that project team members are not only informed, but have input into planning processes and site management decision-making.

8. What effects have on-going remedy implementation had on the Tribe and the surrounding community?

   Response: The site is within the exclusive usual and accustomed fishing area of the Suquamish Tribe. By treaty, the Tribe retains traditional harvest and access rights. The presence of contamination impacts protected resources and limits the Tribe's ability to safely gather and consume fish and shellfish from the area.

9. Are you aware of any Tribal or other community concerns regarding implementation of the remedies? If so, please give details.

   Response: The Tribe has expressed ongoing concern that the remedies implemented at OU 1 and OU 2 Area 8 have not effectively addressed contamination and do not meet remediation goals and regulatory criteria. However, as commented above, the Tribe supports the Navy's current efforts to re-evaluate these sites and determine if additional actions are appropriate.

10. The phytoremediation component of the OU 1 remedy is not operating as anticipated in the southern portion of the former landfill. The Navy has recently begun performing additional investigation to evaluate possible actions to shorten the restoration timeframe and improve the remedy performance. What is your impression of the progress towards reassessing this component of the remedy?

    Response: See the response for Question 4.

11. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on this remediation mechanism. Monitored natural attenuation was also listed as a potential alternative to phytoremediation in the OU 1 ROD. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

    Response: In the southern portion of the landfill, neither phytoremediation nor intrinsic bioremediation appear to be effective in reducing VOC contamination to levels that meet remedial goals or regulatory levels.

12. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at NBK Keyport?

    Response: Not at this time. Pending the findings and recommendations of the Fourth 5RY, the Tribe may submit additional comments and request that this interview form be updated.

APPENDIX G

Navy Response to Ecology's and Suquamish Tribe's Comments on the Draft Report

October 8, 2015

NAVY RESPONSES TO:

ECOLOGY'S COMMENTS ON THE DRAFT FOURTH FIVE-YEAR REVIEW, NAVAL BASE KITSAP KEYPORT, KEYPORT, WASHINGTON, DATED 20 JULY 2015 - COMMENTS RECEIVED SEPTEMBER 3, 2015

1. **General Comment A -**
The Navy agrees that new SMS and the evaluation of HH risk applies. The Navy does not believe the new SMS calls into question the protectiveness of the remedy for the short term exposure. Shellfish harvesting could only occur in the tide flats and not in the marsh because there are no shellfish present in the marsh. Currently no shellfish harvesting is permitted in the tide flats. To assess future human exposures, clam tissue data were collected to directly measure the risks associated with consumption of marine organisms that could be potentially impacted by PCBs in sediment. The clam tissue data were evaluated in light of the new information regarding Suquamish consumption rates to determine whether the change in ARARs (i.e., the new SMS) would indicate that the sediment RGs are no longer protective. As indicated in Ecology's detailed comments, the most recent PCB results for clam samples collected from the tide flats in 2009 were not detected at a reporting limit of 10 ug/kg. Using the reporting limit of 10 ug/kg and the Suquamish ingestion rate of 498 g/day, the associated cancer risk is 3 $x10^{-5}$. With 397 g/day of Ecology's suggested fish consumption rate of Suquamish Tribe (@ 90th Percentile of Puget Sound), the associated cancer risk would be 2.51 x 10^{-5} and 5.78 x 10^{-5} for reporting limit of 10ug/kg and maximum tissue concentration measured, respectively. These cancer risks somewhat exceed Ecology's target risk level of 1 x 10^{-5} under updated Ecology's SMS regulation but falls within the EPA's acceptable risk range of 10^{-6} to 10^{-4}.

   The EPA and the Suquamish tribe/Ecology do not agree on the seafood consumption rates that should be used for risk assessment at the site. The EPA risk assessor, Lon Kissinger, believes that the Tulalip ingestion rates are more appropriate/sustainable based on the size of the exposure area.

   The Navy has agreed to perform the risk assessment using both the Suquamish and the Tulalip fish consumption rates, since the Suquamish Tribe needs that information for their member's health and safety. The Navy agrees with the EPA that it is unrealistic and unsustainable for anyone to eat exclusively from the Keyport site. Using the reporting limit of 10 ug/kg and Tulalip consumption rate of 81.9 g/day, the associated cancer risk is $4.8x10^{-6}$, which is below Ecology's target risk level of 10^{-5}. Thus, calculation of a sediment cleanup level protective of tissue is not needed because the tissue concentrations, based on the Tulalip ingestion rate, do not result in risks above Ecology's target risk goal or the EPA's acceptable risk range and the change in ARAR (i.e., the new SMS) does not call into question the protectiveness of the remedy for the short term protectiveness. However, further discussion between the Navy, Ecology, EPA, and the Suquamish Tribe regarding the application of tribal ingestion rates will be deferred to the Area 1 Phase II SAP development.

The Navy will do additional investigation of PCB concentrations in seep water and sediment as part of the Phase II investigation. The Phase II SAP will be developed in collaboration with EPA, Ecology, and the Suquamish Tribe. Under the revised SMS, the SQS criterion protective of benthic community remained 12 mg/kg for PCBs. The purpose of resampling sediment in the marsh is to evaluate whether the concentrations have increased and whether ecological risk assessment is warranted to assess risks to higher trophic levels. The purpose of resampling tissue in the tide flats using lower reporting limits is to assess human health risk specific to local Tribal consumption rates. The additional data needs required per SMS for upper trophic pathway evaluation will be considered in SAP development. Further discussion between the Navy, Ecology, EPA, and the Suquamish Tribe regarding appropriate PQLs and analytical methods will occur during the Phase II SAP development.

The Navy appreciates Ecology's thoughtful recommendation for a specific mathematical model that could be used to assess potential recontamination of sediment adjacent to seep SP1-1. However, the Lampert and Reible model is not the best choice for this purpose. This model uses porewater concentrations in sediment to design isolation caps, and is generally not used to assess surface water compliance. The Navy believes that empirical sediment data is the best way to evaluate potential recontamination, and historical data are already available. The 5-year review recommends collecting additional sediment data to assess recontamination. The Navy notes that the sediment station located closest to SP1-1 (station MA09) exhibits a decrease PCB concentration trend. This is strong evidence that significant sediment recontamination is not occurring. Even so, the Navy is recommending additional sediment sampling to further assess the recontamination potential.

2. General Comment B – The plume contraction is a conclusion based on a visual assessment of the contour lines. The mass of TCE was calculated in the MNA report in 2012. A similar, but more rigorous calculation can be added as a task for the next 5-year review, and will be added to the recommendations table.

   There is groundwater flow from upgradient through the former landfill area, as documented in the monitoring reports. Groundwater elevation data are available from before the ROD through the present day, and are presented in the monitoring reports.

October 8, 2015

NAVY'S RESPONSE TO ECOLOGY'S SPECIFIC COMMENTS ON THE DRAFT FOURTH FIVE-YEAR REVIEW, NAVAL BASE KITSAP KEYPORT, KEYPORT, WASHINGTON, DATED 20 JULY 2015 - COMMENTS RECEIVED SEPTEMBER 3, 2015

ID#	By	Sec./Pg.	Comment	Navy Response
1	PHS	Ex Sum, ii, 1st ¶	There is no policy on groundwater restoration time under Ecology's MTCA. If the selected cleanup action uses natural attenuation (including phytoremediation, etc.) the selected remedy should conform to the expectations in WAC 173-340-370(7). One of major expectations is "Source Control" including removal and/or treatment should have been conducted to the maximum extent practicable. Under revised SMS of 2013 per WAC 173-204-570(5), the reasonable restoration period for the selected remedy is expected be ten or less year.	The 30 to 50 year expectation is based on verbal statements provided by the Ecology manager reviewing the project during the last 5 years. Text will be changed from "current policy" to "current expectation".
2		Ex Sum, ii, 3rd ¶	Text insert "mainly due to the prevention of human exposure through Institutional Controls. "	The remedy at OU 1 is protective in the short-term based on all of the remedy components, not just ICs, and LTM results. The next sentence broadly states that exposures are being controlled and monitored; therefore, the text insert is redundant. The text insert will not be incorporated. The details explaining why the remedy at OU 1 is protective in the short-term are described in Section 9.
3	PHS	p 4-5, Table 4-2 notes	Clarification of this statement is needed with respect to updated SMS rule.	These notes are from the ROD and based on SQS at the time of the ROD. The text will not be revised.
4	PHS	p 4-5, Table 4-2 notes	SQS is strictly based on protection of the benthic community in marine and low salinity sediment per WAC 173-204-562. Updated Sediment cleanup levels/target tissue concentration needs to be established based on protection of human health per new SMS rule of WAC 173-204-561.	See response to comment 3
5	PHS	p 4-5, Table 4-2 notes	Exposure assumption used Appendix B of the ROD (1998) is with outdated ingestion rate and target risk level of 1E-5 which is not reflecting the updated exposure assumption/SMS rule.	See response to comment 3
6	PHS	p 4-23, Table 4-3	Insert into land use controls inspected for OU 1 "Prevent the ingestion of seafood and sediment exposure at adjacent sediment area."	This inserted statement is not an IC requirement in the ROD or the IC plan. The text insert will not be incorporated.
7	PHS	p 5-1, Table 5-1	What were reasons for not having concurrence from regulator/stakeholder?	Regulators/stakeholders did not concur with the risk assessment inputs used. No change will be made to the text.

ID#	By	Sec./Pg.	Comment	Navy Response
8	PHS	p 6-4, 1st ¶	Any there particular reasons why less three canopy is occurring?	The Navy's assessment so far is that the trees would benefit from on-going fertilization, and this task has been added to the O&M contract.
9	PHS	p 6-5, 4th¶	There must be some means/ways considered to minimize the recharge/infiltration entering into the landfill's solid waste content.	Cut-off and containment was considered in the FS and rejected over concerns regarding reducing the marsh water budget. No change will be made to the text.
10	PHS	p 6-5, 5th¶	Ecology concurs the monitoring frequency of elevations of GW.	The Navy acknowledges this comment.
11	PHS	p 6-6, 4th¶	Does this mean "highly variable?"	The text edit will be incorporated
12	PHS	p 6-8, Table 6-1	How was this trend evaluated from the graph? Through eye-ball – examination?	Exponential regression trend lines were generated using the Excel function, and these were visually assessed for reasonableness. No changes will be made to trend graphs at this time. Ecology requested a more rigorous trend evaluation to be done by LTM contractor following Ecology's NA Guidance for Petroluem, publication No 05-09-091, 2005. Issue will be added to Issues Table p 7-51 and recommendation to the Recommendations Table p 8-1 .
13	PHS	p 6-8, Table 6-1	What's difference between "highly variable" and "stable"?	Highly variable means the concentrations fluctuated up and down from year to year. Stable means the concentrations are similar from year to year. Text defining these criteria will be added to the notes for Tables 6-1 through 6-3.
14	PHS	p 6-12, 2nd¶	This is true typically, but is not always the case.	The text inserts will not be incorporated. The text will be revised to say "The dissolved TCE concentrations in groundwater samples collected from these two monitoring wells remain two orders of magnitude less than the aqueous solubility limit for TCE, so the concentrations are not directly indicative of nonaqueous-phase TCE . "
15	PHS	p 6-12, 4th¶	Isn't it more appropriate to sum on molar basis since the biochemical reaction occurs on molar basis instead of mere concentration basis?	Agreed, summing on a molar basis could be done. However, the USGS reported the concentration sums which were used in the 5-Year Report figures and the concentration sums provide a good, qualitative visual representation of the footprint.
16	PHS	p 6-12, 4th¶	Is there a calculation of total cVOC mass in GW plume to support this statement?	Mass calculations have been done in the past, but not recently. This is based on a visual assessment of the contour maps. No changes will be made to the text. Mass flux calculations will be added to the scope of Phase II investigation as requested by Ecology.

ID#	By	Sec./Pg.	Comment	Navy Response
17	PHS	p 6-12, 4th¶	What's Figure number in Appendix C?	Figures C-33 through C-36 will be added to the last sentence.
18		p 6-13, 4th¶	Insert "...MW-17 could be.."	Insert will be incorporated into fourth paragraph
19	PHS	p 6-14, 1st¶	Need to evaluate the trend for GW concentrations measured in intermediate wells.	The last sentence will be modified to "Overall trends for those chemicals detected above RGs are stable to decreasing at MW1-25, MW1-28, and MW1-38, except cis-1,2-DCE. Concentrations of cis-1,2-DCE have slighly increasing from 1,300 ug/L in 2000 to 1,600 ug/L in 2014. Trend graphs were not performed on the intermediate aquifer in the LTM reports and thus are not available for inclusion in this report."
20	PHS	p 6-14, 2nd¶	Need to evaluate the trend for GW concentrations measured in deep wells.	The last sentence will be modified to "Overall trends were not performed for these wells because there were no detections and thus there are no trends."
21		p 6-20, 5th¶	Insert "…except PCBs"	Insert will not be incorporated because discussing VOCs in this paragraph.
22		p 6-20, 6th¶	Insert "…recently"	Insert will be incorporated in this paragraph.
23	PHS	p 6-21, 2nd¶	See ECY comments at section 7.1.2 for further information for the increase of sampling locations and frequency.	The Navy will do additional investigation of PCB concentrations in seep water and sediment as part of the Phase II investigation. The Phase II SAP will be developed in collaboration with EPA, Ecology, and the Suquamish Tribe.
24		p 6-21, 3rd¶	Insert "…and seep water"	Insert will be incorporated.
25		p 6-22, 2nd¶& 3rd¶	Insert "…of SCL"	Insert will not be incorporated because there is an error. The last sentence should read "There is no established ARAR for hexavalent chromium in accumulated solids for comparison to these data." The last sentence in the previous paragraph will be revised to "There is no established ARAR for hexavalent chromium in the SMS (SCO/SCL) for comparison with these data."
26	JE	p 6-23, 1st¶	Include a figure that shows locations of all PCB sampling throughout duration of project, or alter Figure 4-2 to clearly define PCB sampling stations. Add reference here.	Documenting all historical PCB sampling is not an element of this 5-year review. Such documentation can be made part of the review of PCB data collected under the Phase II investigation work.

ID#	By	Sec./Pg.	Comment	Navy Response
27	JE	p 6-23, 1st¶	Recommend sampling more frequently to collect adequate information on PCB concentration and trends to make decisions in the 2020 or 2025 5 year review. Additional sampling could collect PCB congener data, with sampling stations situated so that any impacts to PCB sediment levels due to elevated concentrations at SP1-1 are quantified.	The Navy will agree to one-time sampling of sediments at and around SP1-1 in collaboration with EPA, Ecology, and the Suquamish Tribe during the Phase II SAP development. The results of the Phase II investigation can be used to assess the need for on-going future sampling. If additional sampling is indicated, the frequency can be discussed at that time.
28		p 6-23, 1st¶	Inserts into first paragraph, last sentence	Inserts will not be incorporated in the last sentence of this paragraph. The purpose of the sampling is to assess whether recontamination is occurring, per the ROD. Therefore, the sentence will be changed as follows: "In addition, collection of sediment samples at and around SP1-1 for PCB analysis is recommended to determine if there is a correlation between the concentrations of PCBs in seep water and sediment and to evaluate if recontamination, as specified in the SMS regulation, is occuring."
29		p 6-23, 4th¶	Insert of "...twice every 5 years."	The Navy can agree to this change.
30	JE	p 6-41, 1st¶	Please expand on the determination that area 8 has been 'minimally impacted'	This statement is based on previous decisions made by the project team as a whole. The Navy directs the commenter to the meeting minutes. Adding additional text to the 5-year review to explain this past decision does not seem warranted.
31	PHS	p 6-43, 3rd¶, 2nd bullet	ATSDR used the consumption rate of 615 g/day (0.615 kg/day) which represents the 95 percent upper confidence limit (UCL95) of the shellfish consumption rate. For children, ATSDR used the consumption rate of 84 g/day (0.084 kg/day) which represents the UCL95 of all shellfish consumption.	The Navy acknowledges this comment.
32		Table 7-1, p 7-1	Revisions to Table 7-1	The Navy does not concur with edits made to Table 7-1, as noted in our response to Ecology's general comments. As such, the revisions to Table 7-1 will not be incorporated. An error was noted for Site 23, Questions C, "No" the yellow highlight will be removed.

ID#	By	Sec./Pg.	Comment	Navy Response
33	JE	Table 7-1, p 7-1	Additional toxicity data (PCB TEQs) should be collected to assess remedy against new cleanup levels in 2013 SMS, so no. Exposure assumptions are not valid any longer.	The Navy acknowledges that tribal exposure assumptions have changed. Evaluation of this change results in calculated risk values in the 10-4 to 10-6 range, which is acceptable per EPA 5-yr review guidance. In addition, the appropriate ingestion rates for use at the site are still under discussion between the Navy, EPA, the Suquamish Tribe and Ecology. Therefore, protectiveness remains as "protective in the short-term" because no shellfish harvesting is currently permitted. See response to Ecology's General Comment A.
34	JE	Table 7-1, p 7-1	Should be no, as exposure parameters have changed as discussed in section 7.3.2 – "Review of Risk Assessment Assumptions".	See response to comment 33.
35		p 7-2, 1st¶	Insert "...should…"	The change to the definitive word "should" is not warranted. The process that would be followed in such a circumstance would be up to the project team making the decision.
36		p 7-2, 2nd¶	Revisions to ARAR bullets	Inserts will be incorporated into the bullets. In addition, the first bullet will include the May 2014 criteria as provided in the CLARC database. Please note that data review period for this 5-year is from July 2009 – June 2014. The Navy acknowledges the changes to EPA's human health surface water criteria and Ecology's CLARC database revisions in August 2015. A direct chemical by chemical value comparison with the revised criteria will not be done, given that these changes occured after the review period for this 5-year review. However, a paragraph acknowledging the August 2015 revisions will be included. Given that institutional controls are in place to prevent exposure to site risks, these changes do not impact the protectiveness of the remedy, so will be assessed during the next 5-year review.
37		p 7-3, 1st¶	Insert "…for a short term…"	Insert will be incorporated into the sentence as follows: ""…not impact the short term protectiveness of the remedy as established in the ROD."

ID#	By	Sec./Pg.	Comment	Navy Response
38		p 7-3, 2nd¶, 2nd bullet; p 7-4, 1st¶ , 1st bullet & 2nd¶, 1st bullet	Insert in RAOs for groundwater, RAOs for surface water, and RAOs for sediment "…groundwater/***seep*** water…"	Insert will not be incorporated because it is not the wording of the RAOs in the ROD.
39	PHS	p 7-4, 2nd¶, 1st bullet	Concentration of acceptable risk level in sediment should also be established based on site-specific BSAF (Biota-Sediment Accumulation Factor).	If elevated PCB concentrations are identified in shellfish tissue sampling conducted under the Phase II investigation, then it may be warranted to calculate a site-specific BSAF. No changes will be made to the document.
40	PHS	p 7-5, 1st¶	Local tribe's subsistence consumption has been changed.	The Navy acknowledges the comment. This text is pulled directly from the ROD. See response to General Comment A.
41	PHS	p 7-5, 1st¶	Inserts into the first paragraph, last sentence	Insert will not be incorporated because it is not the wording of the RAO in the ROD.
42		p 7-5, 3rd¶	Insert into last sentence "…to harmless by-products."	Insert will be incorporated.
43		p 7-5, 5th¶	Insert into first sentence of last paragraph "…except PCBs..."	The Navy cannot agree to the addition of the wording, "except PCBs." The highest PCB concentrations prior to the ROD exceeded 1 ug/L, and todays concentrations are consistently below 1 ug/L.
44		p 7-6, 1st¶	Insert into last sentence of first paragraph "…conditions may call..."	The Navy disagrees. The conditions match those expected by the ROD. The sentence will be changed as follows: "…these conditions match those expected by the ROD, so do not call into question…"
45	PHS	p 7-6, 2nd¶	Insert into first sentence "…during ROD preparation." Were there any quantitative criteria for the expected performance in ROD?	Insert will be incorporated. The performance criteria are provided on page 78-79 of the ROD.
46	PHS	p 7-7, 1st¶	What percent of plume (area/volume) has contracted roughly?	The percent reduction over time will be calculated by looking at the areal extent of TCE concentrations greater than 5 ug/L comparing Figures C-17 to C-20.

ID#	By	Sec./Pg.	Comment	Navy Response
47	PHS	p 7-7, 2nd¶	Does “not impeding biodegradation of VOCs” means that biodegradation will occur without trees?	The ROD expressed concern that phytoremediation could have a detrimental impact on natural biodegradation (page 74 of the ROD). This statement speaks to that concern. No representation is being made regarding whether natural biodegradation would occur without the trees, however biodegradation was occuring prior to the trees being planted.
48	PHS	p 7-7, 2nd¶	Prevention of infiltration should be done mainly by capping over the landfill. Are we sure that there are no significant amount of flow of up-gradient GW flowing into the landfill below the capping? If we have GW elevation comparison table (for same season) before the ROD and 10 year after starting plantation and now, we could easily quantify infiltration rate change.	Please see responses to general comments. There has always been upgradient shallow groundwater flow. There are also many years of groundwater elevation data available.
49	PHS	p 7-7, 4th¶	Navy needs to estimate the rate of overall mass removal rate as a function of time (kg of TCE removal /day) so that the restoration time can be estimated when the information on source mass/volume becomes known later.	This estimation was previously performed (reference 2012c in this report) and found that many decades would be required.
50	PHS	p 7-7, 4th¶	How about shallow aquifer?	The shallow aquifer and intermediate aquifer are not used by receptors. As stated elsewhere, risk conditions in the shallow aquifer are the same or less than at the time of the ROD, when they were found to be acceptable.
51	JE	p 7-7, 2nd¶	Please describe current maintenance issues related to tide gate maintenance issues.	The recent tide gate maintenance issue occurred outside the review period of this 5-year Review (June 2009 to July 2014), so is not covered by this document and will be covered in the next 5-year.
52	JE	p 7-9, 1st¶	With PCB TEQs analysis reported PCB concentrations can be easily compared to new SMS sediment standards. Insert "…for a short term."	The Navy acknowledges the comment. Insert will be incorporated.
53		p 7-9, 2nd & 3rd¶s	Insert "…surface water***/seepwater*** …"	Insert will not be incorporated because RGs were not established specifically for seep water

ID#	By	Sec./Pg.	Comment	Navy Response
54	JE	Table 7-2	Include new sediment ARAR (SMS), as there may be a change in RG if established today.	Please note that data review period for this 5-year is from July 2009 – June 2014. The Navy acknowledges the changes to EPA's human health surface water criteria in June 2015 and Ecology's CLARC database revisions in August 2015. See response to comment 36. Table 7-2 note revised as follows: "[c]MTCA Method B values used are presented in Ecology's (2012) TCE/PCE Guidance. For PCE, the MCL value of 5 ug/L is used as the MTCA Method B value instead of the calculated value based on the guidance document. Although the MTCA Method B value for TCE is lower than the MCL, the MCL is used based on the guidance document and is still protective, meeting target risks of 10-5. The national AWQC for TCE and PCE are recommended for the MTCA Method B value in the guidance. Details are included in Section 7.1.2." A note will be put on all applicable Section 7 tables acknowledging use of CLARC database values and federal surface water criteria as of June 2014 based on the 5-year data review period of July 2009 to June 2014.
55	PHS	Table 7-2	Added here for the comparison purpose.	The RG is based on MTCA Method B; therefore, MTCA Method A values will not be included.
56	PHS	Table 7-2	CAS # added for quick reference and identification.	Crosswalk between CAS# and chemical will be added to front of Appendix B
57	PHS	Table 7-2	Please note the revision per CLARC-August 2015.	See response to comment 36 and 54.
58	PHS	Table 7-2	Revision made per current CLARC.	See response to comment 36 and 54.
59	PHS	Table 7-2	0.029 ug/L is @ 10E-6 risk level.	Navy acknowledges the comment.
60	PHS	Table 7-2	@ 10E-6 risk level children exposed.	Navy acknowledges the comment.
61	PHS	Table 7-2	PCBs is bioacculative. Is this RG of 0.04 ug/L protective of human health risk from sea food ingestion pathway per DOE's SMS 2013? Need to re-evaluate the RG of groundwater and surfacewater to be protective of sediment media based on protection of human health per WAC 173-204-561.	No, the MTCA B value for SW fish ingestion is 0.00011 ug/L; however, there are no shellfish in the marsh, thus, no human health ingestion pathway. See response to Ecology's General Comment A.

ID#	By	Sec./Pg.	Comment	Navy Response
62	PHS	Table 7-2	PQL of PCBs analysis: it is recommend to use of EPA Method 1668 Revision A which is almost 1000 time lower detection limits than the traditional Aroclor analysis. Method 1668 A has fewer problems with matrix interferences in a comple sample. The identification and quantification of individual PCB congeners is more accure than method 8082. Aroclor concentrations can be estimated from the congener concentrations as well.	See response to Ecology's General Comment A. The Navy will do additional investigation of PCB concentrations in seep water and sediment as part of the Phase II investigation. The Phase II SAP will be developed in collaboration with EPA, Ecology, and the Suquamish Tribe including determination of PQL and analytical method for PCBs.
63	PHS	Table 7-2	PCB mixtures	See response to comment 62.
64	PHS	Table 7-2 notes	This memo is outdated and no longer valid. http://www.ecy.wa.gov/programs/tcp/policies/tcppoly.html	Reference to WAC 173-340-720(7)(b) will be inserted into the footnote and the reference to 1993 Memo #1 will be deleted.
65	PHS	Table 7-3	SF used herein is correct. Please double-check the accuracy of Method B value of PCE.	Based on Ecology's 2012 PCE guidance MCL of 5 ug/L is MTCA Method B. Note added to the table, as follows:"[c]MTCA Method B values used are presented in Ecology's (2012) TCE/PCE Guidance. For PCE, the MCL value of 5 ug/L is used as the MTCA Method B value instead of the calculated value based on the guidance document. Although the MTCA Method B value for TCE is lower than the MCL, the MCL is used based on the guidance document and is still protective, meeting target risks of 10-5. The national AWQC for TCE and PCE are recommended for the MTCA Method B value in the guidance. Details are included in Section 7.1.2."
66	PHS	Table 7-3	Are Criteria to determine the protectiveness "IC" or "10E-4 risk level and HI =1?"	Both the ICs and risk level range of 1 x 10-6 to 10-4 and HI of 1 are considered. The only chemical exceeding a risk or hazard is cis-1,2-DCE (HQ = 4) and ICs are in place to prevent exposure to groundwater as drinking water.
67		p 7-15, 3rd¶	Insert into last sentence of third paragraph	Insert will be incorporated as follows, "Although …lower PQLs should be adopted as concentrations decline to near the current PQL."
68	PHS	p 7-16, 2nd¶	Please double-check this value based on new toxicity value of MTCA.	Both of the current MTCA Method B values are federal Clean Water Act AWQC values (consumption of organism only), based on Ecology guidance (Ecology 2012) rather than risk-based values using MTCA Method B equations. No text change will be made.
69	PHS	p 7-16, 2nd¶	Recalcualte the risk/HQ of PCE per new tox info.	See response to comment 68.

ID#	By	Sec./Pg.	Comment	Navy Response
70	JE	p 7-16, 3rd¶	12 mg/kg is the standard that is protective of benthic community per the 2013 revisions. The sediment cleanup objective (SCO) is set at the highest of natural background, practical quantitiation limit or a risk based concentration (the lowest of benthic, human health risk, and higher trophic level standards).	Please see the response to Ecology's General Comment A. The Navy will assess the need for additional risk assessment based on the Phase II data, but declines to make these changes to this portion of the text.
71	PHS	p 7-16, 3rd¶	Refer to WAC173-204-560 and 561.	See response to comment 70.
72		p 7-16, 3rd¶	Insert last sentence of third paragraph "...remedy ***may*** remain...	Given that the 1st part of the sentence is true, the insert will not be incorporated.
73	PHS	p 7-16, 4th¶	Per ROD of 1998, 15ug/kg of RG for clam tissue is based on 10E-5 Cancer risk level and 92 mg/day of ingestion rate for 70 kg body weight, fraction ingested of 0.25. See Table B-1 of ROD. This exposure assumption is no longer valid with new tribal substance consumption rate available.	See response to General Comment A. Further discussion between Ecology, EPA, and the Suquamish Tribe regarding the tribal scenario ingestion rates will be deferred to the Area 1 Phase II SAP development.
74	PHS	p 7-17, 3rd¶	Insert "...in shellfish tissue..." Need to use EPA 1668A method which is sensitive enough to measure much lower concentrations of PCBs.	Insert will be incorporated. The Navy will do additional investigation of PCB concentrations in seep water and sediment as part of the Phase II investigation. The Phase II SAP will be developed in collaboration with EPA, Ecology, and the Suquamish Tribe including determination of PQL and analytical method for PCBs. See response to General Ecology's Comment A.
75	PHS	p 7-17, 4th¶	Inserts into paragraph 4 RG for clam tissue of PCBs should be revised to reflect the updated exposure assumption. New RG for clam tissue of PCBs would be 0.24 ug/kg using 95% UCL of Squamish tribe per ATSDR report, 2013.	Insert "during ROD prepartion" will be incorporated. The Navy declines to add the numerical rates in this text. Appropriate rates would be a topic of discussion during planning for any future risk assessment and should be determined at that time. The Navy disagrees that the RG needs to be changed. The current RG remains protective within the short term because shellfish harvesting is currently not permitted.
76	PHS	p 7-17, 4th¶	Is there evidence to show the correctness of this statement scientifically? If it is true statement, where these COI comes from?	This language is paraphrased from the ROD and Third-5-year review; citations will be added.

ID#	By	Sec./Pg.	Comment	Navy Response
77		p 7-17, 5th¶	Insert into fifth paragraph	Insert will not be incorporated because the Navy disagrees that these changes are warranted. Text will be changed as follows: "Given the low or below detection limit concentrations of PCBs in site sediments, the seafood ingestion pathway is likely incomplete. However, the human health data gaps associated with this exposure pathway are further discussed in Section 7.1.3."
78	PHS	p 7-18, 2nd ¶	Increase of body weight will result in the increase of cleanup level from human health stand point.	This sentence will be revised as follows: "If Ecology adopts the revised EPA default values the cleanup levels could increase or decrease."
79	PHS	p 7-18, 3rd ¶	Current ECY guidance was published on 2009 which will be finalized in the near future.	The Navy acknowledges the comment.
80	PHS	p 7-19, 2nd ¶	There is only a Method C air cleanup levels which is based on 10E-5 risk level. There is no separate Method C air cleanup level for residential or industrial use. Refer to WAC 173-340-750.	Text will be revised as indicated.
81		Table 7-5	Revisions to notes	Inserts will be incorporated.
82	PHS	p 7-23, 2nd ¶, two bullets	Ecology agrees the identification of these two data gaps. And it is about a time to revisit with updated SMS rule and local exposure assumptions.	Insert will not be incorporated. The need to revise existing RGs will be determined based on the data generated during the Phase II investigation.
83		p 7-24, last bullet	Insert into last bullet	Insert will be incorporated.
84	PHS	p 7-25, 3rd¶	PCBs identified as COC at OU 1 are: Aroclor 1016, 1232, 1242, 1254, 1260 per ROD.	The Navy acknowledges this comment.

ID#	By	Sec./Pg.	Comment	Navy Response
85	PHS	p 7-25, 5th¶	Human who harvest and consume shellfish from the Tide Flats or Dogfish~~, the Shallow Lagoon, or Liberty~~ Bay are most likely being exposed to PCBs that are currently being migrated off base into adjacent shallow marine sediment via Groundwater to Seep to surface-water exposure pathway. The figure 7-1 should be revised to reflect this exposure pathway. PCBs have been detected the upper and intermediate aquifer below within the core solid waste content. Groundwater contaminated with PCBs has been flowing into adjacent surface water bodies- Tide flats and dogfish bay. 2001 ATSDER report recommends that Navy continue monitoring at least every five year contaminant levels in seafood from marine waters surrounding NUWC Keyport for minimum of three consecutive sampling periods. Analyses for PCBs, should be made using wet weight methodology and should be lipid adjusted for individual fat content. Table of 2001 report indicates also evaluation of future sampling data is need to determine temporal trends in PCBs concentrations. 2013 ATSDER report indicates that per 2000 Squamish Tribe report, for adults need to use the consumption rate of 615 g/day which represent the 95% upper confidence limit of the shellfish consumption rate.	The Navy disagrees that there is a complete, on-going exposure to PCBs in tissue at concentrations representing an unacceptable risk, as explained in previous responses to Ecology General Comment A and specific comments. The Navy has only found limited detections in the tide flats and not in Dogfish Bay.

ID#	By	Sec./Pg.	Comment	Navy Response
86	PHS	p 7-25, 5th¶	It is critical to achieve the RG of surface water in order to avoid the re-contamination of PCBs in Sediment per WAC 173-204-500(4)(b).	The Navy does not concur. Please see responses to Ecology's General Comment A. The following sentence "Ecology believes that it is critical to achieve the surface water RG to avoid re-contamination of sediments per WAC 173-204-500(4)(b)." will be added after "...consistently detected at concentrations ranging from 0.3 to 0.4 µg/L, with a reported increase in 2014 to 0.696 µg/L. " The cited paragraph of the SMS does not state that surface water CULs must be achieved to prevent recontamination, only that recontamination "may occur from ongoing discharges or releases." Without empirical evidence (sediment samples over time) or loading modeling, we can't say for certain whether the ongoing surface water RG exceedance represents an actual threat of recontamination. Based on the historical sediment data, we have previously concluded (with Ecology's concurrence) that it does not.
87	PHS	p 7-25, 5th¶	There is huge uncertainty regarding future risk, since PCBs degrade extremely slow, bio-accumulative and carcinogenic, the landfill appears to be a long-term and ongoing source of PCBs to the marine environment. As concentration of seep water have continuously exceeded 0.04 ug/L of RG which was based on PQL 15 years ago. This PQL is almost 63 times higher than National AWQ of 0.000064 ug/L. Mathematical Modelling/assessment to predict the concentration of adjacent bay sediment is need to assess the current RG for Seep/GW are sufficiently protective to prevent re-contamination of sediment and resulting in increase of tissue concentration. Current concentrations of PCBs in sediment/tissue may not pose adverse effect to benthic resources, the landfill source is not controlled and therefor further action is needed to prevent concentrations from increasing over time and causing unacceptable risk in the future via food-chain/ecological pathway. Ecology recommends use of simple one-dimensional steady-state model of chemical transport- e.g., Lmapert and Reible model.	The Navy will do additional investigation of PCB concentrations in seep water and sediment as part of the Phase II investigation. The Phase II SAP will be developed in collaboration with EPA, Ecology, and the Suquamish Tribe and mathmatical modelling of sediment concentrations may be incorporated with concurrance of the project team.

ID#	By	Sec./Pg.	Comment	Navy Response
88		p 7-26, 1st¶	Inserts into last sentence.	The inserts will not be incorporated. The Navy will do additional investigation of PCB concentrations in seep water and sediment as part of the Phase II investigation. The Phase II SAP will be developed in collaboration with EPA, Ecology, and the Suquamish Tribe, including determination of PQL and analytical method for PCBs.
89	PHS	Figure 7-1	Revise Figure 7-1 to indicate that both surface run-off and groundwater are migrating into the surfacewater/sediment media. Link the two exposure pathways from shallow & intermediate groundwater to both marine estuarine surface-water and sediments.	The figure will be revised by adding an arrow from the shallow groundwater box to the marine sediment and marine surface water box.
90	JE	Table 7-8	Lack of PCB sampling data since 2009 has not quantified the potential recontamination of the sediments surrounding seep SP1-1 or other sediment area.	The Navy disagrees. Historical data already documented that recontamination was not occurring, and Ecology agreed with the termination of PCB sampling. The Navy has conservatively agreed to re-institute PCB sampling. Insert for OU 1 will not be incorporated as written. Agree to add the follwowing text: " PCB data from seep SP1-1, and in sediment at two stations, imply that PCB concentrations may be increasing."

ID#	By	Sec./Pg.	Comment	Navy Response
91	JE	Table 8-1	Expand PCB sampling program to assess PCB recontamination around the area of elevated seep concentrations. New sampling rationale should include PCB congener analyses to allow for comparison to new SMS standards.	Inserts will not be incorporated. Can agree to add, "collect additional sediment samples at, and in the vicinity of seep SP1-1 during the Phase II investigation and use the data to assess whether expanded, on-going PCB monitoring should be initiated, and whether risk assumptions should be reviewed."

October 8, 2015

NAVY RESPONSES TO:

SUQUAMISH TRIBE COMMENTS ON THE DRAFT FOURTH FIVE-YEAR REVIEW, NAVAL BASE KITSAP KEYPORT, KEYPORT, WASHINGTON, DATED 20 JULY 2015 - COMMENTS RECEIVED SEPTEMBER 3, 2015

Navy Responses follow the Tribe comments in blue italicized text.

OU 1 Protectiveness Determination

The Tribe disagrees with the determination that the OU 1 remedy is protective in the short term and recommends that it be changed to "protectiveness deferred".

As acknowledged in the draft report, contaminated groundwater continues to discharge to surface water at levels in excess of state and federal criteria used to define unacceptable risks at the site. Ongoing issues include the basic characterization of the southern portion of the site, potential impacts to the adjacent marsh and stream, worker exposure via vapor intrusion, and appropriate remedial goals (RGs) and compliance points. Note that similar issues were identified at the conclusion of the third 5YR, resulting in a deferred protectiveness determination.

Since the completion of the third 5YR, considerable progress has been made to re-characterize the southern portion of the site and to optimize the existing remedy. The Tribe supports these efforts and believes that once the necessary information is obtained, the project team will be able to evaluate the need for additional action at OU 1. Until then, the Tribe does not believe there is sufficient documentation to conclude that the remedy is protective in the short term.

It is recommended that the Navy propose to complete a 5YR addendum to document the findings of the re-characterization and whether there is a need for additional action to ensure long-term protectiveness. The addendum and a milestone date should be added to Table 8-1.

The Navy acknowledges the Tribe's recommendation that a protectiveness determination regarding OU 1 be deferred, but respectfully disagrees, based on current Navy Policy (U.S. Navy 2011). Over the last five years the Navy has re-evaluated the appropriateness of deferring protectiveness determinations, and has concluded that deferrals have been overused. The "protective in the short term" determination provides the additional time needed to collaborate with regulators and stakeholder regarding next steps to address identified issues. If deferred, then a one year time limit for an addendum to the 5-year (U.S. Navy 2011) would go into effect limiting the Navy's ability to work collaboratively. At OU 1, there is no evidence of current or short-term detrimental effects on human health or the environment from the existing site conditions. Although there are on-going exceedances of surface water ARARs at one station immediately adjacent to the southern portion of the plantation, this condition was known at the time of the ROD, was found to not represent an unacceptable risk at the time, and the risk conditions have not worsened.

The on-going work to optimize the remedy in the southern portion of the former landfill does not imply that the remedy in this area is not protective in the short term.

The data collection effort planned to assess a potential vapor intrusion pathway in buildings located east of Bradley Road might plausibly reveal a long-term exposure hazard, but worker health is very unlikely to be impacted protectiveness in the short term.

The Navy continues to believe that the remedy at OU 1 is protective in the short term, and does not concur that an addendum to the 5-year review will be needed. Additional data collected based on the recommendations of this 5-year review, and the protectiveness conclusions based on those data, can be documented in reports of the work, which will be available for review by the Tribe.

The Navy proposes no changes to the document based on this comment.

OU 2 Protectiveness Determination

The Tribe agrees that the remedy for OU 2 Area 2 is protective in the short term. Long-term monitoring data indicate that site risks are within acceptable ranges and are expected to continue to decrease. No additional exposure routes have been identified.

The Tribe disagrees with the determination that the remedy for OU 2 Area 8 is protective in the short term and recommends that the determination be changed to "protectiveness deferred".

At Area 8, significant concerns remain regarding potential risks to human health and the environment from the continued discharge of contaminated groundwater to Liberty Bay. As with OU 1, these same concerns were identified during the third 5YR, also resulting in a deferred protectiveness determination for Area 8.

The Tribe supports the current investigation of the Area 8 intertidal zone and the planned human health and ecological risk assessments. Once the necessary information is obtained, the need for additional action at Area 8 can be evaluated. Until then, the Tribe does not believe there is sufficient documentation to conclude that the remedy is protective in the short term.

It is recommended that the Navy propose to complete a 5YR addendum to document the findings of the intertidal investigation and risk assessments and determine whether there is a need for additional action to ensure long-term protectiveness. The addendum and a milestone date should be added to Table 8-1.

The Navy is pleased that the Tribe concurs with the proposed protectiveness determination for OU 2, Area 2.

The Navy acknowledges the Tribe's recommendation that a protectiveness determination regarding OU 2, Area 8 be deferred, but respectfully disagrees based on current Navy Policy (U.S. Navy 2011) as discussed previously for OU 1. There is no evidence of current or short-term detrimental effects on human health or the environment from the existing site conditions. However, it is possible that future long-term exposure to the site could cause detrimental effects and the Navy continues to work with the *regulator/stakeholder team to assess these potential risks.*

The Navy continues to believe that the remedy at OU 2, Area 8 is protective in the short term, and does not concur that an addendum to the 5-year review will be needed. The results of planned risk assessments will be documented in reports of the work, which will be available for review by the Tribe.

The Navy proposes no changes to the document based on this comment.

<u>Site Wide Protectiveness Determination</u>

The Tribe agrees with the site wide determination of “protectiveness deferred”, based on the need to address ongoing issues at OU 1 and OU 2 Area 8.

As stated in Section 9 and in the narrative of the Executive Summary table, the Navy has concluded that the site-wide protectiveness is “protective in the short term.” The use of “deferred” in the Protectiveness Determination cell of the Executive Summary table is an error that will be corrected in the final version of the report.

<u>OU 1 Technical Assessment</u>

Question A:

The answer to Question A should be changed to “No”. The remedy was implemented as intended by the ROD. However, because the restoration timeframe for the southern plantation is slower than anticipated, the phytoremediation and natural attenuation components cannot be said to be functioning as intended.

The Navy acknowledges the Tribe’s concern that the OU 1 remedy should be concluded to not be functioning as intended by the ROD, but respectfully disagrees. The ROD anticipated that many decades would be required for the remedy to meet the remediation goals. It is the desire of the project team to improve upon this restoration timeframe that is resulting in additional investigation, not a lack of remedy functionality.

The Navy proposes no changes to the document based on this comment.

Question B:

Question B needs to be re-evaluated to consider whether the RGs established in the OU 1 ROD remain protective of human health and the environment.

Specifically, this section should include an evaluation of the 2013 revisions to the WA SMS that establish risk-based criteria for the protection of human health and higher trophic level organisms. The SMS rule also provides for a default to background levels if risk-based levels (using tribal exposure parameters) are lower than background. For this site, because regional background has not been established, natural background levels provide the appropriate comparison.

In addition, EPA is in process of promulgating new water quality criteria for Washington, which will also incorporate tribal exposure parameters, including an increased consumption rate. It is likely that surface water RGs based on state and federal standards at the time of the ROD will no longer be considered to be protective for human health via consumption of aquatic organisms.

If RGs established today would be lower than those established at the time of the ROD, site data should be compared to current standards. In particular, metals and PCB data for sediments should be compared to risk-based or background levels. Non-detect values for tissue samples should also be reviewed to determine if analytical detection limits were below current risk-based levels or standards.

The Navy agrees that new SMS and the evaluation of HH risk applies. The Navy does not believe the new SMS calls into question the short term protectiveness of the remedy.

For the tide flats, where human exposures are expected to occur through consumption of shellfish, clam tissue data were collected to directly measure the risks associated with consumption of marine organisms that could be potentially impacted by PCBs in sediment. The clam tissue data were evaluated in light of the new information regarding Suquamish consumption rates to determine whether the change in ARARs (i.e., the new SMS) would indicate that the sediment RGs are no longer protective. The most recent PCB results for clam samples collected from the tide flats in 2009 were not detected at a reporting limit of 10 µg/kg. Given that Suquamish ingestion rates for shellfish are among the highest rates documented for Puget Sound tribes, if PCBs were present at or even below the analytical reporting limit, it can be assumed that the associated cancer risk would be above the SMS acceptable levels of 1×10^{-6} for individual contaminants and 1×10^{-5} for cumulative risk. However, because Suquamish tribal members are not currently harvesting and consuming shellfish from the tide flats, the short term protectiveness of the remedy is not called into question. Further discussion between the Navy, Ecology, EPA, and the Suquamish Tribe regarding the development of risk-based screening levels and appropriate analytical methods and reporting limits will be deferred to the Area 1 Phase II SAP development. In addition, detection limits for historical metals data will be reviewed during SAP development.

In the marsh, because shellfish are not present, calculation of a sediment cleanup level protective of human health via ingestion of clams is not needed. The purpose of resampling sediment in the marsh is to evaluate whether PCB concentrations have increased, and whether ecological risk assessment is warranted to assess risks to higher trophic levels. As discussed above, under the revised SMS, the SCO criterion for total PCBs remains at 12 mg/kg and is considered to be protective for benthic organisms. The additional data needs required per SMS for upper trophic pathway evaluation, PCB PQLs and PCB analytical methods will be considered in consultation with Ecology, EPA and the Suquamish Tribe during the Phase II SAP development.

EPA is in process of promulgating new water quality criteria for Washington State. Because these criteria are not yet finalized, their impact to remedy protectiveness will be evaluated as an ARAR change during the next five-year review.

This information provided above will be summarized in the "Sediment" subsection of Section 7.1.2, Review of ARARs and Toxicity Criteria.

OU 2 Area 8 Technical Assessment

Question A:

The answer for Question A should be changed to “No”. The remedy for Area 8 was implemented as intended by the ROD. However, because of the continued discharge of contaminated groundwater to the marine environment, the RAO to protect sediments and surface water quality offshore of Area 8 in Liberty Bay from contaminants in groundwater that could cause future adverse impacts or human health risks has not been achieved. Reliance on a harvest restriction that does not address site-related exposures, is not part of the remedy, and is not under the jurisdiction of the Navy cannot be considered to be protective. The remedy cannot be considered to be functioning as intended at this time.

The Navy acknowledges the Tribe’s concern that the OU 2, Area 8 remedy should be concluded to not be functioning as intended, but respectfully disagrees. The ROD anticipated that groundwater containing metals would continue to be discharged from the site via intertidal seeps, and therefore the site conditions are consistent with the intent of the remedy.

The Navy proposes no changes to the document based on this comment.

Question B:

The answer to Question B should be changed to “No”.

The discussion in Section 7.3.2 documents that the exposure assumptions used in the baseline HHRA are no longer valid for evaluating subsistence risks and that changes in the exposure parameters are likely to impact the protectiveness of the remedy.

Section 7.3.2 should be revised to consider 2013 revisions to the WA SMS that establish risk-based criteria for the protection of human health and higher trophic level organisms. The SMS rule also provides for a default to background levels if risk-based levels (using tribal exposure parameters) are lower than background. For this site, because regional background has not been established, natural background levels provide the appropriate comparison.

Also, as mentioned in the OU 1 technical assessment comments, EPA is in process of promulgating new water quality criteria for Washington, which will incorporate tribal exposure parameters, including an increased consumption rate. It is likely that surface water RGs based on state and federal standards at the time of the ROD will no longer be considered to be protective of human health via consumption of aquatic organisms.

No numerical sediment RG was established in the ROD. The results of the LTM tissue and sediment sampling have been used to assess the human health risks from exposure to marine sediment and tissue. As there are currently institutional controls in place that prohibit the harvesting of shellfish from Liberty Bay, the change in ARAR (i.e., the new SMS) does not call into question the short-term protectiveness of the remedy. The data gaps evaluation and the sampling plan completed in collaboration with the Stakeholders resulted in a field sampling effort designed to provide the data necessary to complete human health and ecological risk assessments consistent with the new SMS. The *protectiveness of the remedy as it relates to the change in the SMS will be assessed upon completion of the risk assessments. This information provided above will be summarized in a new subsection, "Sediment", added to Section 7.3.2, Review of ARARs and Toxicity Criteria.*

References

U.S. Navy 2011. Memo titled Policy For Conducting Five-Year Reviews. 5090, N453 Ser/11U158119, 7 June 2011. From: Director, Energy and Environmental Readiness Division, To: Commander, Naval Facilities Engineering Command