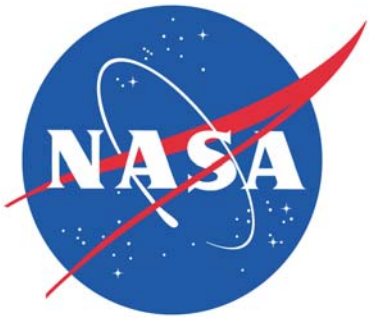
Five-Year Review



National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia

January 2014

FIVE-YEAR REVIEW

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

SUBMITTED BY:
National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Code 250.W, Building F-160
Wallops Island, Virginia 23337

January 2014

CERTIFICATION

The enclosed document was prepared, and is being submitted, in accordance with the requirements of the Administrative Agreement On Consent between the United States Environmental Protection Agency and the National Aeronautics and Space Administration [U.S. EPA Docket Number RCRA-03-2004-0201TH].

I certify that the information contained in or accompanying this document is true, accurate, and complete.

I certify under penalty of law that this document and all attachments were prepared in accordance with procedures designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, or the immediate supervisor of such person(s), the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Signature: Theodore J. Meyer

Name: Mr. Theodore J. Meyer

Title: NASA Project Coordinator

EXECUTIVE SUMMARY

The National Aeronautics and Space Administration (NASA) conducted this Five-Year Review (5YR) for Goddard Space Flight Center, Wallops Flight Facility (WFF) located in Wallops Island, Virginia, as specified in Section VI(G)(5)(c) of the *Administrative Agreement on Consent (AAOC)* (United States [U.S.] Environmental Protection Agency [EPA] and NASA, 2004), and in accordance with Section 121(c) of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act of 1986* (SARA) and implemented by the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP). To date WFF has not been proposed for National Priorities List (NPL) listing; however, by agreement the "AAOC sites" are addressed under the CERCLA regulatory framework. This is the first 5YR [report] conducted at WFF by NASA under the AAOC.

This report is consistent with EPA's (2001) *Comprehensive Five-Year Review Guidance*. It summarizes the evaluation of remedies and remedial actions that resulted in hazardous substances, pollutants, or contaminants remaining at sites above levels that allow for unlimited use and unrestricted exposure (UU/UE), and for which there is a final Record of Decision (ROD). The following two AAOC sites require a CERLCA 5YR:

- Former Fire Training Area (FFTA)
- Waste Oil Dump (WOD)

The objective of the 5YR is to evaluate the effectiveness of the remedies to determine if these continue to be protective of human health and the environment in accordance with the requirements set forth in the RODs. This evaluation was accomplished through a review of various reports and documents pertaining to post-remedy implementation activities, analytical data, and findings, and through site visits, interviews, and inspections. The community was notified of the review process through public notices. This report identifies circumstances that may prevent a particular remedy from functioning as designed or providing sufficient protection of human health and the environment. The overall evaluations of the effectiveness of each remedy are presented as protectiveness statements in the *Five-Year Review Summary Form* provided below.

FIVE-YEAR REVIEW SUMMARY FORM		
Site Identification		
Site name *(from WasteLAN)*: NASA Wallops Island Flight Facility		
EPA ID *(from WasteLAN)*: VA8800010763		
Region: 3	**State:** VA	**City/County:** Wallops Island / Accomack County
Site Status		
NPL status: ☐ Final ☐ Deleted ☒ Other (specify): To date this facility has not been proposed for NPL listing; CERCLA response actions at the subject sites are addressed under the RCRA 7003 Agreement on Consent that was executed between EPA and NASA.		
Remediation status (choose all that apply): ☐ Under Construction ☒ Operating ☐ Complete		
Multiple OUs?* ☒YES ☐ NO	**Construction completion date:** NA	
Has site been put into reuse? ☐ YES ☒ NO		
Review Status		
Lead agency: ☐ EPA ☐ State ☐ Tribe ☒ Other Federal Agency: NASA		
Author name: Theodore J. Meyer		
Author title: NASA Project Coordinator	**Author affiliation:** NASA Environmental Compliance and Restoration Program	
Review period: April 25, 2103 – December 2013		
Date(s) of site inspections: June 25, 2013		
Type of review: ☐ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only ☒ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead ☐ Regional Discretion		
Review number: ☒ 1 (first) ☐ 2 (second) ☐ 3 (third) ☐ Other (specify) _____		
Triggering action: ☒ Actual RA Onsite Construction at OU # both WOD and FFTA ☐ Construction Completion ☐ Actual RA Start at OU#____ ☐ Other (specify) ☐ Previous Five-Year Review Report		
Triggering action date *(from WasteLAN)*: December 2008		
Due date *(five years after triggering action date)*: December 2013		

FIVE-YEAR REVIEW SUMMARY FORM

Former Fire Training Area (FFTA)

- **Issue(s):** Emerging contaminant(s) (i.e., perfluorinated compounds [PFCs]) may be present based on historical usage of aqueous film forming foams (AFFF) in firefighting training exercises. No other issues.
- **Recommendation(s) and Follow-up Action(s):**
  Evaluate PFCs at the site prior to next five-year review. Work with EPA and VDEQ to determine components and complete the evaluation by December 31, 2018.
- **Protectiveness Statement(s):**
  Protectiveness-deferred until PFCs are evaluated at the site.

Waste Oil Dump (WOD)

- **Issue(s):** None.
- **Recommendation(s) and Follow-up Action(s):**
  None.
- **Protectiveness Statement(s):**
  The final remedial action is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled. All of the RAOs are being satisfied. The remedy is functioning as intended by the ROD.

Other Comments:

A Five-Year Review Addendum will be issued prior to the next five-year review to provide the protectiveness determination for FFTA following evaluation of PFCs at the site.

Next Review:

The next five-year review will be completed in December 2018.

Signature of NASA:

William A. Wrobel
Director
Wallops Flight Facility

Date 30 JANUARY 2014

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ACRONYMS AND ABBREVIATIONS

~	approximately / estimated / about
µg	microgram
µg/kg	microgram per kilogram
5YR	five-year review
AFFF	aqueous film forming foams
AOC	Area Of Concern
AAOC	Administrative Agreement On Consent
ARAR	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
COC	Chemical of Concern
CTO	Contract Task Order
DCE	dichloroethene
ECR	[NASA's] Environmental Compliance and Restoration [Program]
EPA	U.S. Environmental Protection Agency
FFTA	Former Fire Training Area
ft	feet / foot
FUDS	Formerly Utilized Defense Sites
GIS	Geographic Information System
GSFC	Goddard Space Flight Center
HHRA	human health risk assessment
HSWA	Hazardous and Solid Waste Amendments of 1984
IC	institutional control
ILCR	Incremental Lifetime Cancer Risk
kg	kilogram
L	liter
LTM	long-term monitoring
LUC	land use control
MARS	Mid-Atlantic Regional Space Port
MB	Main Base [portion of WFF facility]
MCL	Maximum Contaminant Level
mg	milligram
mg/kg	milligram per kilogram
mg/L	milligram per liter
MEC	munitions and explosives of concern
ML	Main Land [portion of WFF facility]
msl	[above] mean sea level
NAAS	[Chincoteague] Naval Auxiliary Air Station
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
Navy	U.S. Navy
NCP	National Oil and Hazardous Substances and Contingency Plan (i.e., National Contingency Plan)
NOAA	National Oceanic and Atmospheric Administration

NPL	National Priorities List
O&M	operation and maintenance
PA	Preliminary Assessment
ppm	part(s) per million
PFC	perfluorinated compound
PFBS	perfluorobutanesulfonic acid
PFHpA	perfluoroheptanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PRP	Potentially Responsible Party
RACR	Remedial Action Completion Report
RAO	Remedial Action Objective
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act of 1976
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
RSL	Regional Screening Level
SDWA	Safe Drinking Water Act [Amendments of 1986]
SI	Site Investigation
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
Tt	Tetra Tech
UCMR3	[EPA's] Unregulated Contaminant Monitoring Rule 3
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
UU/UE	unlimited use and unrestricted exposure
VC	vinyl chloride
VDEQ	Virginia Department of Environmental Quality
WOD	Waste Oil Dump
WFF	Wallops Flight Facility
WI	Wallops Island [portion of WFF]

1.0 INTRODUCTION

The National Aeronautics and Space Administration (NASA) conducted this Five-Year Review (5YR) for Goddard Space Flight Center, Wallops Flight Facility (WFF) located in Wallops Island, Virginia (Figure 1-1); as specified by Section VI(G)(5)(c) of the 2004 *Administrative Agreement on Consent (AAOC)* executed between NASA and the United States (U.S.) Environmental Protection Agency (EPA); and in accordance with Section 121(c) of CERCLA, as amended by the SARA and implemented by the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP).

To date WFF has not been proposed for addition to the National Priorities List (NPL); however, by agreement the obligations of the AAOC are met using the CERCLA process. This is the first 5YR [report] for the sites at WFF addressed by NASA under the AAOC. This report is consistent with EPA's (2001) *Comprehensive Five-Year Review Guidance* and related supplemental EPA guidance and policy(ies) (EPA, 2011, 2012a, and 2012b), and it summarizes the evaluation of remedies and remedial actions that were (i) implemented by a final Record of Decision (ROD) and (ii) resulted in hazardous substances, pollutants, or contaminants remaining at sites above levels that allow for unlimited use and unrestricted exposure (UU/UE). The following two sites addressed by NASA under the AAOC require a CERLCA 5YR (Figure 1-2):

- Former Fire Training Area (FFTA)
- Waste Oil Dump (WOD)

This is the first 5YR for the NASA WFF. Table 1-1 presents the status of the areas of concern or sites identified at WFF. Further detail regarding individual sites is provided in the WFF Site Management Plan. The triggering action for this review is the initiation of remedial actions via pilot studies at FFTA and WOD in December 2008. This review is required because hazardous substances, pollutants, or contaminants remain at the sites above levels that allow for UU/UE. Two other sites at NASA WFF requiring remedial action are not addressed in this 5YR. A removal action was completed at the Scrapyard Site (N-222) and a ROD selecting No Action as the remedy was signed and issued in December 2008 (Tetra Tech [Tt], 2008f). The ROD confirmed that no hazardous substances, pollutants, or contaminants remain at the site above levels that allow for UU/UE and declared that no 5YR was required. A ROD selecting excavation and offsite disposal as the final remedy for the Paint Stain and Former Wind Tunnel (Sites 5 and 12, respectively) was signed in December 2011 (Tt, 2011c). Implementation of the selected remedy is ongoing, and when completed, no hazardous substances, pollutants, or contaminants will remain at the site above levels that allow for UU/UE. Therefore, a 5YR is not required for Sites 5 and 12.

This 5YR report was prepared pursuant to CERCLA §121(c) and the NCP. CERCLA §121(c) 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 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.

EPA interpreted this requirement further in 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 actions no less often than every five years after the initiation of the selected remedial action.

The triggering action of the statutory review process was the pilot study remedial action for the FFTA and WOD initiated in December 2008. This 5YR for WFF was accomplished through a review of various reports and documents pertaining to post remedy-implementation activities, analytical data, and findings, and through site visits, inspections, and interviews. The community was notified of the review process through public notices.

2.0 FIVE-YEAR REVIEW PROCESS

2.1 ADMINISTRATIVE COMPONENTS

EPA and the Virginia Department of Environmental Quality (VDEQ) were notified of the initiation of the 5YR process in December 2012 during the quarterly Remedial Project Manager (RPM) meeting associated with the AAOC sites. The 5YR team was led by Mr. Theodore J Meyer, the NASA Project Coordinator (i.e., RPM) for the Environmental Compliance and Restoration Program at WFF. Mr. Steven Hirsh is the RPM for EPA, the lead regulatory agency, and Mr. Paul Herman is the RPM for VDEQ, the support agency.

Information relevant to the ROD sites is presented in Sections 4 and 5 and the appendices. The components of the 5YR process consist of the following:

- Community Involvement
- Document Review
- Data Review
- Site Inspection
- Interviews

2.2 COMMUNITY INVOLVEMENT

NASA communicates with the public through periodic public meetings and the issuance of fact sheets. The Community Involvement Plan for NASA WFF (Tetra Tech, 2003) details community involvement strategies and protocol, and community relations activities are documented in the NASA WFF Administrative Record file.

A public notice was posted in the *Eastern Shore News* and the *Chincoteague Beacon* on April 20 and 25, 2013, respectively, to indicate the initiation of the 5YR effort and the sites to be included. Upon completion of the 5YR, a notice will be sent to the same newspapers to indicate the completion of the Final 5YR Report, summarize the results, and detail the report's availability to the public in the Administrative Record file and the Information Repositories maintained at the Eastern Shore Public Library (23610 Front Street, Accomack, Virginia 23301) and Island Library (4077 Main Street, Chincoteague, Virginia 23336). If warranted, summary 5YR results fact sheets also will be prepared and made available.

3.0 BACKGROUND INFORMATION

The information in this section is adapted from the most recent *Site Management Plan* for the sites NASA addresses under the AAOC (Tt, 2012a). Refer to the SMP for additional detail.

3.1 FACILITY PHYSICAL CHARACTERISTICS

WFF is located in Accomack County, Virginia, and consists of three land parcels: Main Base (MB), Mainland (ML), and Wallops Island (WI). The MB is comprised of 1927 acres located near the intersection of Virginia Routes 798 and 175. The ML is located about 6 miles to the south of the MB on Virginia Route 679 and consists of 1,207 acres containing about 100 acres of usable land (the remaining acreage is marshland). The ML parcel is connected to the WI parcel by a causeway constructed in 1960. The WI parcel is a 7-mile-long 3,395 acre barrier island.

The MB is the most heavily developed of the parcels that comprise the NASA WFF. The MB includes NASA administrative and technical offices, tracking and data acquisition components, the range control center, rocket motor storage and processing facilities, research and development facilities, an airfield and control tower, aircraft hangars, and maintenance facilities. The MB also supports tenant organizations including the U.S. Navy (Navy), who maintains a Naval Surface Combat Systems Center, engineering training center, and housing operations; National Oceanic and Atmospheric Administration (NOAA), who maintains satellite antennae and data acquisition operations; and the Mid-Atlantic Regional Space Port (MARS), who maintain an office complex at the MB. The Town of Chincoteague, Virginia, is located 5 miles east of the MB.

The MB is bordered to the east by extensive marshland and creeks that drain to the Chincoteague Bay and inlet. Little Mosquito Creek, which eventually also flows east into the inlet and to the Atlantic Ocean, borders the MB to the north and west. State Routes 175 and 798 form the southern and southeastern borders of the facility. The runway complex covers a large portion of the MB and forms a flat plateau-like feature that covers the majority of the highest elevations at MB. Surface water drainage from the MB is through natural and manmade drainage structures. Drainage within the industrialized portions of the MB is controlled and diverted by stormwater collection and conveyance systems. In addition, portions of the base have been isolated from surface water drainage areas by the formation of berms and higher elevation structures. The natural drainage patterns for the southwestern, western, and northern portions of the MB are to Mosquito Creek and its tributaries. The eastern, southeastern, and southern portions of the MB drain to a series of marshlands, creeks, and bays that lead to Chincoteague Bay and the Atlantic Ocean.

In general, groundwater beneath WFF occurs within two water-bearing units or formations: the Columbia Aquifer and the Yorktown Aquifer. The Columbia Aquifer is unconfined extending to a depth of about 60 feet below the ground surface. It's is underlain by a 20- to 40-feet-thick clay aquitard that isolates the Columbia from the underlying Yorktown Aquifer. Groundwater beneath the MB serves as the source of drinking and process water for NASA and tenant organizations as well as the Town of Chincoteague. NASA operates and maintains a permitted water supply system that includes five active wells located across the center portion of the MB. NOAA maintained a single water supply well, drilled into the Yorktown formation, until 2005 when the facility discontinued use of the well and connected to the NASA water supply system. The Town of Chincoteague maintains eight water supply wells located on WFF property along the eastern boundary of the MB. NASA supply wells withdraw water from the Yorktown Aquifer at depths that range from 100 to 260 feet below ground surface. Five of the Town of

Chincoteague wells also are completed within the Yorktown Aquifer and withdraw water from depths that range from 96 to 256 feet below ground surface. Three of the Town of Chincoteague wells are completed within the Columbia Aquifer at depths of 40 to 60 feet below ground surface.

The ML is located along the Virginia Inside Passage and borders Hog Creek, which drains the ML. The primary function of the ML is to provide access to WI. A controlled access causeway, extending from the ML over Hog Creek and its marshlands, is the only vehicular access route to the WI parcel. NASA maintains guard houses and limited radar and optical tracking stations on the ML. The ML also provides all drinking and process water for WI. NASA operates and maintains two drinking water supply wells on the ML. The drinking water wells withdraw water from the Yorktown Aquifer at depths of 195 to 255 feet below the ground surface. In September 2006, NASA abandoned two former fire protection water supply wells (U51 and U52) located on the ML.

WI is located immediately east of the ML and is accessed by the causeway leading from the ML. NASA maintains launch, launch support and research, and tracking facilities on WI. NASA also maintains emergency services on WI. The Navy, as a tenant, operates and maintains training, research and development, and launch facilities on WI. MARS operates two launch facilities located on WI. The primary drainage from WI is to the west to Hog Creek and its tributaries, which flow to Bogues Bay, and finally to the Atlantic Ocean. Drainage from the eastern coastline portion of the island is directly to the Atlantic Ocean. There are no groundwater supply wells located on WI.

3.2 LAND AND RESOURCE USE

NASA, and its predecessor organization, the National Advisory Committee for Aeronautics (NACA), have had a presence at WFF since 1945. NACA established a presence on the southern portion of WI in 1945 launching its first rocket during that year. In 1946, NACA constructed launch and radar support and experimental facilities. Access to WI at that time was by water vessel, only. Operations by NACA at WFF were limited to these test facilities until 1959 (Occu-Health, 1999).

NASA was officially created by the federal government in 1958. In 1959, NASA expanded its presence at WFF with the lease of the MB from the Navy on June 30, 1959, and the acquisition of the ML. NASA formally acquired the MB from the Navy on December 1, 1961. The Navy operated the Chincoteague Naval Auxiliary Air Station (NAAS) at the MB from 1942 until 1959, when NASA acquired the facility. The Navy took control of the MB in 1942 and in 1943 constructed runways, buildings, and other support facilities for naval aviation and aviation ordnance testing and training. The Navy conducted pilot training and aviation and ordnance testing at the facility until the base was closed in 1959 [(Occu-Health, 1999) and (USACE, 2000)].

NASA continues to maintain the runways constructed at the facility by the Navy and occupies many of the structures and buildings that were present at the time of the property transfer. In addition, NASA has expanded and constructed additional buildings within the WFF area to support their mission and to provide support to other tenant organizations. NASA constructed the causeway that connects the ML to WI in 1960. The mission of WFF has undergone several changes since it was established by NASA in 1959, but the main focus has been and continues to be rocket research, the management of suborbital projects, suborbital and orbital tracking, aeronautical research, and space technology research. NASA does not manufacture rockets or rocket fuels/propellants at WFF. Rocket motors are transported to the facility from other government facilities.

4.0 FORMER FIRE TRAINING AREA

4.1 SITE CHRONOLOGY

The FFTA is located along Runway 10-28 in the northern portion of the MB (Figures 1-2 and 4-1). The site was used by NASA for fire fighter training exercises circa 1965 to 1987. It is reported that flammable liquids were dispersed onto the ground, into a pit, onto an abandoned plane fuselage, and/or into a tank and ignited for these exercises. Petroleum-contaminated soils were excavated and removed from the site by NASA in 1986 as a result of a removal order from VDEQ (Tt, 2012a). The area was identified as an AOC because of the site use history as well as visible staining. A chronology of documents and/or events for FFTA is presented in Table 4-1.

Photograph of FFTA facing northeast.

4.2 BACKGROUND

4.2.1 Land and Resource Use

FFTA is currently an open grass field and is no longer used for fire fighter training. The FFTA is not used for any specific purpose, and there are no plans for residential development of the site. No change in the use of the Site is likely as it is adjacent to an active runway that is an important part of the future facility plan for the installation. Shallow groundwater is not used by NASA for any purpose other than environmental monitoring and there are no plans for the development of this resource for potable use in the future. Residential development of FFTA is restricted as detailed in the ROD (Tt, 2007b), and both residential and commercial development is further prohibited by the Land Use Control (LUC) Remedial Design (RD) (Tt, 2008a). The Town of Chincoteague shallow groundwater supply wells are located about 4,500 feet southeast of the FFTA impacted shallow groundwater.

4.2.2 Basis for Remedial Action

The need for remedial action at FFTA was based on the history of site activities, nature and extent of the contamination, risk assessment to determine the effects of contamination on human and ecological receptors, and exceedances of cleanup levels (Maximum Contaminant Levels [MCLs] or risk-based calculated values) for the Chemicals of Concern (COCs). The COCs were identified initially by the human health risk assessment (HHRA) in the Remedial Investigation (RI) Report (Tt, 2004a), proposed in the Feasibility Study (FS) with cleanup levels (Tt, 2005a), and finalized in the Record of Decision (ROD) (Tt, 2007b). There are no COCs associated with ecological risk.

4.2.3 Summary of Contamination

Surface soil, subsurface soil, groundwater, surface water, and sediment were sampled during previous investigations (Figure 4-2). COCs were identified only in groundwater based on the risk drivers from the HHRA and/or exceedances of regulatory criteria (i.e., MCLs). The COCs and associated cleanup levels are shown in Table 4-2. It is likely that groundwater downgradient of the Site discharges to surface water. However, groundwater monitoring confirms that site contaminants above cleanup goals are not migrating off the Site.

4.3 REMEDIAL ACTIONS

4.3.1 Remedial Action Objectives

Based on the evaluation of site conditions, an understanding of the contaminants, the physical properties in media of concern, the results of risk assessments, and an analysis of applicable or relevant and appropriate requirements (ARARs), the following are the remedial action objectives (RAOs) finalized in the ROD for FFTA (Tt, 2007b):

- Prevent the exposure to and use of the FFTA-contaminated groundwater, which presents an unacceptable risk associated with the hypothetical future resident use of shallow groundwater

- Restore FFTA-impacted groundwater to drinking water standards and attain cleanup levels established in the ROD.

These RAOs were developed following guidance provided in EPA (1995) *Land Use in the CERCLA Remedy Selection Process*. According to this guidance, RAOs should reflect the reasonably anticipated future land use or uses. The need for RAOs for groundwater was evaluated following EPA (1988) *Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites*. No RAO was developed specific to soil vapor or potential vapor intrusion issues at the time of the FS and ROD.

4.3.2 Selected Remedy

The selected remedy for FFTA consists of the following components:

- In-Situ Biological Treatment (Biostimulation)
- Institutional Controls
- Monitoring

The remedial action has been fully implemented. The *Remedial Design for LUCs,* addressing the institutional controls specified in the ROD, and a *Pilot Study Work Plan* were finalized and approved in 2008 (Tt, 2008a

and 2008d, respectively). LUCs were implemented and the pilot study, including injections of biostimulation substrate within the contaminant plume area, was conducted in December 2008. The results of the pilot study were presented in a Pilot Study Report in July 2009 (Tt 2009a). The biostimulation substrate successfully reduced the concentration in the plume area sufficiently such that EPA and VDEQ concurred full in-situ implementation of the biostimulation component of the remedy was not necessary. Quarterly groundwater performance monitoring was initiated in August 2009 and the long-term monitoring (LTM) program was approved and implemented in 2010 (Tt, 2009a and 2010). The *Remedial Action Completion Report (RACR)* documenting all components of the remedy had been implemented and were functioning was finalized and issued in 2009 (Tt, 2011b).

4.4 PROGRESS SINCE THE LAST REVIEW

This is the first 5YR Report for FFTA.

4.5 FIVE-YEAR REVIEW PROCESS

4.5.1 Document Review

Part of the 5YR consisted of a review of relevant documents. This included the review of RODs, PRAPs, risk assessments, RACRs, and LTM reports (i.e., LTM data), among other documents. In addition, LUC Inspection forms documenting annual inspections for the last 4 years were reviewed. Historical documents are summarized with significant events in Table 4-1 and detailed in the References section.

4.5.2 Data Review

The data review included looking at the ARARs and LTM data monitoring the FFTA remedy performance. There have been no changes to the ARARs in the ROD for the FFTA that affect protectiveness of the remedy. Monitoring data has been collected since the implementation of the remedial action. The monitoring locations and constituents were identified in the FFTA ROD as part of the Performance Standards. The ROD also required the preparation of an LTM Plan. An LTM Plan (Tt, 2010) was developed in 2010 to comply with the groundwater monitoring requirements specified in the ROD for FFTA. Considering performance monitoring results through December 2011, a revised LTM Plan reducing the number of wells and decreasing the analytical parameters was issued in 2012 (Tt, 2012b).

The current groundwater monitoring program at FFTA consists of the analysis of benzene, cis-1,2-dichloroethene (DCE), vinyl chloride, naphthalene, 4-methylphenol, [total and dissolved] arsenic, and [total and dissolved] manganese. Sampling events occur semiannually in March and September. The groundwater monitoring data (frequency of detections) for the period of this review (December 2008 – September 2012) is provided in Table 4-3, and frequency of detection information is summarized in Table 4-4. The analytical results show that the COCs, at levels of concern, are limited to benzene at one well, naphthalene at two wells, arsenic at two wells, and manganese in six wells. Compared to the site conditions prior to the biostimulation injection in 2009, maximum COC concentrations have decreased and the contaminant plume(s) has(have) decreased in size. Temporal analytical data graphs for the COCs are provided in Appendix D. There are no COC exceedances in the downgradient point-of-compliance wells.

4.5.3 Site Inspection

The 5YR inspection of the site was conducted on June 25, 2013, by representatives of Tt, NASA, EPA, and VDEQ. The purpose of the inspection was to assess the monitoring well network and the

protectiveness of the remedy. Appendix A contains the site inspection checklist. Photographs taken during the site inspection are included in Appendix B. No issues were identified during the site inspection.

4.5.4 Interviews

Interviews were conducted via questionnaire with VDEQ and EPA RPMs (Appendix C). No issues were identified by the RPMs. There were no public responses or inquiries for interviews.

4.6 TECHNICAL ASSESSMENT

4.6.1 Question A: Is The Remedy Functioning As Intended By The Decision Documents?

The review of documents, monitoring results, and site inspection indicate the final remedy, which includes a biostimulation, LUCs, and LTM, is functioning as intended by the ROD (see Section 4.3.2 for a full description of the selected remedy). The site inspection did not identify any problems or disturbances of the soil or vegetation and found no damage to the LTM well network. The LUCs are responsible for the remedial action functioning as intended. The institutional controls include restrictions on use of shallow groundwater (Columbia aquifer), prohibiting the development of commercial or residential buildings, and maintaining the integrity of any current or future remediation and monitoring systems. NASA manages and maintains a base-wide geographic information system (GIS). FFTA is identified on the GIS. All work performed at the FFTA must be approved by the NASA Environmental Office.

The groundwater monitoring indicated the concentrations of the majority of the site contaminants in groundwater were decreasing or relatively stable over time.

No signs of intrusion or invasive development of the site were observed. No activities were observed that would have violated the institutional controls. In summary, the remedy is in place to successfully prevent exposure to the site-related contaminants.

4.6.2 Question B: Are The Exposure Assumptions, Toxicity Data, Clean-Up Levels, And RAOs Used At The Time Of The Remedy Selection Still Valid?

The physical conditions of FFTA have not changed since execution of the ROD in a way that would affect the protectiveness of the remedy. Based on the remedy evaluation for data in existing documents and confirmation that the applicable state and federal standards for the COCs have not changed significantly, the exposure assumptions, toxicity data, cleanup levels, and RAOs are still valid. The remedy is in compliance with the ARARs.

The selected remedy is functioning as intended and the groundwater (and potential vapor; see below) continues to be protected from human exposure. Because LTM is still ongoing, FFTA will continue to be subject to the 5YR requirement.

Changes in Exposure Pathways: There have been no changes at the site that would have resulted in new exposure pathways to human or ecological receptors. However, potential exposures from vapor intrusion into buildings were not evaluated in the HHRA for the FFTA. This does not impact the protectiveness of the selected remedy, because there are currently no buildings on the site and the LUCs prohibit the development of commercial or residential buildings at the site to avoid vapor intrusion issues (Tt, 2008a). The LUCs have been implemented and are enforced by NASA.

Changes in Land Use: There have been no changes in land use that would impact the protectiveness of the remedy.

New Contaminants and/or Contaminant Sources: There have been no new contaminants detected and no new contaminant sources identified at the site. Groundwater monitoring for COCs and other indicator compounds and contaminants of interest has not indicated the presence of new contaminants. There have been no new activities or use of the FFTA or adjacent areas.

Changes in Standards and TBCs: ARARs and TBCs considered during preparation of the ROD were reviewed to determine changes since the LTM Plan for FFTA was issued. There have been no changes to currently relevant ARARs and TBCs.

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in human health toxicity criteria that would impact the monitoring criteria with the exception of the criteria for 4-methylphenol. An oral reference dose of 0.005 mg/kg/day was used to derived the remedial goal of 27 µg/L for 4-methylphenol. The current oral reference dose of 0.1 mg/kg/day would result in a remedial goal of 540 µg/L.

Changes in Screening Criteria: When the risk assessment was conducted in 2003, the 2003 EPA Region 3 Risk-Based Concentrations (RBCs) were used as the basis of the COPC screening criteria for groundwater. In 2008, the Region 3 RBCs were discontinued and replaced with the EPA Regional Screening Levels (RSLs). The RSLs are based on different exposure pathways and are generally lower than the Region 3 RBCs. For example, the Region 3 RBCs for groundwater were based on ingestion and inhalation whereas the RSLs also consider dermal contact. Also the toxicity criteria for some chemicals have changed since 2003. The changes in screening criteria do not impact the protectiveness of the selected remedy because the major chemicals detected in groundwater were organics which are addressed by the selected remedy.

Changes in Risk Assessment Methods: There have been several changes in EPA risk assessment methodology since the Supplement RI Report was finalized in 2004, although none of the changes would impact the protectiveness of the remedy. Among these are:

- The implementation of the EPA's Dermal Guidance (RAGS-Part E) which was finalized in July 2004. Use of the RAGS-Part E guidance would result in slight changes in some dermal exposure parameters. However, the effect of these changes on the calculated risks would be minimal and would not affect the results and conclusions of the risk assessment or the protectiveness of the selected remedy.

- Carcinogens that Act by a Mutagenic Mode of Action. In March 2005, the EPA provided general direction on implementing the EPA's 2005 *Guidelines for Carcinogen Risk Assessment and Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* because of special considerations for carcinogens that act via a mutagenic mode of action. This guidance does not impact the conclusions of the risk assessment or the protectiveness of the selected remedy because vinyl chloride was the only mutagenic chemical detected in groundwater at the FFTA, vinyl chloride was retained as a COC, and the MCL was selected as the remedial goal.

- EPA's RAGS Part F, Supplemental Guidance for Inhalation Risk Assessment was published in January 2009. Use of the RAGS Part F guidance would result in minor changes in the inhalation

risks. However, the effect of these changes on the calculated total risks would be minimal and would not affect the results and conclusions of the risk assessment or the protectiveness of the selected remedy.

Vapor Intrusion was not specifically evaluated for the FFTA; instead, it is presumed that vapor intrusion would be a potential issue for a future structure until concentrations of the volatile COCs (i.e., [benzene; cis-1,2-DCE; and vinyl chloride) meet cleanup levels. There is no RAO to minimize human health risk due to potential vapor issues. However, the LUCs portion of the remedy is protective in the short term: The LUC portion of the remedy for FFTA prohibits the development of commercial or residential buildings at the site to avoid vapor intrusion issues (Tt, 2008a). The LUCs have been implemented and are enforced by NASA.

The remedy is functioning as intended. FFTA will continue to be subject to the 5YR requirement until groundwater cleanup levels are achieved (or waived).

4.6.3 Question C: Has Any Other Information Come To Light That Calls Into Question The Protectiveness Of The Remedy?

The only new information calling into question the remedy's protectiveness at FFTA is the potential presence of new emerging contaminant(s). EPA defines an emerging contaminant as a chemical or material characterized by a perceived, potential, or real threat to human health or the environment or by a lack of published health standards (EPA, 2013). A contaminant also may be "emerging" because of the discovery of a new source or a new pathway to humans.

EPA proposes no more than 30 new emerging, unregulated contaminants every 5 years—as required by the Safe Drinking Water Act amendments in 1996—to be monitored and evaluated in the U.S. public water supply. This allows EPA to determine the primary sources of occurrence and exposure information the agency uses to develop regulatory decisions for contaminants of concern. EPA's latest proposal for 28 unregulated chemicals and 2 viruses was published in the Federal Register in 2012 (see Unregulated Contaminant Monitoring Rule 3 [UCMR3] at http://water.epa.gov/lawsregs/rulesregs/sdwa/ucmr/ucmr3/index.cfm). These will undergo assessment monitoring and/or screening surveys throughout the U.S. public water supply in 2013 to 2015. Six of the unregulated chemicals detailed in UCMR3 are the following perfluorinated compounds (PFCs): perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), perfluoroheptanoic acid (PFHpA), and perfluorobutanesulfonic acid (PFBS).

PFCs were a component of Aqueous Film Forming Foam (AFFF) used for firefighting responses and/or for training exercises. While there are no specific records of PFC-based AFFFs at WFF, the records are limited and, thus, PFC-based AFFFs were presumably used at some time or another at FFTA. AFFF is composed of complex mixtures of fluorocarbon surfactants designed to spread over hydrocarbon fires, extinguish the flames and prevent re-ignition. These compounds consist of a carbon backbone with fluorine atoms attached. Due to the fluorine atoms, these chemicals are extremely persistent in the environment and resistant to typical environmental degradation processes. Two of the PFCs that have come under increased regulatory scrutiny are PFOA and PFOS. Studies have shown both PFOS and PFOA have the potential to bioaccumulate and biomagnify in wildlife. They are readily adsorbed after oral exposure and accumulate primarily in the serum, kidney, and liver. Human health toxicity values are available only for these two PFCs, but these values are considered "Tier 3" toxicity values, which means they are the most uncertain, and consensus has not been reached about the validity of these values. In

2009, EPA developed Provisional Health Advisory values for drinking water for PFOA (0.4 micrograms per liter [ug/L]) and PFOS (0.2 µg/L). The provisional health advisories are not legally enforceable.

Other than the potential presence of PFCs in the groundwater, no other information has been made available that calls into question the protectiveness of the remedial action.

4.6.4 Technical Assessment Summary

According to the site inspection, the final remedy is functioning as intended by the ROD. There have been no changes in the physical conditions at FFTA that would affect the protectiveness of the final remedy. All ARARs cited in the ROD have been met by construction of the remedial action. However, the potential presence of PFCs (emerging contaminants) in the groundwater at FFTA from potential historical usage of AFFFs for fire emergency response and/or training exercises calls into question the protectiveness of the final remedy.

4.7 ISSUES

The only issue identified during this review is the potential for the presence of one or more PFCs (namely PFOA and PFOS) in the groundwater at FFTA. Groundwater at the site has not been tested for these emerging contaminants.

4.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The presence of PFOA and PFOS in groundwater should be evaluated by December 31, 2018, prior to the next 5YR. NASA will work with EPA and VDEQ to determine the most appropriate path forward for the future evaluation.

4.9 PROTECTIVENESS STATEMENT

Protectiveness for this operable unit is being deferred. PFCs have been recently identified by the USEPA as an emerging contaminant; however, no Tier I screening values have been established to evaluate risk associated with these contaminants. Based on the site history and use of the Site as a fire training area, the potential for elevated concentrations of PFCs is present. Although the presence of these compounds are unknown, it can be reasonably expected that the LUC portion of the existing remedy is adequate to protect human health and the environment from potential risks (if any) associated with these contaminants in the short-term. Groundwater sampling for PFCs will be conducted prior to the next Five Year Review in 2018 to determine the presence/absence of PFCs in site groundwater and if found the concentrations will be compared to Tier I toxicological values or other final, regulatory standards once established by USEPA.

4.10 NEXT REVIEW

The next 5YR for FFTA is required by 2018, 5 years from the date of this review.

5.0 WASTE OIL DUMP

5.1 SITE CHRONOLOGY

The WOD was reportedly used for disposal of waste oils and possibly solvents from the 1940s through the 1950s. Reportedly, the site was used for disposal of excess waste oil that could not be used for firefighting training activities. No records are available to determine the types and quantities of materials disposed or the duration of this activity at the site. A review of aerial photographs from 1943 through 1994 indicate the presence of ground scarring and possible excavation at the WOD from 1943 to 1961. A chronology of documents and/or events for WOD is presented in Table 5-1.

Photograph of WOD facing east from the top of the site.

5.2 BACKGROUND

5.2.1 Land and Resource Use

WOD is at the north end of the runway 17/35 and is currently maintained as an open space (Figure 5-1). The WOD is not used for any specific purpose, and there are no plans for residential development of the site. No change in the use of the site is likely as it is adjacent to an active runway that is an important part of the future facility plan for the installation. Shallow groundwater is not used by NASA for any purpose other than environmental monitoring and there are no plans for the development of this resource for potable use in the future. Residential development of WOD is restricted as detailed in the ROD (Tt, 2008a), and both residential and commercial development is further prohibited by the LUC RD (Tt, 2008c). The Town of Chincoteague shallow groundwater supply wells are located about 4,000 feet east-southeast of the WOD impacted shallow groundwater.

5.2.2 Basis for Remedial Action

The need for remedial action at WOD was based on the history of site activities, nature and extent of the contamination, risk assessment to determine the effects of contamination on human and ecological receptors, and exceedances of cleanup levels (Maximum Contaminant Levels [MCLs] or risk-based calculated values) for the COCs. The COCs were identified initially by the HHRA in the RI Report (Tt, 2004b), proposed in the Feasibility Study (FS) with cleanup levels (Tt, 2005b), and finalized in the Record of Decision (ROD) (Tt, 2008a). There are no COCs associated with ecological risk.

5.2.3 Summary of Contamination

Surface soil, subsurface soil, groundwater, soil gas, and sediment were sampled during previous investigations. COCs were identified only in groundwater based on the risk drivers from the HHRA and/or exceedances of regulatory criteria (i.e., MCLs). The COCs and associated cleanup levels are shown in Table 5-2. It is likely that groundwater downgradient of the Site discharges to surface water. However, groundwater monitoring confirms that site contaminants above cleanup goals are not migrating off the Site.

5.3 REMEDIAL ACTIONS

5.3.1 Remedial Action Objectives

Based on the evaluation of site conditions, an understanding of the contaminants, the physical properties in media of concern, the results of risk assessments, and an analysis of ARARs, the following are the RAOs finalized in the ROD for WOD (Tt, 2008a):

- Prevent exposure to and use of WOD-contaminated groundwater which presents an unacceptable risk associated with hypothetical future residential use of shallow groundwater.

- Restore WOD-impacted groundwater to drinking water standards (MCLs).

These RAOs were developed following guidance provided in EPA (1995) *Land Use in the CERCLA Remedy Selection Process*. According to this guidance, RAOs should reflect the reasonably anticipated future land use or uses. The need for RAOs for groundwater was evaluated following EPA (1988) *Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites*. No RAO was developed specific to soil vapor or potential vapor intrusion issues at the time of the FS and ROD.

5.3.2 Selected Remedy

The selected remedy for WOD consists of the following components:

- In-Situ Biological Treatment (Biostimulation)
- Institutional Controls
- Monitoring

The remedial action has been fully implemented. The *Pilot Study Work Plan* to support the design and implementation of the biostimulation injections was issued in November 2008 (Tt, 2008e). The pilot study injections in the area of highest contamination were conducted in December 2008 and the results presented in the *Remedial Action Work Plan* issued in September 2009 (Tt, 2009b). The *LTM Plan* for the WOD was finalized and approved in October 2009 (Tt, 2009c). The full-scale biostimulation injection was conducted in December 2009 and the first round of post-injection monitoring was conducted in March 2010. The *Remedial*

Design for LUCs, addressing the institutional controls specified in the ROD, was approved and implemented in December 2008 (Tt, 2008c). The *RACR* documenting all components of the remedy had been implemented and were functioning was finalized and issued in April 2011 (Tt, 2011a).

5.4 PROGRESS SINCE THE LAST REVIEW

This is the first 5YR Report for WOD.

5.5 FIVE-YEAR REVIEW PROCESS

5.5.1 Document Review

Part of the 5YR consisted of a review of relevant documents. This included the review of RODs, PRAPs, risk assessments, RACRs, and LTM reports (i.e., LTM data), among other documents. In addition, LUC Inspection forms documenting annual inspections for the last 4 years were reviewed. Historical documents are summarized with significant events in Table 5-1 and detailed in the References section.

5.5.2 Data Review

Data reviewed included looking at the ARARs and LTM data for WOD's remedy. There have been no changes to the ARARs in the ROD for the WOD that affect protectiveness of the remedy. Monitoring data has been collected since the implementation of the remedial action, which was a pilot test followed by a fullscale oxygen-release compound (ORC) biostimulation injection. The monitoring locations and constituents were identified in the WOD ROD as part of the Performance Standards. The ROD also required the preparation of an LTM Plan. An LTM Plan (Tt, 2009c) was developed in 2009 to comply with the groundwater monitoring requirements of the ROD for WOD. A revised LTM Plan (Tt, 2012c) was issued in 2012 to update the LTM Program considering performance monitoring results through December 2012 (e.g., to remove wells and/or monitoring parameters from the LTM Program).

The current groundwater monitoring program at WOD consists of the analysis of benzene, and [total and dissolved] arsenic. Sampling events occur semiannually in March and September. The groundwater monitoring data (frequency of detections) for the period of this review (December 2008 – September 2012) is provided in Table 5-3, and frequency of detection information is summarized in Table 5-4. The analytical results show isolated detections of both COCs since the ORC injection. Compared to the site conditions prior to the biostimulation injection in 2008 (pilot study) and 2009 (full-scale injection), maximum COC concentrations have decreased and the contaminant plume(s) has(have) decreased in size. Arsenic recently has been detected at low levels (<15 µg/L) in monitoring well 15-MW001 (Figure 5-2). Temporal analytical data graphs for the COCs are provided in Appendix D.

5.5.3 Site Inspection

The 5YR inspection of the site was conducted on June 25, 2013, by representatives of Tt, NASA, EPA, and VDEQ. The purpose of the inspection was to assess the protectiveness of the remedy. Appendix A contains the site inspection checklist. Photographs taken during the site inspection are included in Appendix B. No issues were identified during the site inspection.

5.5.4 Interviews

Interviews were conducted via questionnaire with VDEQ and EPA RPMs (Appendix C). No issues were identified by the RPMs. There were no public responses or inquiries for interviews.

5.6 TECHNICAL ASSESSMENT

5.6.1 Question A: Is The Remedy Functioning As Intended By The Decision Documents?

The review of documents, monitoring results, and site inspection indicate the final remedy which includes a biostimulation, LUCs, and LTM is functioning as intended by the ROD. The site inspection did not identify any problems or disturbances of the soil or vegetation. The LUCs are responsible for the remedial action functioning as intended. The institutional controls include restrictions on use of shallow groundwater (Columbia aquifer), prohibiting the development of commercial or residential buildings, and maintaining the integrity of any current or future remediation and monitoring systems. NASA manages and maintains a base-wide GIS. WOD is identified on the GIS. All work performed at the WOD must be approved by the NASA Environmental Office.

The groundwater monitoring indicated that that the concentrations of the two COCs in groundwater were decreasing over time, with the exception of arsenic in 15-MW001.

No signs of intrusion or invasive development of the site were observed. No activities were observed that would have violated the institutional controls. In summary, the remedy is in place to successfully prevent exposure to the site-related contaminants.

5.6.2 Question B: Are The Exposure Assumptions, Toxicity Data, Clean-Up Levels, And RAOs Used At The Time Of The Remedy Selection Still Valid?

The physical conditions of WOD have not changed since execution of the ROD in a way that would affect the protectiveness of the remedy. Based on the remedy evaluation for data in existing documents and confirmation that the applicable state and federal standards for the COCs have not changed significantly, the exposure assumptions, toxicity data, cleanup levels, and RAOs are still valid. The remedy is in compliance with the ARARs.

Vapor Intrusion was evaluated in the uncertainty section of the HHRA for the WOD and it was concluded there were no vapor intrusion issues. The LUC RD for WOD prohibits the development of commercial or residential buildings at the site to avoid vapor intrusion issues (Tt, 2008c). The LUCs have been implemented and are enforced by NASA.

The selected remedy is functioning as intended and the groundwater (and potential vapor) continues to be protected from human exposure. Because LTM is still ongoing, WOD will continue to be subject to the 5YR requirement.

Changes in Exposure Pathways: There have been no changes at the site that would have resulted in new exposure pathways to human or ecological receptors.

Changes in Land Use: There have been no changes in land use that would impact the protectiveness of the remedy.

New Contaminants and/or Contaminant Sources: There have been no new contaminants detected and no new contaminant sources identified at the site. Groundwater monitoring for COCs and other indicator compounds and contaminants of interest has not indicated the presence of new contaminants. There have been no new activities or use of the WOD or adjacent areas.

Changes in Standards and TBCs: ARARs and TBCs considered during preparation of the ROD were reviewed to determine changes since the LTM Plan for WOD was issued. There have been no changes to current ARARs, including monitoring criteria (i.e., MCLs).

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in human health toxicity criteria that would impact the monitoring criteria.

Changes in Screening Criteria: When the risk assessment for the WOD Site was conducted in 2003, the April 2003 EPA Region 3 RBCs were used as the basis of the COPC screening criteria for groundwater, in accordance with Region 3 policy. In 2008, the Region 3 RBCs were discontinued and replaced with the EPA RSLs. Some RSLs are based on different exposure assumptions and are generally lower than the Region 3 RBCs. For example, the Region 3 RBCs for groundwater were based on ingestion and inhalation whereas the RSLs also consider dermal contact. Also, the toxicity criteria for some chemicals have changed since 2003. The changes in screening criteria do not impact the protectiveness of the selected remedy because the major chemicals detected in groundwater are addressed by the selected remedy.

Changes in Risk Assessment Methods: There have been no major changes in HHRA methodology since the signing of the ROD that would impact the protectiveness of the remedy. Several changes in EPA risk assessment methodology have occurred since the baseline HHRA included in the 2004 Supplemental RI Report was completed in 2003. Among these are the following:

- The implementation of the EPA's Dermal Guidance (RAGS-Part E) which was finalized in July 2004. Use of the RAGS-Part E guidance would result in slight changes in some dermal exposure parameters, such as exposed skin surface areas and dermal absorption factors. However, the effect of these changes on the calculated risks would be minimal and would not affect the results and conclusions of the risk assessment for the WOD Site.

- Carcinogens that Act by a Mutagenic Mode of Action. In March 2005, the EPA provided general direction on implementing the EPA's 2005 *Guidelines for Carcinogen Risk Assessment and Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* because of special considerations for carcinogens that act via a mutagenic mode of action. This guidance affects risks calculated for children and adolescents. However, there were no chemicals considered to act via a mutagenic mode of action detected in groundwater. Therefore, using the new guidance would not affect the results of the risk assessment for groundwater or the remedy for the site.

- EPA's RAGS Part F, Supplemental Guidance for Inhalation Risk Assessment was published in January 2009. Use of the RAGS Part F guidance would result in minor changes in the inhalation risks. However, the effect of these changes on the calculated total risks would be minimal and would not affect the results and conclusions of the risk assessment or the protectiveness of the remedy for the site.

5.6.3 Question C: Has Any Other Information Come To Light That Calls Into Question The Protectiveness Of The Remedy?

There are no emerging contaminants associated with WOD. No other information has been made available that calls into question the protectiveness of the remedial action.

5.6.4 Technical Assessment Summary

According to the site inspection, the final remedy is functioning as intended by the ROD. There have been no changes in the physical conditions at WOD that would affect the protectiveness of the final remedy. All ARARs cited in the ROD have been met by construction of the remedial action.

5.7 ISSUES

No issues with the remedy were identified during this review.

5.8 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Based on the results of this 5YR, no recommendations or follow-up actions are required at this time.

5.9 PROTECTIVENESS STATEMENT

The remedy for WOD is protective of human health and the environment and is functioning as intended by the ROD. The exposure pathways that could result in unacceptable risks have been controlled and the RAOs have been satisfied. The exposure assumptions, toxicity data, and RAOs used at the time of the final remedy selection are still valid. No other information that could call into question the protectiveness of the remedy has been identified in this review.

5.10 NEXT REVIEW

The next 5YR for WOD is required by 2018, 5 years from the date of this review.

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APPENDIX A

FIVE-YEAR REVIEW
SITE INSPECTION CHECKLISTS

Site Inspection Checklist

I. SITE INFORMATION	
Site name: NASA Wallops Flight Facility Former Fire Training Area (FFTA)	**Date of inspection:** June 25, 2013
Location and Region: Wallops Island, VA | EPA Region 3	**EPA ID:** VA8800010763
Agency, office, or company leading the five-year review: NASA	**Weather/temperature:** High 80°F Partly Cloudy Winds: Out of West at 10 mph with gust of 20 mph

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ☒ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☒ Other: In Situ Biological Treatment
- ☒ Long Term Monitoring
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Photo Log ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **Site Manager** T.J. Meyer (**Name**) | NASA Project Coordinator (**Title**) | 06/25/2013 (**Date**)
   Interviewed ☒ at site ☒ at office ☐ by phone Phone No. (757) 824-1987
   Problems, suggestions; ☐ Report attached:

2. **O&M staff** N/A (**Name**) | _____ (**Title**) | _____ (**Date**)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone No. _____
   Problems, suggestions; ☐ Report attached:

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

   Agency: Virginia Department of Environmental Quality
   Contact: Paul Herman (**Name**) | Project Manager (**Title**) | **Date** | **Phone no.**
   Problems; suggestions; ☒ Report attached

   Agency: US Environmental Protection Agency
   Contact: Steve Hirsh (**Name**) | Project Manager (**Title**) | **Date** | **Phone no.**
   Problems; suggestions; ☒ Report attached

4. **Other interviews** (optional) ☐ Report attached.

Site Inspection Checklist

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

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

Remarks:

2. **Site-Specific Health and Safety Plan** ☐ Readily available ☒ Up to date ☐ N/A
   Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☒ N/A
   Remarks:
   SSHSP utilized during LTM sampling events. Developed and maintained by LTM sampling contractor(s) and present onsite during activities.

3. **O&M and OSHA Training Records** ☐ Readily available ☐ Up to date ☒ N/A
   Remarks:
   Collected during the initial field event's kickoff meeting then filed away by LTM sampling contractor

4. **Permits and Service Agreements**

☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A
☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
☐ Other permits:	☐ Readily available	☐ Up to date	☒ N/A

Remarks:

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☒N/A
   Remarks:

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ☒ N/A
   Remarks:

7. **Groundwater Monitoring Records** ☒ Readily available ☒ Up to date ☐ N/A
   Remarks:
   Two semiannual groundwater monitoring reports are issued upon completion of each field event. Then an annual groundwater monitoring report is issued at the end of the year.

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ☒ N/A
   Remarks:

9. **Discharge Compliance Records**

☐ Air	☐ Readily available	☐ Up to date	☒ N/A
☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A

Remarks:

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☒ N/A
    Remarks:

Site Inspection Checklist

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** N/A

☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place
Original O&M cost estimate N/A ☐ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

None, only maintenance is mowing and clearing of brush.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks:
Other than the perimeter facility fence no fence is present at FFTA.

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A
Remarks:

Site Inspection Checklist

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs are properly implemented	☒ Yes	☐ No	☐ N/A
Site conditions imply ICs are being fully enforced	☒ Yes	☐ No	☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by): Drive by / Site walk
Frequency: Annual inspections (also unofficially inspected during semiannual groundwater monitoring events)
Responsible party/agency: NASA
Contact: TJ Meyer (Name) WFF Restoration Program Manager (Title)

Reporting is up-to-date	☒ Yes	☐ No	☐ N/A
Reports are verified by the lead agency	☒ Yes	☐ No	☐ N/A
Specific requirements in deed or decision documents have been met	☐ Yes	☐ No	☒ N/A
Violations have been reported	☐ Yes	☐ No	☒ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: Site is on federal facility with restricted access.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
Remarks: No signs of unauthorized activities evident.

2. **Land use changes on site** ☐ N/A
Remarks: Land use has not changed at FFTA.

3. **Land use changes off site** ☐ N/A
Remarks: None

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☒ N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ☒ N/A
Remarks:
The only road present at FFTA is an abandoned taxiway adjacent to the airfield and it is maintained by the facility.

B. Other Site Conditions

Remarks: Grass around monitoring wells was mowed. A small dead tree (2 feet tall) was directly next to FFTA-MW055S which should be removed. NASA will coordinate the removal.

Site Inspection Checklist

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident
   Areal extent: Depth:
   Remarks: Not applicable.

2. **Cracks** ☐ Location shown on site map ☐ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks: Not applicable.

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent_____ Depth_____
   Remarks: Not applicable.

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
   Areal extent_____ Depth_____
   Remarks: Not applicable.

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks: Not applicable.

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
   Remarks: Not applicable.

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident
   Areal extent_____ Height_____
   Remarks: Not applicable.

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_____
   ☐ Seeps ☐ Location shown on site map Areal extent_____
   ☐ Soft subgrade ☐ Location shown on site map Areal extent_____
   Remarks: Not applicable.

9. **Slope Instability**
   ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability
   Areal extent_____
   Remarks: Not applicable.

Site Inspection Checklist

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☒ N/A or okay
   Remarks:

2. **Bench Breached** ☐ Location shown on site map ☒ N/A or okay
   Remarks:

3. **Bench Overtopped** ☐ Location shown on site map ☒ N/A or okay
   Remarks:

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement
   Areal extent_____ Depth_____
   Remarks: Not applicable.

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
   Material type_____ Areal extent_____
   Remarks: Not applicable.

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
   Areal extent_____ Depth_____
   Remarks: Not applicable.

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
   Areal extent_____ Depth_____
   Remarks: Not applicable.

5. **Obstructions** Type_____ ☐ No obstructions
   ☐ Location shown on site map Areal extent_____
   Size_____
   Remarks: Not applicable.

6. **Excessive Vegetative Growth** Type_____
   ☐ No evidence of excessive growth
   ☐ Vegetation in channels does not obstruct flow
   ☐ Location shown on site map Areal extent_____
   Remarks: Not applicable.

Site Inspection Checklist

D. Cover Penetrations ☐ Applicable ☒ N/A

1. **Gas Vents** ☐ Active ☐ Passive
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance
   ☒ N/A
   Remarks:

2. **Gas Monitoring Probes**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
   Remarks: Not applicable.

3. **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: There are monitoring wells at FFTA but none within landfill.

4. **Leachate Extraction Wells**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
   Remarks: Not applicable.

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☒ N/A
   Remarks: Not applicable.

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition ☐ Needs Maintenance
   Remarks: Not applicable

2. **Gas Collection Wells, Manifolds and Piping**
   ☐ Good condition ☐ Needs Maintenance
   Remarks: Not applicable

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   ☐ Good condition ☐ Needs Maintenance ☒ N/A
   Remarks:

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☒ N/A
   Remarks:

2. **Outlet Rock Inspected** ☐ Functioning ☒ N/A
   Remarks:

Site Inspection Checklist

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

1. **Siltation** Areal extent_____ Depth_____ ☒ N/A
   ☐ Siltation not evident
   Remarks:

2. **Erosion** Areal extent_____Depth_____
   ☐ Erosion not evident
   Remarks: Not applicable

3. **Outlet Works** ☐ Functioning ☒ N/A
   Remarks:

4. **Dam** ☐ Functioning ☒ N/A
   Remarks:

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks: Not applicable.

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
   Remarks: Not applicable.

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☒ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
   Areal extent_____ Depth_____
   Remarks: Not applicable.

2. **Vegetative Growth** ☐ Location shown on site map ☒ N/A
   ☐ Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks:

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent_____ Depth_____
   Remarks: Not applicable.

4. **Discharge Structure** ☐ Functioning ☒ N/A
   Remarks:

Site Inspection Checklist

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
   Areal extent_____ Depth_____
   Remarks: Not applicable

2. **Performance Monitoring** Type of monitoring_____
   ☐ Performance not monitored
   Frequency_____ ☐ Evidence of breaching
   Head differential_____
   Remarks: Not applicable

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipeline ☐ Applicable ☒ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   ☒ N/A ☐ All required wells properly operating ☐ Need Maintenance
   Remarks:

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☒ N/A ☐ Good condition ☐ Needs Maintenance
   Remarks:

3. **Spare Parts and Equipment**
   ☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be Provided
   Remarks: Not applicable

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

1. **Collection Structures, Pumps and Electrical**
   ☒ N/A ☐ Good Condition ☐ Need Maintenance
   Remarks:

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Appurtenances**
   ☒ N/A ☐ Good condition ☐ Needs Maintenance
   Remarks:

3. **Spare Parts and Equipment**
   ☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be Provided
   Remarks: Not applicable

Site Inspection Checklist

C. Treatment System ☐ Applicable ☒ N/A

1. **Treatment Train** (Check components that apply)
   ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
   ☐ Air stripping ☐ Carbon adsorbers
   ☐ Filters_____
   ☐ Additive (*e.g.*, chelation agent, flocculent)_____
   ☐ Others_____
   ☐ Good condition ☐ Needs Maintenance
   ☐ Sampling ports properly marked and functional
   ☐ Sampling/maintenance log displayed and up to date
   ☐ Equipment properly identified
   ☐ Quantity of groundwater treated annually_____
   ☐ Quantity of surface water treated annually_____
   Remarks: Not applicable

2. **Electrical Enclosures and Panels** (properly rated and functional)
   ☒ N/A ☐ Good condition ☐ Needs Maintenance
   Remarks:

3. **Tanks, Vaults, Storage Vessels**
   ☒ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
   Remarks:

4. **Discharge Structure and Appurtenances**
   ☒ N/A ☐ Good condition ☐ Needs Maintenance
   Remarks:

5. **Treatment Building(s)**
   ☒ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair
   ☐ Chemicals and equipment properly stored
   Remarks:

6. **Monitoring Wells** (pump and treatment remedy)
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ All required wells located ☐ Needs Maintenance ☒ N/A
   Remarks: There are no pump and treat monitoring wells at FFTA.

D. Monitoring Data

1. **Monitoring Data**
   ☒ Is routinely submitted on time ☒ Is of acceptable quality
   Remarks: Two semiannual reports and one annual report are issued each year.

2. **Monitoring data suggests:**
   ☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining
   Remarks: Contaminants are contained with a small area onsite.

Site Inspection Checklist

E. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks: All wells are clearly labeled, locked, and look to be in good condition.

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. 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.).

The selected remedy at FFTA includes in-situ biological treatment (biostimulation), institutional controls, and monitoring. The objective of the biostimulation and monitoring was to document the reduction of concentrations of the volatile organic compounds, the semi-volatile organic compounds, as well as arsenic and manganese in site groundwater to meet the clean-up goals identified in the Record of Decision. For in-situ biological treatment a pilot study was conducted which showed minor effects on site contaminants as well as an environment unsuitable for a full scale biostimulation event.

Source and distal plume are attenuating accordingly with only benzene and naphthalene exceeding site cleanup goals. Arsenic and manganese seem to be stable both in concentration and aerial extent. Long-term monitoring continues semiannually. The remedy is effective and functioning as designed.

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.

No issues. Adequate.

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.

A few protective casings had to be replaced at select monitoring wells due to rusted/broken hinges but this is expected over time.

Site Inspection Checklist

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Potentially remove monitoring wells and/or analytes from the LTM program if there are no detections of COCs above cleanup goals for *four* consecutive LTM sampling events.

Site Inspection Checklist

I. SITE INFORMATION	
Site name: NASA Wallops Flight Facility Waste Oil Dump (WOD)	**Date of inspection:** June 25, 2013
Location and Region: Wallops Island, VA | EPA Region 3	**EPA ID:** VA8800010763
Agency, office, or company leading the five-year review: NASA	**Weather/temperature:** High 80°F Partly Cloudy Winds: Out of West at 10 mph with gust of 20 mph

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ☒ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☒ Other: In Situ Biological Treatment
- ☒ Long Term Monitoring
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Photo Log ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **Site Manager** T.J. Meyer (**Name**) NASA Project Coordinator (**Title**) 06/25/2013 (**Date**)
   Interviewed ☒ at site ☒ at office ☐ by phone Phone No. (757) 824-1987
   Problems, suggestions; ☐ Report attached:

2. **O&M staff** N/A (**Name**) _____ (**Title**) _____ (**Date**)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone No. _____
   Problems, suggestions; ☐ Report attached:

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

   Agency: Virginia Department of Environmental Quality
   Contact: Paul Herman (**Name**) Project Manager (**Title**) **Date** **Phone no.**
   Problems; suggestions; ☒ Report attached

   Agency: US Environmental Protection Agency
   Contact: Steve Hirsh (**Name**) Project Manager (**Title**) **Date** **Phone no.**
   Problems; suggestions; ☒ Report attached

4. **Other interviews** (optional) ☐ Report attached.

Site Inspection Checklist

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

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

Remarks:

2. **Site-Specific Health and Safety Plan** ☐ Readily available ☒ Up to date ☐ N/A
   Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☒ N/A
   Remarks:
   SSHSP utilized during LTM sampling events. Developed and maintained by LTM sampling contractor(s) and present onsite during activities.

3. **O&M and OSHA Training Records** ☐ Readily available ☐ Up to date ☒ N/A
   Remarks:
   Collected during the initial field event's kickoff meeting then filed away by LTM sampling contractor.

4. **Permits and Service Agreements**

☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A
☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
☐ Other permits:	☐ Readily available	☐ Up to date	☒ N/A

Remarks:

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A
   Remarks:

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ☒ N/A
   Remarks:

7. **Groundwater Monitoring Records** ☒ Readily available ☒ Up to date ☐ N/A
   Remarks:
   Two semiannual groundwater monitoring reports are issued upon completion of each field event. Then an annual groundwater monitoring report is issued at the end of the year.

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ☒ N/A
   Remarks:

9. **Discharge Compliance Records**

☐ Air	☐ Readily available	☐ Up to date	☒ N/A
☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A

Remarks:

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☒ N/A
    Remarks:

Site Inspection Checklist

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** N/A

☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place
Original O&M cost estimate N/A ☐ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

None, only maintenance is mowing and clearing of brush.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks:
Other than the perimeter facility fence no fence is present at WOD.

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A
Remarks:

Site Inspection Checklist

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs are properly implemented	☒ Yes	☐ No	☐ N/A
Site conditions imply ICs are being fully enforced	☒ Yes	☐ No	☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by): Drive by / Site walk
Frequency: Annual inspections (also unofficially inspected during semiannual groundwater monitoring events)
Responsible party/agency: NASA
Contact: TJ Meyer (Name) WFF Restoration Program Manager (Title)

Reporting is up-to-date	☒ Yes	☐ No	☐ N/A
Reports are verified by the lead agency	☒ Yes	☐ No	☐ N/A
Specific requirements in deed or decision documents have been met	☐ Yes	☐ No	☒ N/A
Violations have been reported	☐ Yes	☐ No	☒ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: Site is on federal facility with restricted access.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
Remarks: No signs of unauthorized activities evident.

2. **Land use changes on site** ☐ N/A
Remarks: Land use has not changed at WOD.

3. **Land use changes off site** ☐ N/A
Remarks: None

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☒ N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ☒ N/A
Remarks:
The only road present at WOD is Runway 17-35 and it is maintained by the facility.

B. Other Site Conditions

Remarks: Grass around monitoring wells was mowed.

Site Inspection Checklist

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident
   Areal extent: Depth:
   Remarks: Not applicable.

2. **Cracks** ☐ Location shown on site map ☐ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks: Not applicable.

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent_____ Depth_____
   Remarks: Not applicable.

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
   Areal extent_____ Depth_____
   Remarks: Not applicable.

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks: Not applicable.

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
   Remarks: Not applicable.

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident
   Areal extent_____ Height_____
   Remarks: Not applicable.

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_____
   ☐ Seeps ☐ Location shown on site map Areal extent_____
   ☐ Soft subgrade ☐ Location shown on site map Areal extent_____
   Remarks: Not applicable.

9. **Slope Instability**
   ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability
   Areal extent_____
   Remarks: Not applicable.

Site Inspection Checklist

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☒ N/A or okay
   Remarks:

2. **Bench Breached** ☐ Location shown on site map ☒ N/A or okay
   Remarks:

3. **Bench Overtopped** ☐ Location shown on site map ☒ N/A or okay
   Remarks:

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement
   Areal extent_____ Depth_____
   Remarks: Not applicable.

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
   Material type_____ Areal extent_____
   Remarks: Not applicable.

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
   Areal extent_____ Depth_____
   Remarks: Not applicable.

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
   Areal extent_____ Depth_____
   Remarks: Not applicable.

5. **Obstructions** Type_____ ☐ No obstructions
   ☐ Location shown on site map Areal extent_____
   Size_____
   Remarks: Not applicable.

6. **Excessive Vegetative Growth** Type_____
   ☐ No evidence of excessive growth
   ☐ Vegetation in channels does not obstruct flow
   ☐ Location shown on site map Areal extent_____
   Remarks: Not applicable.

Site Inspection Checklist

D. Cover Penetrations ☐ Applicable ☒ N/A

1. **Gas Vents** ☐ Active ☐ Passive
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance
   ☒ N/A
   Remarks:

2. **Gas Monitoring Probes**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
   Remarks: Not applicable.

3. **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: There are monitoring wells at WOD but none within a landfill.

4. **Leachate Extraction Wells**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
   Remarks: Not applicable.

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☒ N/A
   Remarks: Not applicable.

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition ☐ Needs Maintenance
   Remarks: Not applicable

2. **Gas Collection Wells, Manifolds and Piping**
   ☐ Good condition ☐ Needs Maintenance
   Remarks: Not applicable

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   ☐ Good condition ☐ Needs Maintenance ☒ N/A
   Remarks:

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☒ N/A
   Remarks:

2. **Outlet Rock Inspected** ☐ Functioning ☒ N/A
   Remarks:

Site Inspection Checklist

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

1. **Siltation** Areal extent_____ Depth_____ ☒ N/A
   ☐ Siltation not evident
   Remarks:

2. **Erosion** Areal extent_____Depth_____
   ☐ Erosion not evident
   Remarks: Not applicable

3. **Outlet Works** ☐ Functioning ☒ N/A
   Remarks:

4. **Dam** ☐ Functioning ☒ N/A
   Remarks:

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks: Not applicable.

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
   Remarks: Not applicable.

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☒ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
   Areal extent_____ Depth_____
   Remarks: Not applicable.

2. **Vegetative Growth** ☐ Location shown on site map ☒ N/A
   ☐ Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks:

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent_____ Depth_____
   Remarks: Not applicable.

4. **Discharge Structure** ☐ Functioning ☒ N/A
   Remarks:

Site Inspection Checklist

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
   Areal extent_____ Depth_____
   Remarks: Not applicable

2. **Performance Monitoring** Type of monitoring_____
   ☐ Performance not monitored
   Frequency_____ ☐ Evidence of breaching
   Head differential_____
   Remarks: Not applicable

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipeline ☐ Applicable ☒ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   ☒ N/A ☐ All required wells properly operating ☐ Need Maintenance
   Remarks:

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☒ N/A ☐ Good condition ☐ Needs Maintenance
   Remarks:

3. **Spare Parts and Equipment**
   ☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be Provided
   Remarks: Not applicable

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

1. **Collection Structures, Pumps and Electrical**
   ☒ N/A ☐ Good Condition ☐ Need Maintenance
   Remarks:

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Appurtenances**
   ☒ N/A ☐ Good condition ☐ Needs Maintenance
   Remarks:

3. **Spare Parts and Equipment**
   ☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be Provided
   Remarks: Not applicable

Site Inspection Checklist

C. Treatment System ☐ Applicable ☒ N/A

1. **Treatment Train** (Check components that apply)
   ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
   ☐ Air stripping ☐ Carbon adsorbers
   ☐ Filters_____
   ☐ Additive (*e.g.*, chelation agent, flocculent)_____
   ☐ Others_____
   ☐ Good condition ☐ Needs Maintenance
   ☐ Sampling ports properly marked and functional
   ☐ Sampling/maintenance log displayed and up to date
   ☐ Equipment properly identified
   ☐ Quantity of groundwater treated annually_____
   ☐ Quantity of surface water treated annually_____
   Remarks: Not applicable

2. **Electrical Enclosures and Panels** (properly rated and functional)
   ☒ N/A ☐ Good condition ☐ Needs Maintenance
   Remarks:

3. **Tanks, Vaults, Storage Vessels**
   ☒ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
   Remarks:

4. **Discharge Structure and Appurtenances**
   ☒ N/A ☐ Good condition ☐ Needs Maintenance
   Remarks:

5. **Treatment Building(s)**
   ☒ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair
   ☐ Chemicals and equipment properly stored
   Remarks:

6. **Monitoring Wells** (pump and treatment remedy)
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ All required wells located ☐ Needs Maintenance ☒ N/A
   Remarks: There are no pump and treat monitoring wells at WOD.

D. Monitoring Data

1. **Monitoring Data**
   ☒ Is routinely submitted on time ☒ Is of acceptable quality
   Remarks: Two semiannual reports and one annual report are issued each year.

2. **Monitoring data suggests:**
   ☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining
   Remarks: Contaminants are contained with a small area onsite.

Site Inspection Checklist

E. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks: All wells are clearly labeled, locked, and look to be in good condition.

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. 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.).

The selected remedy at FFTA includes in-situ biological treatment (biostimulation), institutional controls, and monitoring. The objective of the biostimulation and monitoring was to document the reduction of concentrations of the volatile organic compounds, the semi-volatile organic compounds, as well as arsenic and manganese in site groundwater to meet the clean-up goals identified in the Record of Decision. Biostimulation was conducted in two phases a pilot study and full scale event. Biostimulation. Concentration of site contaminants decreased as a result of the elevated dissolved oxygen levels, although oxygen levels decreased rapidly afterwards.

Source and distal plume are attenuating accordingly with only benzene exceeding site cleanup goals (SVOCs were removed from sampling due to concentrations below clean up goals in four consecutive events). Arsenic also seems to be stable both in concentration and aerial extent. Long-term monitoring continues semiannually. The remedy is effective and functioning as designed.

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.

No issues. Adequate.

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.

A few protective casings had to be replaced at select monitoring wells due to rusted/broken hinges but this is expected over time.

Site Inspection Checklist

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Potentially remove monitoring wells and/or analytes from the LTM program if there are no detections of COCs above cleanup goals for *four* consecutive LTM sampling events.

APPENDIX B

FIVE-YEAR REVIEW
SITE INSPECTION PHOTOGRAPH LOGS

FFTA Five-Year Review Photo Log

Photo 1: Looking northwest across FFTA with FFTA-MW101S, -MW055D, -MW055S, and –MW002S (left to right) in the distance.

Photo 2: At FFTA-MW055S and –MW055D looking southeast across FFTA at –MW002S (left) and –MW101S with the airfield in the background.

FFTA Five-Year Review Photo Log

Photo 3: At FFTA-MW055S and –MW055D looking east at –MW061I and –MW056D.

Photo 4: Looking at FFTA-MW055S with the small tree next to the well head.

FFTA Five-Year Review Photo Log

Photo 5: Looking NW at north boundary of FFTA with FFTA-MW106 in the distance.

Photo 6: At southeastern end of FFTA looking west across the site.

FFTA Five-Year Review Photo Log

Photo 7: At eastern portion of FFTA looking south along tree line at FFTA-MW059S.

Photo 8: At FFTA-MW060I looking at the newly refurbished protective casing.

WOD Five-Year Review Photo Log

Photo 1: At WOD-MW003R looking north across the site.

Photo 2: Looking east with 15-MW007 in the foreground and WOD-MW001 in the far distance.

WOD Five-Year Review Photo Log

Photo 3: Looking east at WOD-MW001 which was recently refurbished.

Photo 4: Looking north down the dirt road that leads to the wells in the northern portion of the site as well as a perimeter facility gate.

WOD Five-Year Review Photo Log

Photo 5: Along the dirt road looking east at WOD-MW002S and –MW002D.

Photo 6: In the western portion of WOD looking at 15-MW001.

Photo 7: Looking north at the perimeter facility gate. The gate is locked at all times and permission must be granted by security to access the wells outside the fence.

Photo 8: Outside the gate looking at WOD-MW006.

APPENDIX C

FIVE-YEAR REVIEW INTERVIEWS

FIVE-YEAR REVIEW QUESTIONNAIRE

Facility:	NASA Wallops Flight Facility, Wallops Island, Virginia
Five-Year Review No.:	Five-Year Review No. 1 (first); Year 2013
Site(s):	1. Former Fire Training Area (FFTA) 2. Waste Oil Dump (WOD)
Interviewee:	Mr. Paul Herman, P.E.
Agency/Title/etc:	Virginia Department of Environmental Quality (VDEQ)
Date:	May 23, 2013

Background

1. Are you aware of any efforts by NASA to solicit or engage input and concerns from the Public? If so, please describe these efforts."

Yes. NASA held meetings with the public to present the proposed remedial action plans for the FFTA and WOD sites.

2. What effects have site operations had on the surrounding community or area?

No effects to the surrounding community have been observed by or presented to VDEQ relative to operations at FFTA or WOD.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

VDEQ is unaware of any community concerns regarding the FFTA or WOD sites or their operation and administration.

4. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, give details.

No.

5. Are you aware of any intrusive activities being conducted at the site or uses of the site other than monitoring or maintenance?

No.

6. Are you aware of any uses of the groundwater at or downgradient of the site?

No, none downgradient or on site. Groundwater is used by the Town of Chincoteague via wells located over 4000' east-southeast and cross-gradient of the sites.

FIVE-YEAR REVIEW QUESTIONNAIRE

State and Local Considerations (Regulatory)

1. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.

Yes, NASA provides VDEQ site inspection results and annual monitoring reports specific to each site for the purpose of reporting on groundwater quality and integrity of land use controls.

2. Have there been any complaints, violations, or other compliance issues related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

No.

3. Have there been any changes in regulations or cleanup levels since implementation that may impact the site?

No.

Performance, Operation, and Maintenance Problems

1. Is the remedy functioning as intended by the decision documents? How well is the remedy performing?

Yes, the remedy is functioning as well as intended at this time.

2. Describe the Long Term Monitoring (LTM) staff and activities. If there is not a continuous on-site presence, describe the staff and frequency of site inspections and activities.

VDEQ has not met the LTM staff so a description of them is not possible. As to their activities, all indications are the staff follows the requirements of the long-term monitoring plan visiting each site as detailed in the site-specific plan.

3. Have there been any significant changes in the LTM requirements, operational adjustments, maintenance schedules, or sampling routines since start up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe the changes and impacts.

Yes. Each site has experienced some change to their LTM requirements based on the data generated. The changes have not affected the remedy protectiveness or effectiveness at either site at this time. The changes included elimination of select chemicals from the analyte list and the reduction in post-performance monitoring sampling frequency from semi-annual to annual. Certain

changes have yet to be implemented as they were only just (Spring 2013) proposed. No impacts have been noted at either site at this time.

4. Do you have any comments or feedback on the adequacy of the implemented remedy? Are all the right constituents included? Is the monitoring frequency adequate?

VDEQ has no comments concerning the adequacy of the remedies at either site. Regarding the constituents being monitored at each site, VDEQ is concerned about the latest trend of vinyl chloride data presented in the 2012 groundwater monitoring report for the FFTA (submitted Spring 2013). The level detected remained below the cleanup goal for the required number of consecutive samples as specified in the ROD and justifying its removal from the analyte list, however, the last three rounds of data have shown a steadily increasing trend approaching the cleanup goal. VDEQ will request vinyl chloride be added to the list of analytes for the FFTA groundwater sampling event to demonstrate remedy protectiveness during the next Five-year Review.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

VDEQ offers no comment concerning NASA's management or operation of either site at this time.

FIVE-YEAR REVIEW QUESTIONNAIRE

Facility:	NASA Wallops Flight Facility, Wallops Island, Virginia
Five-Year Review No.:	Five-Year Review No. 1 (first); Year 2013
Site(s):	1. Former Fire Training Area (FFTA) 2. Waste Oil Dump (WOD)
Interviewee:	Mr. Steve Hirsh and Ms. Dawn Fulsher
Agency/Title/etc:	U.S. Environmental Protection Agency (EPA) Region 3 / Remedial Project Mangers (RPMs)
Date:	May 31, 2013

Background

1. Are you aware of any efforts by NASA to solicit or engage input and concerns from the Public? If so, please describe these efforts."

Yes. NASA has help public meetings at the appropriate points in the CERCLA process and has informed the public of this 5 Year Review process.

2. What effects have site operations had on the surrounding community or area?

Cleanup actions and investigations have not had an effect on the surrounding community.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

No. EPA is not aware of any community concerns related to the cleanup actions at this site.

4. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, give details.

Not specifically associated with the FFTA or the WOD. However emergency response actions have been taken when suspect munitions items have been located at the facility during cleanup actions.

5. Are you aware of any intrusive activities being conducted at the site or uses of the site other than monitoring or maintenance?

No.

6. Are you aware of any uses of the groundwater at or downgradient of the site?

Groundwater under the Wallops facility is used by the Town of Chincoteague however; the production wells are not close to the WOD or FFTA sites.

State and Local Considerations (Regulatory)

1. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.

Yes, NASA provides EPA site inspection results, annual monitoring reports and land use control inspection results. EPA and NASA are in frequent contact regarding these and other NASA Wallops sites in the cleanup program.

2. Have there been any complaints, violations, or other compliance issues related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

No.

3. Have there been any changes in regulations or cleanup levels since implementation that may impact the site?

None identified for the WOd and FFTA sites.

Performance, Operation, and Maintenance Problems

1. Is the remedy functioning as intended by the decision documents? How well is the remedy performing?

Yes, the remedy is functioning as expected. No changes recommended at this time.

2. Describe the Long Term Monitoring (LTM) staff and activities. If there is not a continuous on-site presence, describe the staff and frequency of site inspections and activities.

EPA is not involved with the LTM activities at these sites but receives and reviews LTM reports on a routine basis.

3. Have there been any significant changes in the LTM requirements, operational adjustments, maintenance schedules, or sampling routines since start up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe the changes and impacts.

Yes. Monitoring frequency and constituents are under review and changes have been requested and approved. Additional changes will be made in the future based on monitoring results.

4. Do you have any comments or feedback on the adequacy of the implemented remedy? Are all the right constituents included? Is the monitoring frequency adequate?

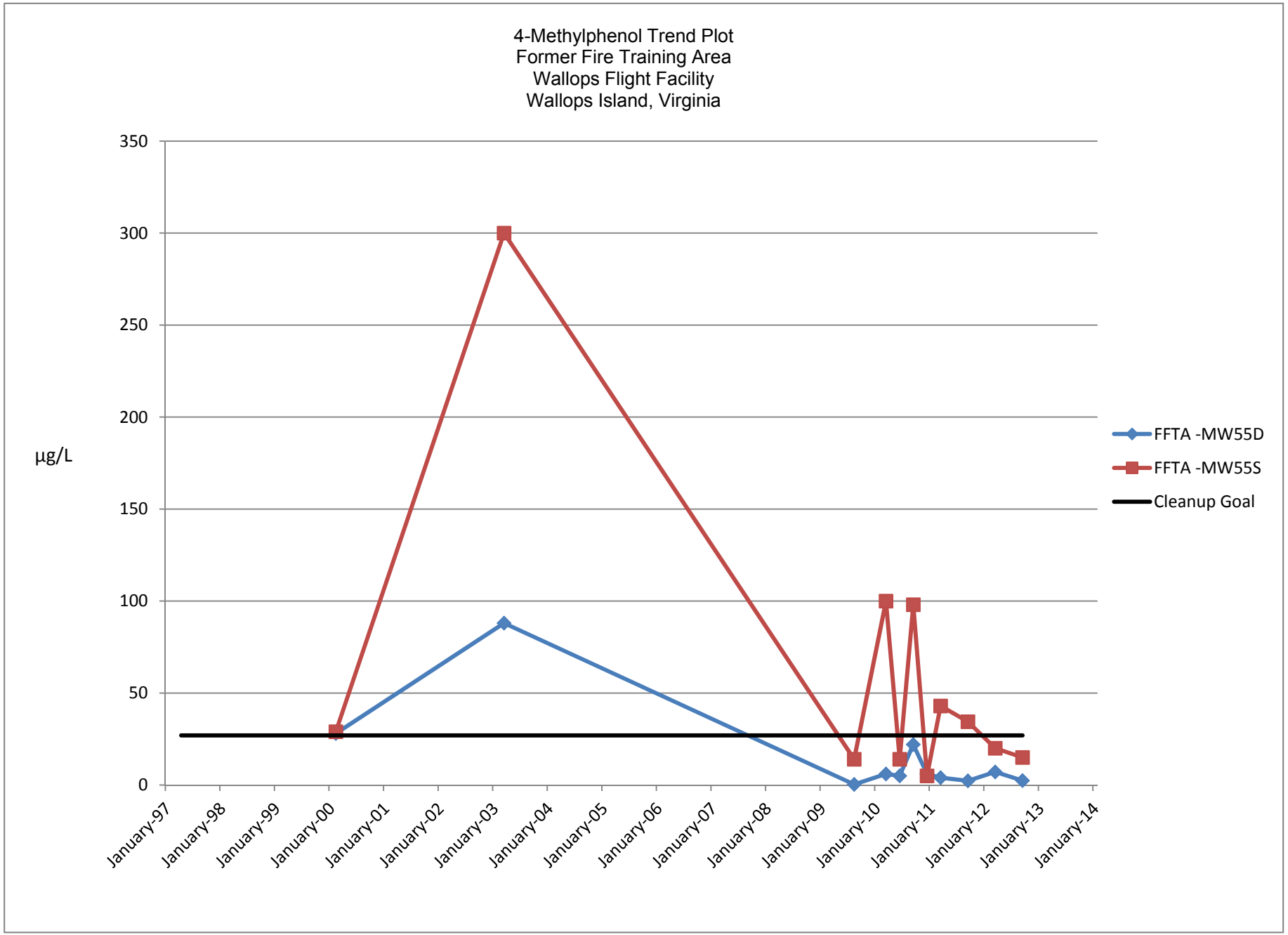
Remedies are performing as anticipated.

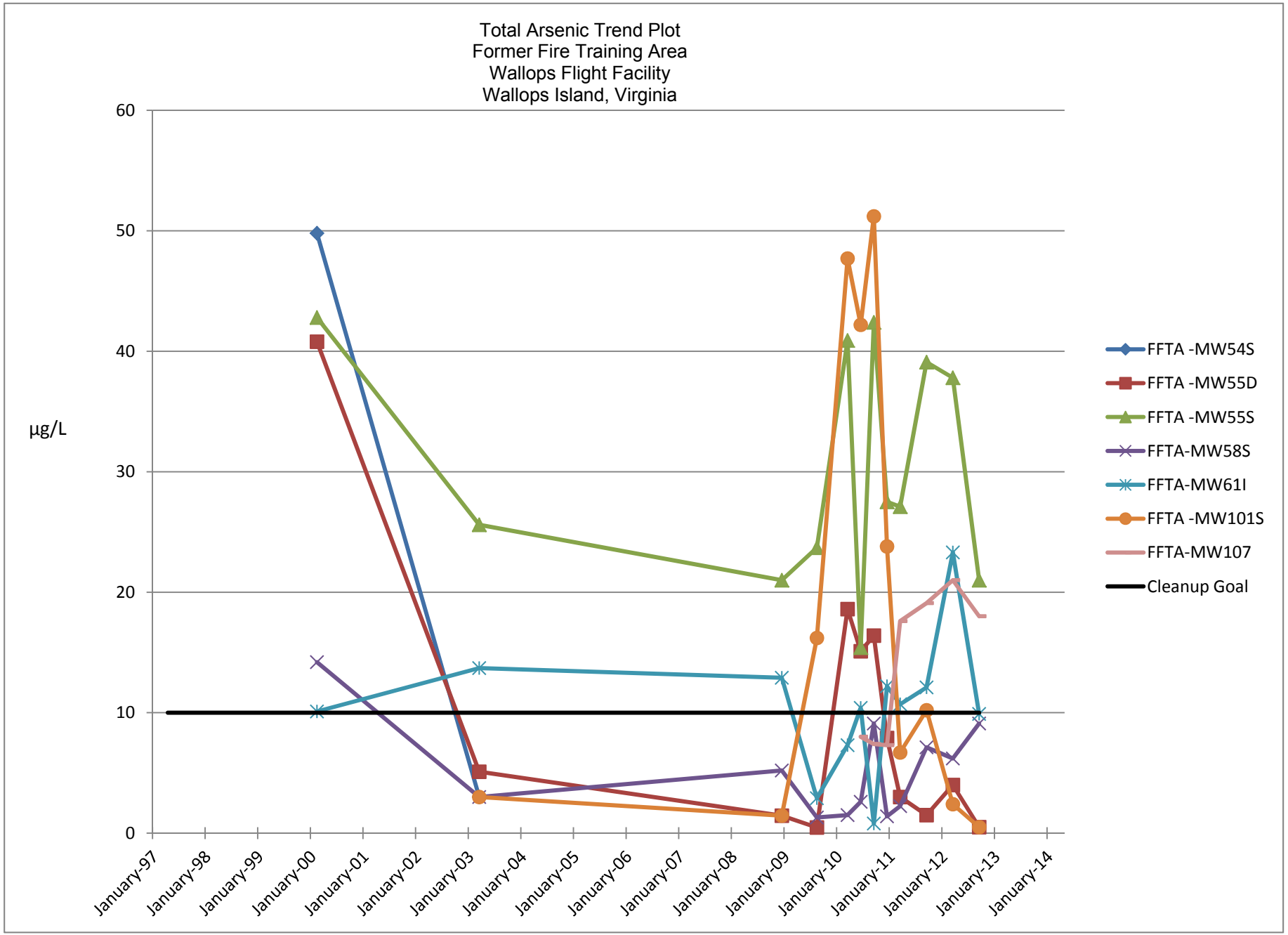
5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

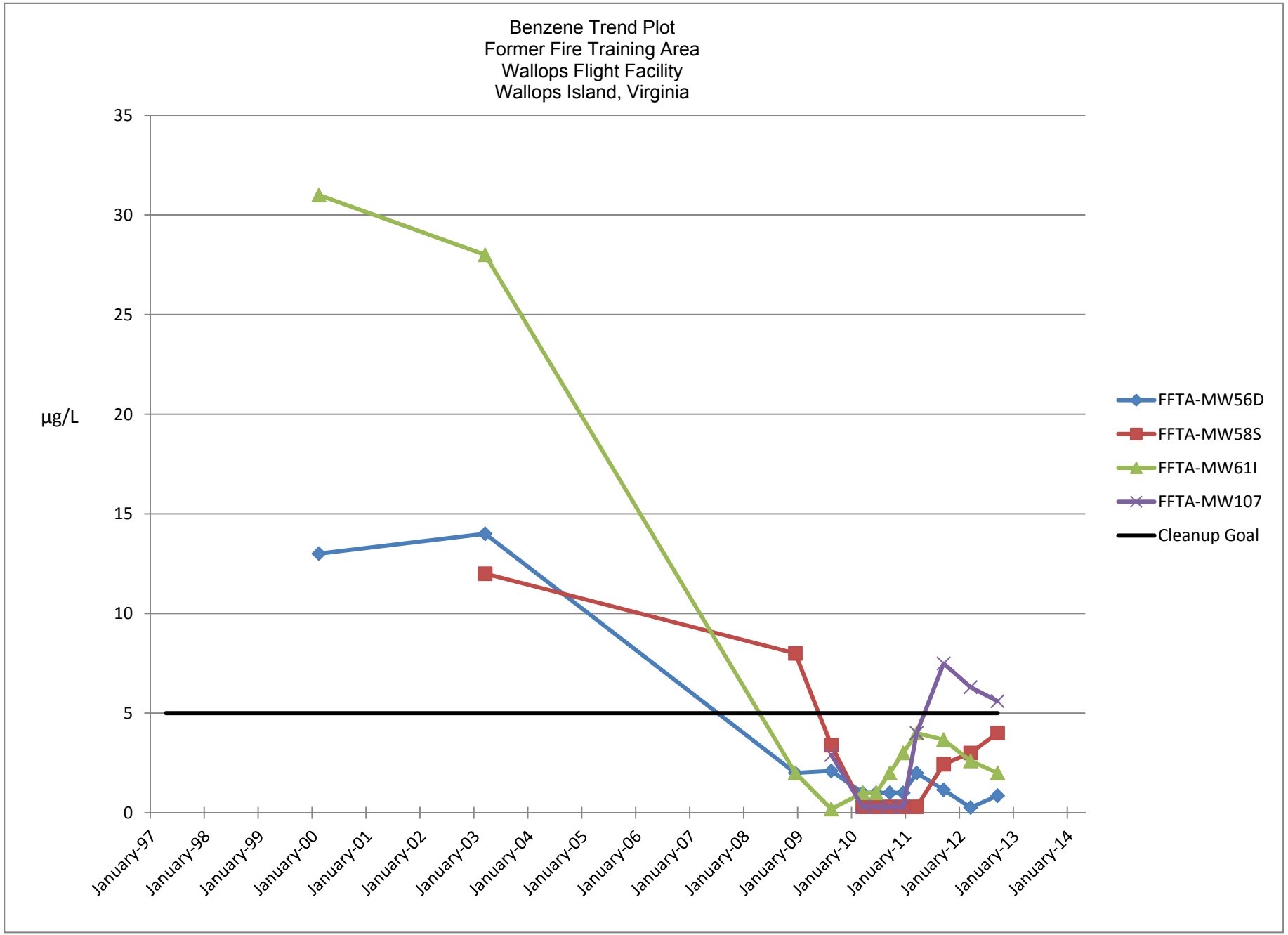
No comments at this time.

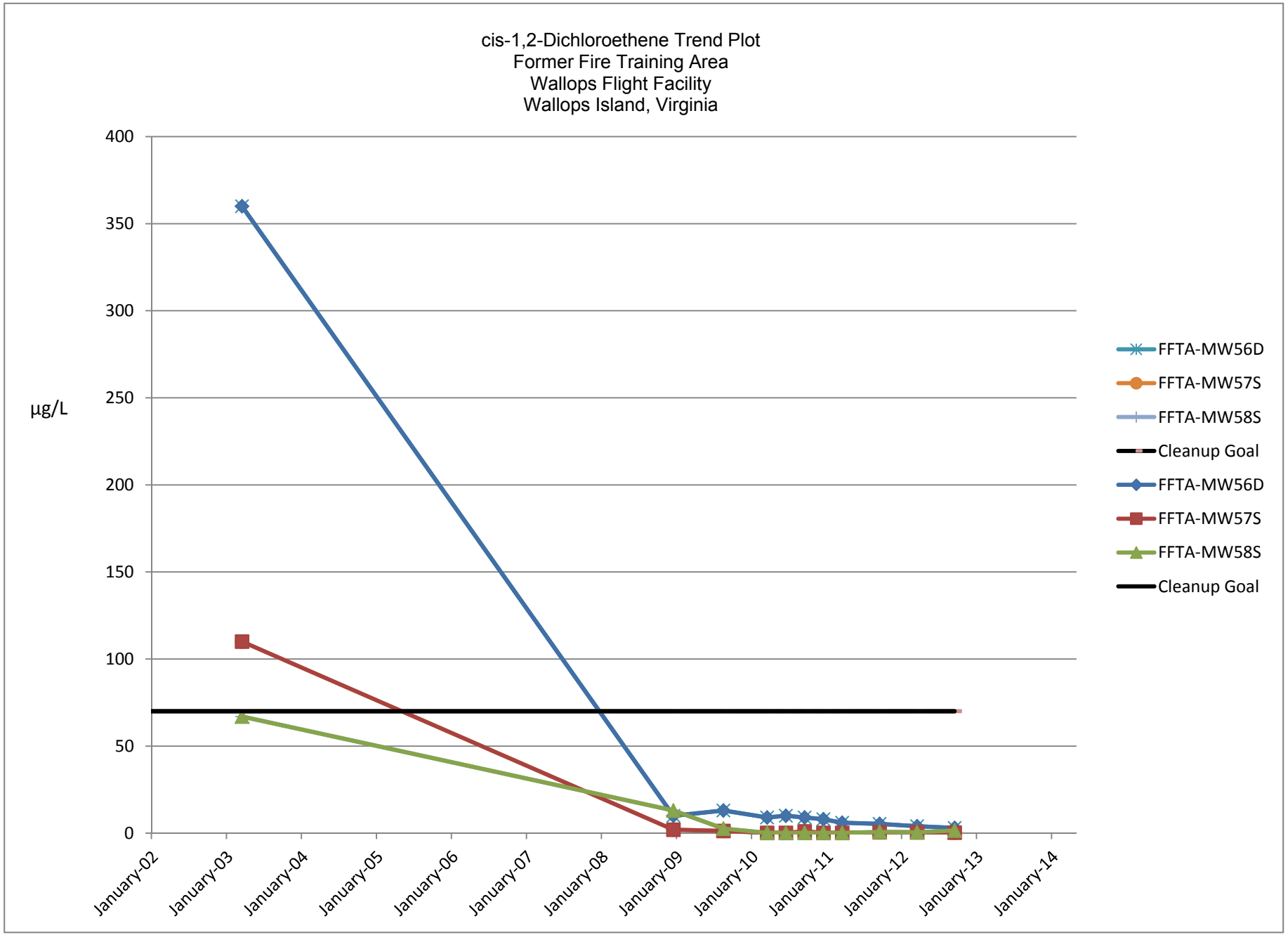
APPENDIX D

CHEMICAL OF CONCERN TEMPORAL DATA GRAPHS


4-Methylphenol Trend Plot
Former Fire Training Area
Wallops Flight Facility
Wallops Island, Virginia
µg/L
350
300
250
200
150
100
50
0
January-97
January-98
January-99
January-00
January-01
January-02
January-03
January-04
January-05
January-06
January-07
January-08
January-09
January-10
January-11
January-12
January-13
January-14
FFTA -MW55D
FFTA -MW55S
Cleanup Goal


Total Arsenic Trend Plot
Former Fire Training Area
Wallops Flight Facility
Wallops Island, Virginia
µg/L
60
50
40
30
20
10
0
January-97
January-98
January-99
January-00
January-01
January-02
January-03
January-04
January-05
January-06
January-07
January-08
January-09
January-10
January-11
January-12
January-13
January-14
FFTA -MW54S
FFTA -MW55D
FFTA -MW55S
FFTA-MW58S
FFTA-MW61I
FFTA -MW101S
FFTA-MW107
Cleanup Goal


Benzene Trend Plot
Former Fire Training Area
Wallops Flight Facility
Wallops Island, Virginia
µg/L
35
30
25
20
15
10
5
0
January-97
January-98
January-99
January-00
January-01
January-02
January-03
January-04
January-05
January-06
January-07
January-08
January-09
January-10
January-11
January-12
January-13
January-14
FFTA-MW56D
FFTA-MW58S
FFTA-MW61I
FFTA-MW107
Cleanup Goal


cis-1,2-Dichloroethene Trend Plot
Former Fire Training Area
Wallops Flight Facility
Wallops Island, Virginia
µg/L
400
350
300
250
200
150
100
50
0
January-02
January-03
January-04
January-05
January-06
January-07
January-08
January-09
January-10
January-11
January-12
January-13
January-14
FFTA-MW56D
FFTA-MW57S
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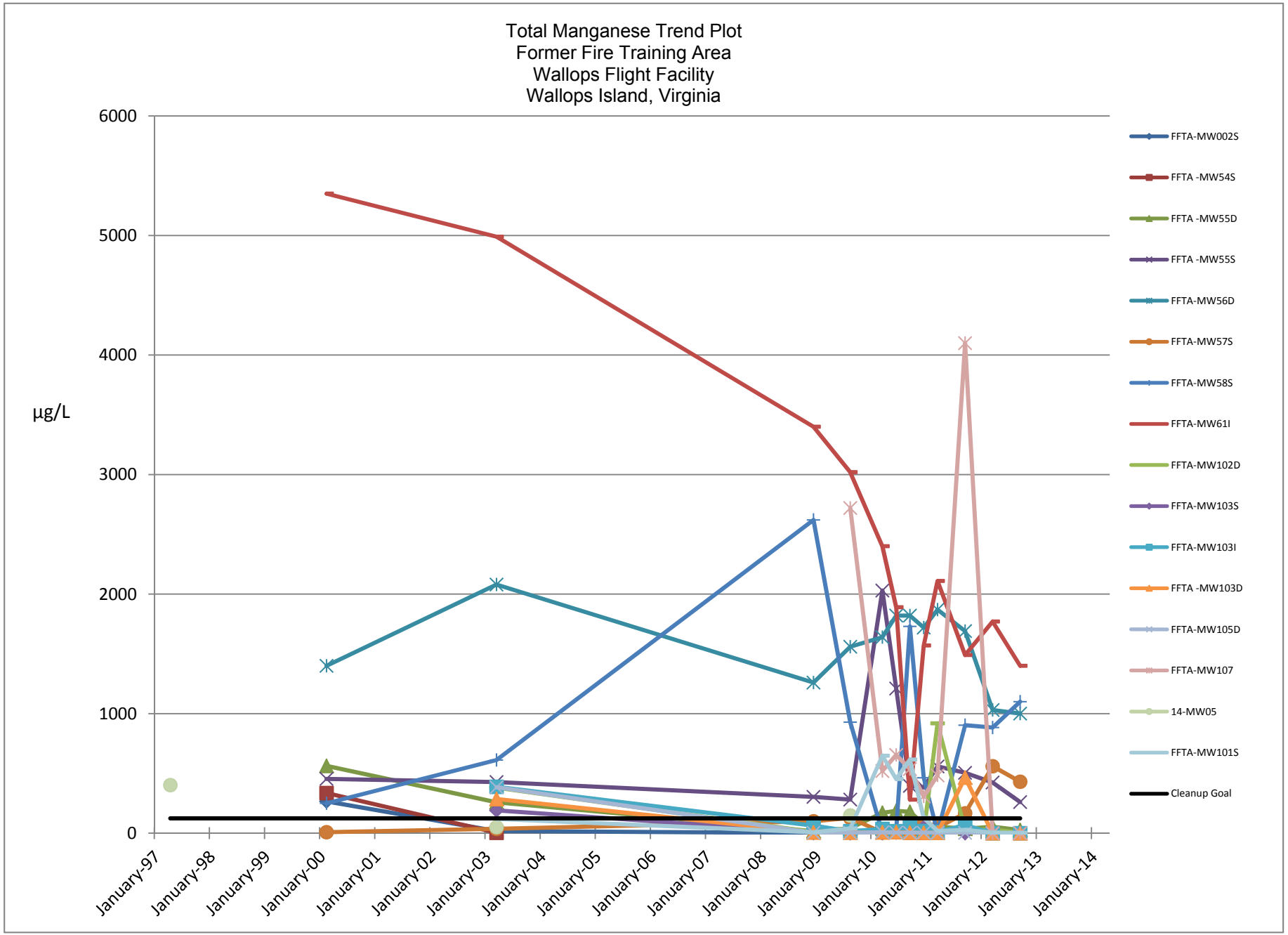
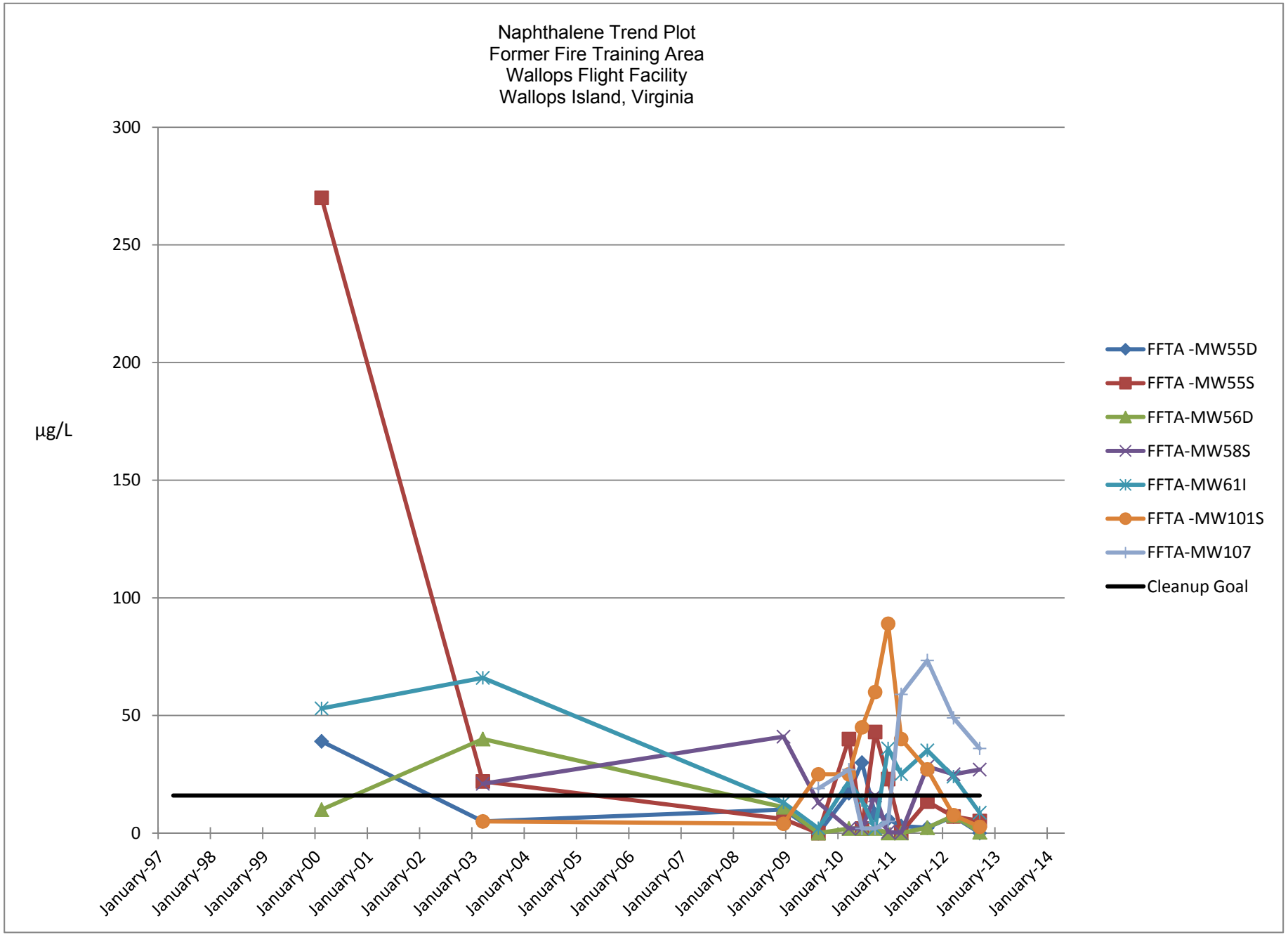
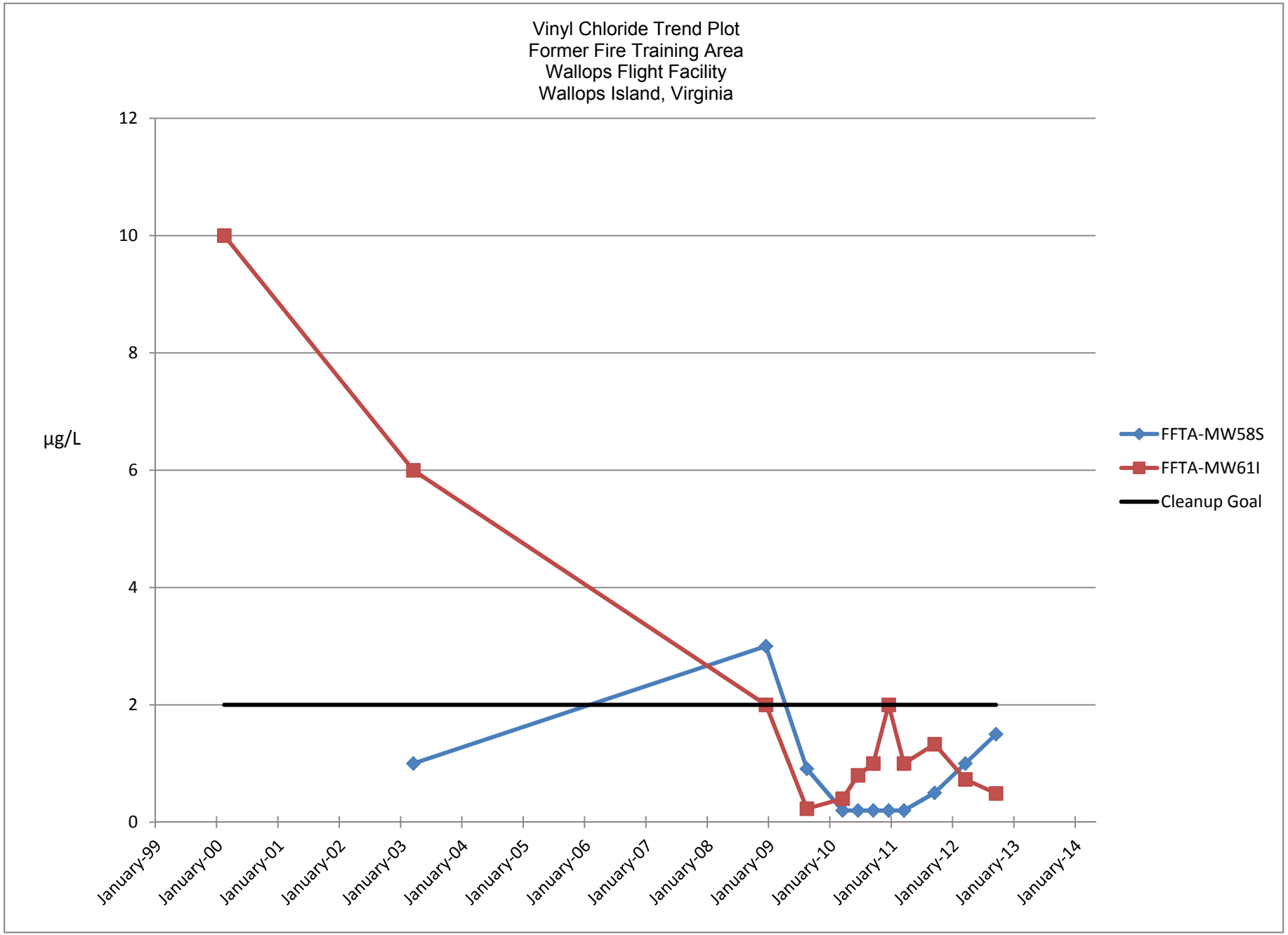
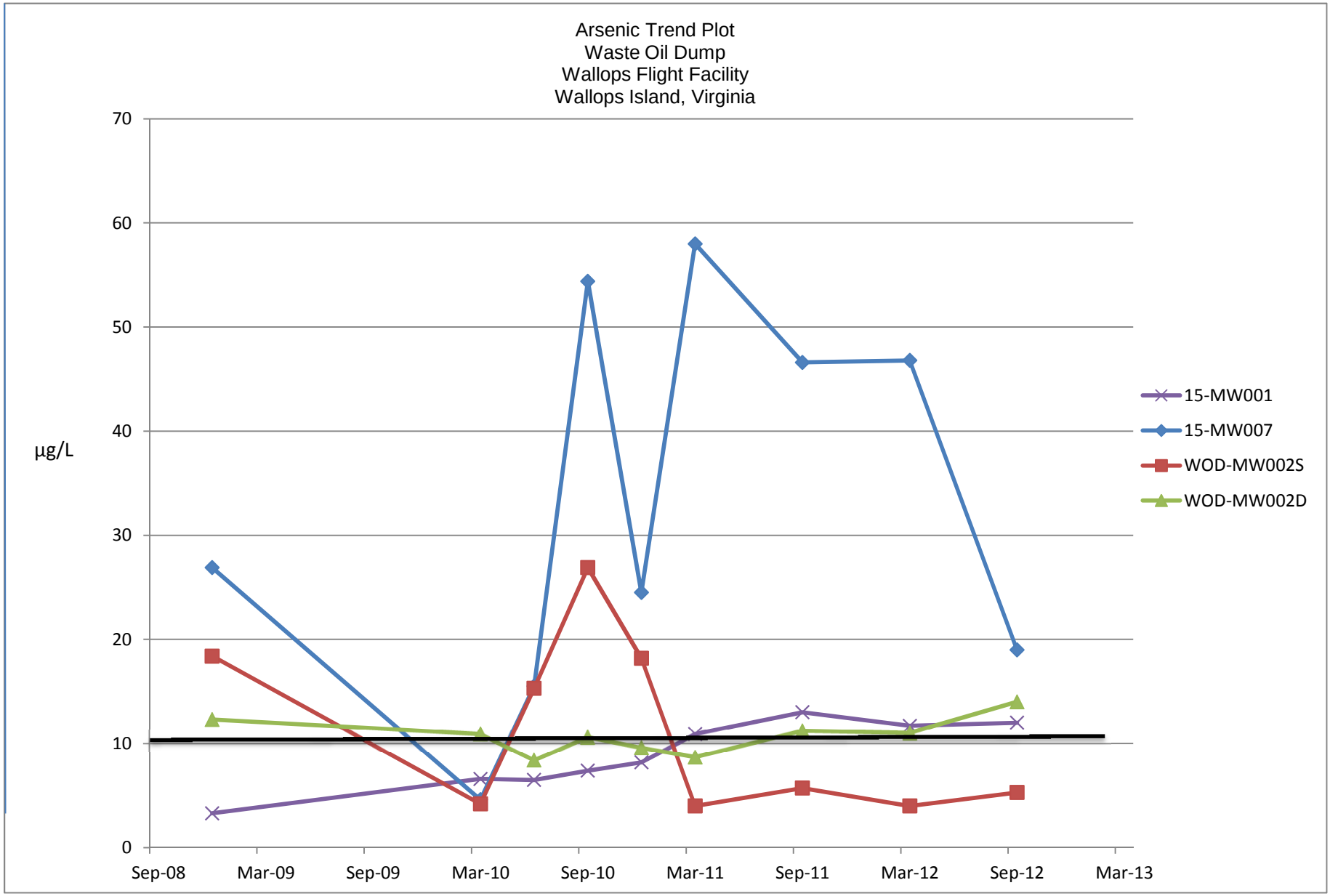
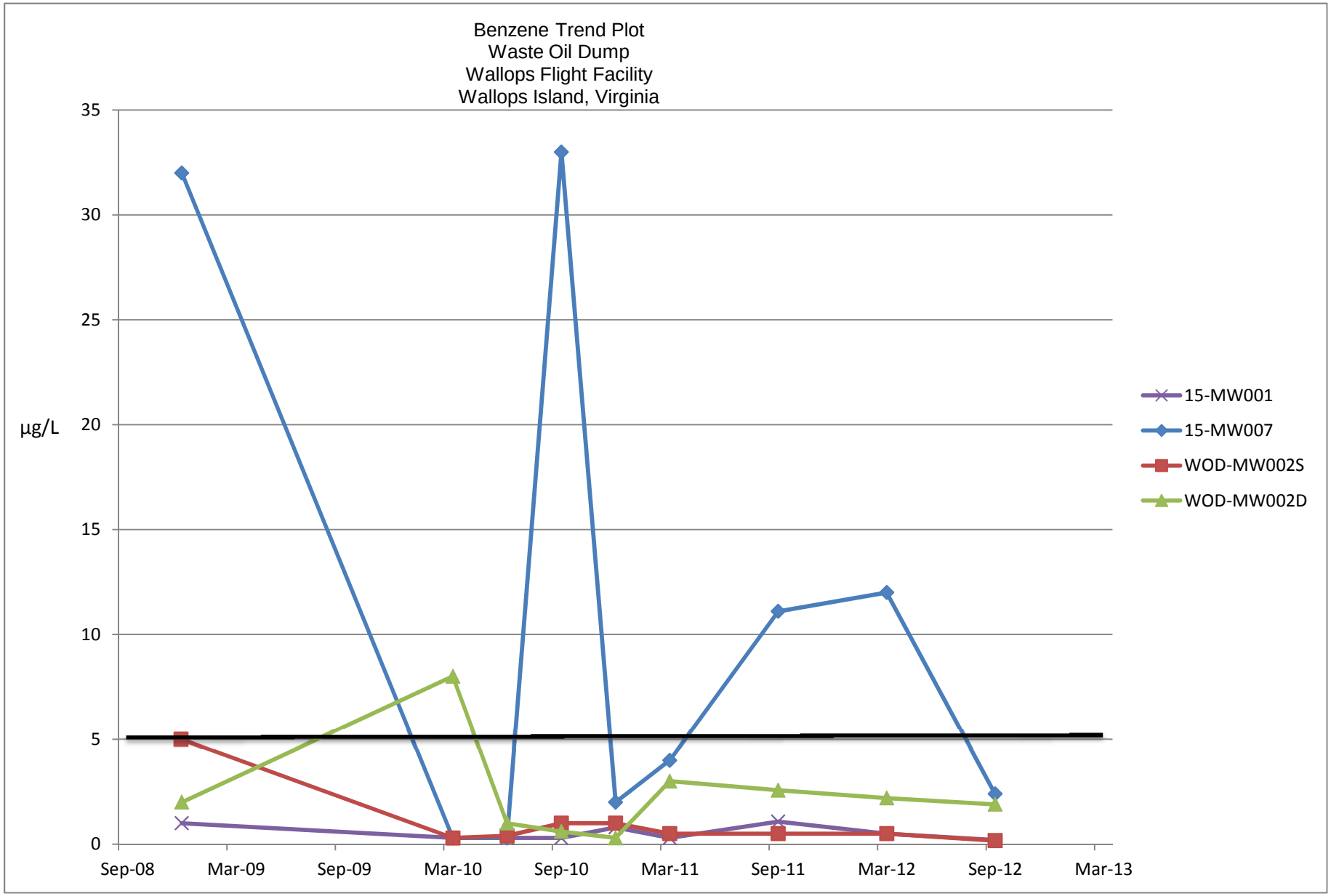
Cleanup Goal
FFTA-MW56D
FFTA-MW57S
FFTA-MW58S
Cleanup Goal


Total Manganese Trend Plot
Former Fire Training Area
Wallops Flight Facility
Wallops Island, Virginia
µg/L
6000
5000
4000
3000
2000
1000
0
January-97
January-98
January-99
January-00
January-01
January-02
January-03
January-04
January-05
January-06
January-07
January-08
January-09
January-10
January-11
January-12
January-13
January-14
FFTA-MW002S
FFTA -MW54S
FFTA -MW55D
FFTA -MW55S
FFTA-MW56D
FFTA-MW57S
FFTA-MW58S
FFTA-MW61I
FFTA-MW102D
FFTA-MW103S
FFTA-MW103I
FFTA -MW103D
FFTA-MW105D
FFTA-MW107
14-MW05
FFTA-MW101S
Cleanup Goal


Naphthalene Trend Plot
Former Fire Training Area
Wallops Flight Facility
Wallops Island, Virginia
µg/L
300
250
200
150
100
50
0
January-97
January-98
January-99
January-00
January-01
January-02
January-03
January-04
January-05
January-06
January-07
January-08
January-09
January-10
January-11
January-12
January-13
January-14
FFTA -MW55D
FFTA -MW55S
FFTA-MW56D
FFTA-MW58S
FFTA-MW61I
FFTA -MW101S
FFTA-MW107
Cleanup Goal


Vinyl Chloride Trend Plot
Former Fire Training Area
Wallops Flight Facility
Wallops Island, Virginia
µg/L
12
10
8
6
4
2
0
January-99
January-00
January-01
January-02
January-03
January-04
January-05
January-06
January-07
January-08
January-09
January-10
January-11
January-12
January-13
January-14
FFTA-MW58S
FFTA-MW61I
Cleanup Goal


Arsenic Trend Plot
Waste Oil Dump
Wallops Flight Facility
Wallops Island, Virginia
µg/L
70
60
50
40
30
20
10
0
Sep-08
Mar-09
Sep-09
Mar-10
Sep-10
Mar-11
Sep-11
Mar-12
Sep-12
Mar-13
15-MW001
15-MW007
WOD-MW002S
WOD-MW002D


Benzene Trend Plot
Waste Oil Dump
Wallops Flight Facility
Wallops Island, Virginia
µg/L
35
30
25
20
15
10
5
0
Sep-08
Mar-09
Sep-09
Mar-10
Sep-10
Mar-11
Sep-11
Mar-12
Sep-12
Mar-13
15-MW001
15-MW007
WOD-MW002S
WOD-MW002D

TABLES

TABLE 1-1
AAOC AREAS OF CONCERN
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

AOC NO.[1]	AOC[2] NAME	LOCATION[3]	CURRENT STATUS[4] / ALIAS
1	Old Wastewater Treatment Plant	MB	Deferred to FUDS Program / Site 1.
2	***Maintenance Facility***	***MB***	***Closed Out under AAOC/ Building E-52, Site 2.***
3	Two 600,000-Gallon Fuel Tanks	MB	Deferred to FUDS Program / Buildings A46-A and A46-B.
4	***Debris Pile***	***WI***	***Closed Out under AAOC/ Island Debris Pile - North End, Site 4.***
5	**Paint Stain**	**WI**	**Under Remediation / Paint Spray Booth, Site 5.**
6	Former Island Fueling System	WI	Deferred to UST Programs / Site 6.
7	***Transformer Pads***	***MB, ML, WI***	***Closed Out under AAOC / Site 7.***
8	Former Main Base Fueling System	MB	Deferred to UST Program / Site 8.
9	Abandoned Drum Field	MB	Deferred to FUDS Program / Site 9.
10	Advanced Data Acquisition Support Facility	MB	Closed Out under CERCLA / Site 10, ADAS.
11	***Transformer Storage Areas***	***MB, WI***	***Closed Out under AAOC/ Site 11.***
12	**Former Wind Tunnel**	**WI**	**Under Remediation / Site 12.**
13	Ordnance Disposal Area	MB	Deferred to FUDS Program / Boat Basin, Site 13.
14	Debris Pile	MB	Deferred to FUDS Program / Site 14.
15	Debris Pile	MB	Deferred to FUDS Program / Site 15.
	Waste Oil Dump	**MB**	**Remedy In Place; Long-Term Monitoring / Site 16, Pits at end of Runway 17-35.**
	Old Aviation Fuel Tank Farm	MB	Deferred to UST Program.
	Scrapyard	***MB***	***Closed Out under AAOC / Building N-222.***
	PCB Transformer Pad	MB	Closed Out under TSCA and CERCLA / N-161C.
	Photographic Tank	***MB***	***Closed Out under AAOC/ M-15 Photo Tank, Building M-15.***

TABLE 1-1
AAOC AREAS OF CONCERN
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

AOC NO.(1)	AOC(2) NAME	LOCATION(3)	CURRENT STATUS(4) / ALIAS
	Former Fire Training Area	**MB**	**Remedy In Place; Long-Term Monitoring.**
	Industrial/Sanitary Landfill	MB	Deferred to FUDS Program.
	Construction Debris Landfill	MB	Deferred to FUDS Program.
	Pistol/Rifle Range	**MB**	**Under investigation / Main Base Firing Range Complex.**
	South End Disposal Area (SEDA)	**WI**	**Under investigation.**

(1) Blank indicates no number was assigned.
(2) Area of Concern (AOC)
(3) Refers to the land parcel where the AOC is located; Main Base (MB); Main Land (ML); Wallops Island (WI).
(4) The following abbreviations are used to describe Current Status: Administrative Agreement On Consent (AAOC); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); Formerly Utilized Defense Sites (FUDS); Toxic Substance Control Act (TSCA).

A bolded and shaded entry indicates that the AOC is considered a NASA Site and is being pursued for further response actions under the AAOC. ***Italicized entry indicates that the AOC has been closed under the AAOC.***

TABLE 4-1
CHRONOLOGY OF EVENTS - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

EVENT / DOCUMENT	DATE
FFTA Site Operations	circa 1965-1987
Excavation of petroleum impacted soils (subsequent to 1986 VDEQ inspection findings)	1986
Preliminary Assessment (PA) (NASA, 1988)	1988
Site Inspection (SI) (Ebasco, 1990)	1989-1990
Supplemental SI (Metcalf & Eddy, 1992)	1991-1992
Remedial Investigation (RI) (Metcalf & Eddy, 1996)	1993-1994; 1996
Supplemental RI (*Revised Final Supplemental RI Report* dated 2004) (Tt, 2004a)	2000-2003; 2004
Feasibility Study (FS) (Tt, 2005a)	September 2005
Proposed Remedial Action Plan (PRAP) (Tt, 2007a)	October 2007
Record of Decision (ROD) (Tt, 2007b)	December 2007
Pilot Study Work Plan (Tt, 2008d)	November 2008
Land Use Control (LUC) Remedial Design (RD) (Tt, 2008a)	October 2008
Free Product Monitoring Plan	April 2009
Remedial Action Implementation (including Pilot Test) (Tt, 2009a)	2008-2010
Pilot Study Report (Tt, 2009a)	July 2009
Supplemental Sampling Report	April 2010
Remedial Action Work Plan & Long-Term Monitoring (LTM) Plan (Tt, 2010)	July 2010
2010 Annual LTM Report	November 2011
Remedial Action Completion Report (RACR) (Tt, 2011b)	December 2011
2011 Annual Groundwater Summary Report	June 2012
LTM Plan – Revision 1 (Tt, 2012b)	August 2012
2012 Annual LTM Report (Tt, 2013a)	May-13

Notes
LTM and enforcement of LUCs ongoing

TABLE 4-2
SUMMARY OF CHEMICALS OF CONCERN - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Exposure Scenario	Chemical of Concern (COC)	Range of Detected Concentrations During Remedial Investigation (µg/L)	Cleanup Level (µg/L)	*Basis of Cleanup Level*
Future Resident exposed to groundwater via ingestion, dermal contact, inhalation	Benzene	0.26 – 7.49	5	*MCL*
	cis-1,2-DCE	0.3 – 16	70	*MCL*
	Vinyl Chloride	0.3 – 2	2	MCL
	4-Methylphenol	0.37 – 140	27	*HI = 0.5*
	Naphthalene	0.04 – 89	16	*HI = 0.5*
	Arsenic	0.36 – 51.2	10	*MCL*
	Manganese	0.812 – 4,100	124	*HI = 0.5*

Notes
µg/L - microgram(s) per liter
DCE - dichloroethene
MCL - Maximum Contaminant Level
HI = [non-cancer] Hazard Index

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[1]	Cleanup Goal	FFTA-MW55D																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	1	U	1	U	0.11	U	0.3	U	0.3	U	0.3	U	0.3	UJ	0.3	U	0.5	U	0.5	U	0.2	U
cis-1,2-Dichloroethene	70	1		1	U	0.24	U	0.6	J	0.5	J	2		0.3	J	0.2	U	0.5	U	0.5	U	0.3	U
Vinyl chloride	2	1	U	2	U	0.23	U	0.2	U	0.2	U	0.1	U	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	**88**		NA		0.33	J	6	J	5	UJ	22		6		4		2.31	UL	7.1	U	0.25	U
Naphthalene	16	5	U	10	U	0.029	U	**17**		**30**		8	J	6		3		2.31	U	7.1	U	0.04	U
Metals (ug/L)																							
Total Arsenic	10	5.1		1.45	U	0.47	J	**18.6**		**15.1**		**16.4**		7.9		3	J	1.5	U	4	UL	0.5	U
Dissolved Arsenic	---							18.4		15.1		17.5		8.5		3.7	J	1.5	U	2.25	UL	0.5	U
Total Manganese	124	**258**		16.4		41.2		**170**		**187**		**178**		77		55.6		37.6		53.4		26	J
Dissolved Manganese	---							170		186	J	198		78.7	L	60.4		33.7		71.8		21	
Field Parameters																							
ph (S.U.)	---	6.48		5.37		4.64		6.73		6.04		7.37		5.52		5.55		4.84		5.58		4.98	
S. Conductivity (mS/cm)	---	0.069		0.060		0.067		0.151		0.182		0.139		0.087		0.074		0.057		0.072		0.072	
Dissolved Oxygen (mg/L) - Horiba	---	3.06		4.8		1.85		0		0.8		>20.00		3.15		6.38		8.51		3.41		5.19	
Dissolved Oxygen (mg/L) - Test Kit																		5		3		4	
Temperature (ºC)	---	14.8		17.1		21.26		13.64		16.29		20.7		15.07		14.91		18.21		16.97		20.72	
Oxygen Reduction Potential (mV)	---	50		168		121		-156		-84		-16		-27		101		-153.9		116		171	
Turbidity (NTU)	---	8.22		7.2		-2.32		1.35		1		1.20		1.2		0		0.96		0.55		5.52	
Alkalinity (ppm)	---							175		600		15		35		<10		0		<10		12	
Ferrous Iron (ppm)	---							2.0		7.0		4.5		1.2		1.7		0.0		1.0		0.0	
Hydrogen Sulfide (ppm)	---							0.1		0.0		0.1		0.1		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.1		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level
greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[1] Presents only compounds with Cleanup Goals and Field Parameters
[2] FFTA-MW54S was replaced by FFTA-MW108 in August 2009
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[1]	Cleanup Goal	FFTA -MW55S																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	2		1	U	1.1	U	1		0.3	U	2		1	J	0.8	J	0.687	J	0.61	J	0.36	J
cis-1,2-Dichloroethene	70	8		1	U	2.4	UJ	2		0.3	J	2		2	J	1		1.21		0.69	J	0.45	J
Vinyl chloride	2	1	U	1	U	2.3	U	0.2	U	0.2	U	0.5	J	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	**300**		NA		14	J	**100**		14		**98**		5		**43**		**34.4**		20		15	
Naphthalene	16	**22**		6	U	0.031	U	**40**		2	U	**43**		**23**	L	0.4		13.4		7.1	U	5.2	J
Metals (ug/L)																							
Total Arsenic	10	**25.6**		**21**		**23.7**		**40.9**		**15.4**		**42.4**		**27.5**		**27.1**		**39.1**		**37.8**		**21**	
Dissolved Arsenic	---							38.2		15.5		41.4		25.3		28.8		42.9		37.4		25	
Total Manganese	124	**428**		**303**		**281**		**2,030**		**1,210**		**396**		**383**		**558**		**505**		**424**		**260**	J
Dissolved Manganese	---							1,990		1,480	J	408		368	L	586		577		421		270	
Field Parameters																							
ph (S.U.)	---	7.14		5.88		5.26		6.36		5.99		8.98		5.67		6.60		5.05		5.56		6.14	
S. Conductivity (mS/cm)	---	0.183		0.064		0.112		0.305		0.243		0.234		0.161		0.153		0.122		0.156		0.100	
Dissolved Oxygen (mg/L) - Horiba	---	0.46		2.52		0		0		4.91		15.68		0		-		1.06		0.04		0.85	
Dissolved Oxygen (mg/L) - Test Kit																		1.5		0.05		0.8	
Temperature (ºC)	---	14		16.64		21.72		12.7		17.38		20.2		15.64		14.5		19.57		15.15		21.54	
Oxygen Reduction Potential (mV)	---	-96		-31		-101		-158		-148		-125		-116		-99		-233.8		-35		-57	
Turbidity (NTU)	---	5.1		5.2		0.73		7.15		0.78		3.51		2.83		4.41		1.29		2.66		6.72	
Alkalinity (ppm)	---							20		150		50		32		40		10		25		40	
Ferrous Iron (ppm)	---							3.0		5.0		5.0		3.8		4.2		0.0		3.5		2.5	
Hydrogen Sulfide (ppm)	---							0.5		0.0		0.3		0.5		0.3		0.0		0.1		0.3	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[1] Presents only compounds with Cleanup Goals and F
[2] FFTA-MW54S was replaced by FFTA-MW108 in Au
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[(1)]	Cleanup Goal	FFTA-MW56D																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	**14**		2		2.1		1	J	1		1	J	1	J	2		1.15		0.26	J	0.86	J
cis-1,2-Dichloroethene	70	**360**		10		13		9		10		9		8	J	6		5.31		4		3	
Vinyl chloride	2	2		2	U	0.33	J	0.2	U	0.3	J	0.6		0.2	UJ	0.5	J	0.352	J	1	U	0.31	J
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.053	J	6	U	6	U	5	UR	0.4	UL	0.4	U	2.31	U	7.5	U	0.28	U
Naphthalene	16	**40**		11	U	0.026	U	2	U	2	U	2	U	0.06	UL	0.06	U	2.31	U	7.5	U	0.37	
Metals (ug/L)																							
Total Arsenic	10	3	U	1.45	U	0.14	U	1.5	U	2.6	B	3.6	B	3.2	B	3.2	J	1.88	J	4	UL	1.7	
Dissolved Arsenic	---							1.5	U	3	B	3.1	B	1.8	B	3	J	1.72	J	2.25	UL	0.55	J
Total Manganese	124	**2,080**		**1,260**		**1560**		**1,640**		**1,820**		**1,820**		**1,720**		**1,870**		**1,690**		**1,030**		**1,000**	J
Dissolved Manganese	---							1,620		1,810	J	1,840		1,670	L	1800		1,780		943		970	
Field Parameters																							
ph (S.U.)	---	6.12		6.08		5.27		6.23		5.83		5.86		5.81		6.03		4.82		6.06		6.33	
S. Conductivity (mS/cm)	---	0.154		0.122		0.136		0.127		0.115		0.140		0.129		0.123		0.112		0.110		0.110	
Dissolved Oxygen (mg/L) - Horiba	---	0.67		2.05		0.97		0.12		2.34		2.9		1.27		-		5.00		0.00		0.82	
Dissolved Oxygen (mg/L) - Test Kit																		0.8		0.6		1	
Temperature (ºC)	---	15.1		16.14		17.9		15.24		16.24		18.95		15.22		16.7		19.43		17.96		20.13	
Oxygen Reduction Potential (mV)	---	44		36		18		147		136		103		61		-13		-269.7		77		40	
Turbidity (NTU)	---	1		0.2		4.12		0.88		0		0.0		0.89		0.34		0		0		6.80	
Alkalinity (ppm)	---							35		32		40		18		14		36		35		20	
Ferrous Iron (ppm)	---							0.8		0.6		0.0		0.4		0.6		1.0		0.0		0.0	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
(1) Presents only compounds with Cleanup Goals and F
(2) FFTA-MW54S was replaced by FFTA-MW108 in Aug
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[1]	Cleanup Goal	FFTA-MW57S																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	3	L	0.8	J	0.44	J	0.3	U	0.3	U	1	U	0.3	UJ	0.3	U	0.5	U	0.5	U	0.3	J
cis-1,2-Dichloroethene	70	**110**	L	2		1.3		0.2	U	0.2	U	1	U	0.2	UJ	0.2	U	0.5	U	0.5	U	0.3	U
Vinyl chloride	2	1	UL	2	U	0.23	U	0.2	U	0.2	U	2	U	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.019	J	6	U	6	U	5	U	0.4	U	0.4	U	2.45	U	7.1	U	0.24	U
Naphthalene	16	5	U	6	J	2.3		2	U	2	U	2	U	0.4		0.3		4.11	J	2.6	J	2.1	
Metals (ug/L)																							
Total Arsenic	10	3	U	1.45	U	0.23		1.5	U	1.5	B	2.8	B	2.3	B	2.25	U	1.5	U	4	UL	0.5	U
Dissolved Arsenic	---							1.5	U	2	B	2.4	B	1.6	B	2.25	U	1.5	U	2.25	UL	0.48	J
Total Manganese	124	36	U	99.4		**128**		5.3	J	15.6		2.3		78.8		46.6		**166**		**560**		**430**	J
Dissolved Manganese	---							4.9	J	15.2	J	2.2		72.8		50.1		152		520		510	
Field Parameters																							
ph (S.U.)	---	5.64		4.61		5.06		6.33		5.88		5.35		5.46		4.91		4.51		6.00		5.44	
S. Conductivity (mS/cm)	---	0.090		0.116		0.112		0.202		0.170		0.139		0.090		0.078		0.070		0.085		0.112	
Dissolved Oxygen (mg/L) - Horiba	---	2.83		2.93		3.16		1.91		2.24		>20.0		5.15		-		1.73		0.00		5.36	
Dissolved Oxygen (mg/L) - Test Kit																		1		0.8		2	
Temperature (ºC)	---	14.7		16.9		17.9		10.29		15.02		18.1		15.13		15.6		18.37		25.44		17.8	
Oxygen Reduction Potential (mV)	---	92		147		138		139		356		108		77		150		-238.1		6		42	
Turbidity (NTU)	---	1.6		0.91		1.06		1.26		0.28		1.28		0		3.71		0.76		0		1.12	
Alkalinity (ppm)	---							27		25		21		40		20		20		25		20	
Ferrous Iron (ppm)	---							0.0		0.0		0.0		0.2		0.0		0.4		0.0		0.5	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.1	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[1] Presents only compounds with Cleanup Goals and F
[2] FFTA-MW54S was replaced by FFTA-MW108 in Au
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[1]	Cleanup Goal	FFTA-MW58S																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	**12**		**8**		3.4	J	0.3	U	0.3	U	0.3	U	0.3	UJ	0.3	U	2.44		3		4	J
cis-1,2-Dichloroethene	70	**67**		13		2.6	J	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.679	J	0.47	J	1.5	U
Vinyl chloride	2	1	U	**3**		0.91	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	1	U	1.5	U
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.62	J	5	U	5	U	5	U	0.4	UR	0.4	U	5.23		7.5	UR	4.1	
Naphthalene	16	**21**		**41**		13		2	U	2	U	16	U	0.5		0.06	U	**28.3**		**25**		**27**	
Metals (ug/L)																							
Total Arsenic	10	3	U	5.2	U	1.3		1.5	U	2.6	B	9.1	L	1.4	B	2.25	U	7.13		6.2	L	9.1	
Dissolved Arsenic	---							1.5	U	2.3	B	9.3	L	1.6	B	2.25	U	7.37		6.3	L	10	
Total Manganese	124	**612**		**2,620**		**929**		4.2		24.9		**1,730**		**463**		4.3		**903**		**884**		**1,100**	J
Dissolved Manganese	---							3.9		3.1	J	1,870		400	L	1.9	B	978		892		1,100	
Field Parameters																							
ph (S.U.)	---	7.13		6.30		5.50		6.03		5.34		6.06		6.07		6.24		4.84		6.73		6.67	
S. Conductivity (mS/cm)	---	0.112		0.219		0.218		0.091		0.063		0.090		0.139		0.175		0.198		0.183		2.110	
Dissolved Oxygen (mg/L) - Horiba	---	5.59		1.85		2.13		7.58		7.62		>20.0		2.78		5.28		1.14		0.68		0.57	
Dissolved Oxygen (mg/L) - Test Kit																		2		2		0	
Temperature (ºC)	---	12.6		16.76		19.6		12.93		17.13		19.6		15.62		13.59		19.32		15.31		20.11	
Oxygen Reduction Potential (mV)	---	167		-47		-31		220		192		24		39		-51		-11.5		-78		-140	
Turbidity (NTU)	---	5.38		3.5		0.16		1.61		0.8		0.6		1.2		4.69		1.81		0		2.11	
Alkalinity (ppm)	---							20		<10		25		17		65		0		55		50	
Ferrous Iron (ppm)	---							0.5		0.8		2.5		1.2		2.8		5.5		6.0		4.6	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[1] Presents only compounds with Cleanup Goals and F
[2] FFTA-MW54S was replaced by FFTA-MW108 in Au
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[(1)]	Cleanup Goal	FFTA-MW61I																					
Date Sampled		Mar-03		Dec-08		Aug-09		March-10		June-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	**28**		2		0.19	J	1		1		2		3	J	4		3.67		2.6		2	
cis-1,2-Dichloroethene	70	**460**		6		2.3		2		2		2		2	J	2		1.38		1.4		0.87	J
Vinyl chloride	2	**6**		2	U	0.23	U	0.4	J	0.8	J	1	J	**2**	J	1		1.33		0.73	J	0.49	J
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.017	U	6	U	6		5	UR	0.4	UR	0.5	UR	2.36	U	7.1	UR	0.27	U
Naphthalene	16	**66**		13		2.1		**22**		14		2	UR	**36**	L	**25**	L	**35.2**		**24**		8.7	
Metals (ug/L)																							
Total Arsenic	10	**13.7**		**12.9**		2.9		7.3	J	**10.4**		0.8	UL	**12.2**		**10.7**		**12.1**		**23.3**		9.9	
Dissolved Arsenic	---							6.8	J	7.9		0.9	J	9		10.6		10.9		10.5		11	
Total Manganese	124	**4,990**		**3,400**		**3,020**		**2,400**		**1,890**		**280**		**1,570**		**2,110**		**1,490**		**1,770**		**1,400**	J
Dissolved Manganese	---							2,340		1,990	J	307		2,010	L	2160		1,880		1,660		1,500	
Field Parameters																							
ph (S.U.)	---	6.35		6.01		5.85		5.46		6.29		5.68		6.16		6.26		5.36		5.91		6.70	
S. Conductivity (mS/cm)	---	0.179		0.145		0.118		0.162		0.122		0.191		0.185		0.229		0.183		0.202		0.191	
Dissolved Oxygen (mg/L) - Horiba	---	0.56		0.75		6.46		2.67		5.83		4.86		1.89		5		0.79		0.00		0.58	
Dissolved Oxygen (mg/L) - Test Kit																		0.05		0		0	
Temperature (ºC)	---	14.9		17.24		20.13		15.21		15.39		18.13		15.38		15.36		18.91		15.2		18.42	
Oxygen Reduction Potential (mV)	---	-45		-66		33		32		-24		-23		-31		-94		-310.6		-99		-133	
Turbidity (NTU)	---	9		2.2		1.15		3.43		9.28		2.47		2		1.57		0		0		2.25	
Alkalinity (ppm)	---							55		50		80		50		50		70		40		50	
Ferrous Iron (ppm)	---							0.8		2.6		5.0		1.6		4.0		4.8		4.0		60.0	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
(1) Presents only compounds with Cleanup Goals and F
(2) FFTA-MW54S was replaced by FFTA-MW108 in Aug
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[1]	Cleanup Goal	FFTA -MW101S																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	1	U	1	U	0.84	U	0.8	J	0.8	J	0.3	J	0.3	UJ	0.3	U	0.5	U	0.5	U	0.2	U
cis-1,2-Dichloroethene	70	1	U	1	U	1.9	U	1		2		2		0.4	J	0.2	U	0.5	U	0.5	U	0.3	U
Vinyl chloride	2	1	U	2	U	1.8	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		19		**140**		**48**		**79**		4		0.8	J	2.31	U	7.1	U	0.37	J
Naphthalene	16	5	U	4	J	**25**		**25**		**45**		**60**		**89**		**40**		**27.1**		7.7	J	2.7	
Metals (ug/L)																							
Total Arsenic	10	3	U	1.45	U	**16.2**		**47.7**		**42.2**		**51.2**		**23.8**		6.7		**10.2**		2.4	J	0.5	U
Dissolved Arsenic	---							42.3		41.4		48.1		22		6.1		8.48		3	J	0.5	U
Total Manganese	124	119		7.6		39.3		**648**		**452**		**616**		**128**		18.2		27		4.8		2.3	B
Dissolved Manganese	---							622		458	J	612		121		18.3		27.3		6.6		3.9	B
Field Parameters																							
ph (S.U.)	---	6.28		5.25		5.05		6.54		5.61		5.81		5.73		6.06		4.78		5.44		5.16	
S. Conductivity (mS/cm)	---	0.084		0.075		0.125		0.408		8.04		0.238		0.095		0.071		0.076		0.086		0.094	
Dissolved Oxygen (mg/L) - Horiba	---	2.28		5.33		1.57		0		3.39		2.88		3.46		-		12.95		4.55		2.98	
Dissolved Oxygen (mg/L) - Test Kit																		4		4		3	
Temperature (ºC)	---	15.3		18.63		19.5		15.89		16.48		21.26		17.17		14.5		19.36		16.7		19.21	
Oxygen Reduction Potential (mV)	---	122		69		-61		-65		-112		-48		-42		-26		-190.2		126		143	
Turbidity (NTU)	---	5.07		1.27		9.85		5.03		1.58		4.78		0.59		4.92		3.49		0.49		5.33	
Alkalinity (ppm)	---							140		70		70		18		11		18		11		15	
Ferrous Iron (ppm)	---							2.2		5.0		5.5		2.1		1.4		5.0		0.8		1.0	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.1		0.3		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[1] Presents only compounds with Cleanup Goals and F
[2] FFTA-MW54S was replaced by FFTA-MW108 in Au
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[(1)]	Cleanup Goal	FFTA-MW102D																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	1	U	1	U	0.11	U	0.3	U	0.3	U	0.3	U	0.3	UJ	0.3	U	0.5	U	0.5	U	0.2	U
cis-1,2-Dichloroethene	70	1	U	1	U	0.24	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	J	0.5	U	0.5	U	0.3	U
Vinyl chloride	2	1	U	2	U	0.23	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.017	U	6	U	6	U	5	U	0.4	U	0.5	U	2.31	U	7.9	U	0.25	U
Naphthalene	16	5	U	10	J	0.048	J	2	U	2	U	2	U	0.06	U	8		2.31	U	7.9	U	0.04	J
Metals (ug/L)																							
Total Arsenic	10	6.4	B	1.45	U	0.14	U	1.5	U	2	B	1.8	B	0.8	U	2.25	U	3	U	4	UL	0.5	U
Dissolved Arsenic	---							1.5	U	3.4	B	2	B	1.4	B	2.25	U	3	U	2.25	UL	0.5	U
Total Manganese	124	**381**		9.5		3.3		15		2.9	B	4.6		4.2		**918**		28.9		32.1		4.6	B
Dissolved Manganese	---							4.4		2.3	B	2		3.3		869		24.5		6		2.5	B
Field Parameters																							
ph (S.U.)	---	5.69		4.46		5.04		5.82		5.33		5.03		5.47		4.50		3.22		5.25		5.57	
S. Conductivity (mS/cm)	---	0.098		0.114		0.105		0.107		0.108		0.121		0.085		0.094		0.100		0.110		0.126	
Dissolved Oxygen (mg/L) - Horiba	---	3.02		6.11		3.38		2.64		4.97		>20.00		3.52		-		7.68		3.47		2.73	
Dissolved Oxygen (mg/L) - Test Kit																		5		2		3	
Temperature (ºC)	---	14.7		15.85		20.36		18.7		17.66		18.1		15.13		15.3		17.72		15.82		19.2	
Oxygen Reduction Potential (mV)	---	157		392		246		248		297		127		119		189		681.2		267		116	
Turbidity (NTU)	---	10		0.97		2.83		1.53		8.34		1.19		0		0.82		3.26		7.13		0.53	
Alkalinity (ppm)	---							10		<10		10		<10		70		12		<10		<10	
Ferrous Iron (ppm)	---							0.6		0.4		0.0		0.8		0.2		0.0		0.0		0.40	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
(1) Presents only compounds with Cleanup Goals and F
(2) FFTA-MW54S was replaced by FFTA-MW108 in Aug
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[1]	Cleanup Goal	FFTA-MW103S																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	1	U	1	U	0.11	U	0.3	U	0.3	U	0.3	U	0.3	UJ	0.3	U	0.5	U	0.5	U	0.2	U
cis-1,2-Dichloroethene	70	9		1	U	0.24	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	0.5	U	0.3	U
Vinyl chloride	2	1	U	2	U	0.23	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.017	U	5	U	6	UJ	5	U	0.4	U	0.5	U	2.31	U	8.3	U	0.24	U
Naphthalene	16	5	U	11	U	0.027	U	2	U	2	UJ	2	U	0.06	U	0.07	U	2.31	U	8.3	U	0.038	U
Metals (ug/L)																							
Total Arsenic	10	3	U	1.45	U	0.22	J	1.5	U	0.8	U	3	B	1	B	2.25	U	1.5	U	4	UL	1.1	
Dissolved Arsenic	---							1.5	U	0.84	B	1.6	B	1.8	B	2.25	U	1.5	U	2.25	UL	0.5	U
Total Manganese	124	**191**		5.9		0.43	J	1.5	J	6.2		11.3		48.9		5.7		1.07	J	0.56	B	16	J
Dissolved Manganese	---							1.5	J	5.9	J	13.3		44.9		5.1		0.976	J	0.92	B	0.83	B
Field Parameters																							
ph (S.U.)	---	5.88		5.50		4.49		6.01		5.88		5.78		6.12		5.47		5.24		5.86		5.75	
S. Conductivity (mS/cm)	---	0.071		0.177		0.104		0.186		0.193		0.609		0.466		0.316		0.270		0.167		0.278	
Dissolved Oxygen (mg/L) - Horiba	---	5.9		5.17		5.72		3.49		4.41		3.51		4.5		6.53		10.60		4.46		3.50	
Dissolved Oxygen (mg/L) - Test Kit																		5.5		5		3	
Temperature (ºC)	---	11.2		13.82		19.7		9.51		14.5		19.16		17.29		12.22		18.5		15.42		17.95	
Oxygen Reduction Potential (mV)	---	169		256		253		268		290		145		272		220		571.6		246		230	
Turbidity (NTU)	---	0		8.1		0.97		2		0.78		0.36		0.38		5.13		3.26		2.63		41.2	
Alkalinity (ppm)	---							40		25		35		25		17		0		35		19	
Ferrous Iron (ppm)	---							0.0		0.0		0.0		0.5		0.5		0.0		0.0		0.4	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[1] Presents only compounds with Cleanup Goals and F
[2] FFTA-MW54S was replaced by FFTA-MW108 in Au
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[(1)]	Cleanup Goal	FFTA-MW103I																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	1		1	U	0.11	U	0.3	U	1		1		0.3	UL	0.3	U	0.5	U	0.5	U	0.2	U
cis-1,2-Dichloroethene	70	55		5		4.2		11		16		14		7	J	4		2.22		1.1		1.3	
Vinyl chloride	2	1	U	2	U	0.23	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.018	U	5	U	5	U	5	U	0.4	U	0.4	U	2.31	UL	7.9	U	0.27	U
Naphthalene	16	5	U	12	U	0.029	U	2	U	2	U	2	U	0.06	U	0.06	U	2.31	U	7.9	U	0.043	U
Metals (ug/L)																							
Total Arsenic	10	3	U	1.45	U	0.5	J	1.5	U	1.7	B	1.8	B	0.8	U	2.25	U	1.5	U	4	UL	0.5	U
Dissolved Arsenic	---							1.5	U	2.9	B	3.1	B	0.8	U	2.25	U	1.5	U	2.25	UL	0.5	U
Total Manganese	124	**388**		62.8		16.5		35.3		16.3		56.8		17.7		10.3		68.8		9.1		9.3	B
Dissolved Manganese	---							1.8	J	4.6	J	18.3		2.1		1.3	B	2.5	U	0.98	B	0.38	B
Field Parameters																							
ph (S.U.)	---	6.01		5.99		5.46		5.82		5.68		5.20		6.11		5.84		3.80		5.70		5.95	
S. Conductivity (mS/cm)	---	0.143		0.133		0.155		0.150		0.121		0.129		0.118		0.146		0.102		0.135		0.149	
Dissolved Oxygen (mg/L) - Horiba	---	0.93		5.33		3.48		0		3.05		>20.00		4.11		5.99		9.57		2.45		3.10	
Dissolved Oxygen (mg/L) - Test Kit																		4.5		2		4	
Temperature (ºC)	---	14.8		15.5		20.62		12.75		15.57		17		17.62		14.98		17.12		16.38		16.70	
Oxygen Reduction Potential (mV)	---	107		233		193		268		331		115		300		226		700.2		251		229	
Turbidity (NTU)	---	0		1.1		-1.77		0.7		0.00		1.57		0.41		0		1.11		8.19		3.28	
Alkalinity (ppm)	---							18		19		20		20		25		25		35		25	
Ferrous Iron (ppm)	---							0.0		0.4		0.0		0.6		0.5		0.0		0.0		0.4	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
(1) Presents only compounds with Cleanup Goals and F
(2) FFTA-MW54S was replaced by FFTA-MW108 in Au
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[1]	Cleanup Goal	FFTA -MW103D																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	1	U	1	U	0.11	U	0.3	U	0.3	U	0.3	U	0.3	UL	0.3	U	0.5	U	0.5	U	0.2	U
cis-1,2-Dichloroethene	70	9		2		1.1		0.6	U	0.8	J	1	U	1	J	0.8	J	1.08		0.86	J	0.9	J
Vinyl chloride	2	1	U	2	U	0.23	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.19	U	5	U	6	U	5	U	0.4	U	0.4	UJ	2.34	U	7.6	U	0.25	U
Naphthalene	16	5	U	10	U	0.03	U	2	U	2	U	2	U	0.06	U	0.06	U	2.34	U	7.6	U	0.039	U
Metals (ug/L)																							
Total Arsenic	10	3	U	1.45	U	0.14	U	1.5	U	1.9	B	2.2	B	1	B	2.25	U	5.16		4	UL	0.5	U
Dissolved Arsenic	---							1.5	U	3	B	1.5	B	0.8	U	2.25	U	1.5	U	2.25	UL	0.5	U
Total Manganese	124	**286**		5.3		4.8		6		8.4		3.5		2.9		3.1		**465**		4.3		4	B
Dissolved Manganese	---							3.5		5.5	J	4.1		3		3.3		3.91	K	3.5	B	4.1	B
Field Parameters																							
ph (S.U.)	---	5.60		4.18		4.85		5.78		5.28		5.40		5.52		5.31		5.13		5.61		5.38	
S. Conductivity (mS/cm)	---	0.100		0.102		0.090		0.096		0.094		0.122		0.091		0.165		0.073		0.101		0.117	
Dissolved Oxygen (mg/L) - Horiba	---	1.6		1.5		0		0.5		1.36		2.76		3.96		5.09		2.15		0.00		1.07	
Dissolved Oxygen (mg/L) - Test Kit																		2		0.8		1	
Temperature (ºC)	---	15.3		15.02		20.69		17.41		16.48		17.04		16.81		15.94		16.91		16.11		16.39	
Oxygen Reduction Potential (mV)	---	2.39		410		208		271		363		276		338		240		446.9		272		225	
Turbidity (NTU)	---	9.3		0.95		-4.32		0.49		0.00		0.00		0		1		2.18		0.38		1.76	
Alkalinity (ppm)	---							300		<10		<10		<10		<10		<10		<10		<10	
Ferrous Iron (ppm)	---							0.0		0.6		0.0		0.5		0.7		0.0		0.0		0.6	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[1] Presents only compounds with Cleanup Goals and F
[2] FFTA-MW54S was replaced by FFTA-MW108 in Au
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[(1)]	Cleanup Goal	FFTA-MW105D																					
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	1	U	1	U	0.11	U	0.3	U	0.3	U	0.3	U	0.3	UJ	0.3	U	0.5	U	0.5	U	0.2	U
cis-1,2-Dichloroethene	70	1		1	U	0.24	U	0.6	J	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	0.5	U	0.3	U
Vinyl chloride	2	1	U	2	U	0.23	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.018	U	5	U	6	U	6	U	0.4	U	0.4	U	2.34	U	7.1	U	0.24	U
Naphthalene	16	5	U	10	U	0.028	U	2	U	2	U	2	U	0.06	U	0.06	U	2.34	U	7.1	U	0.038	U
Metals (ug/L)																							
Total Arsenic	10	3	U	1.45	U	0.14	U	1.5	U	3.7	B	1.8	B	1.2	B	2.25	U	1.5	U	4	UL	0.36	J
Dissolved Arsenic	---							1.5	U	3.8	B	1.8	B	1.8	B	2.25	U	1.5	U	2.25	UL	0.5	U
Total Manganese	124	**384**		3.2		2.5		8.5	J	4.3		2.2		3.7	B	2.3		2.98	J	1.7	B	1.7	B
Dissolved Manganese	---							3.5	J	2.3	B	2		2.7	B	2.3		1.84	J	1.7	B	1.9	B
Field Parameters																							
ph (S.U.)	---	5.51		4.29		5.06		5.77		5.28		5.28		5.70		4.52		4.95		5.37		5.08	
S. Conductivity (mS/cm)	---	0.095		0.950		0.088		0.101		0.091		0.113		0.087		0.081		0.070		0.090		0.100	
Dissolved Oxygen (mg/L) - Horiba	---	2.95		4.32		2.59		2.67		4.87		4.77		8.14		-		4.58		3.47		2.57	
Dissolved Oxygen (mg/L) - Test Kit																		4		4		2	
Temperature (ºC)	---	16.1		15.95		19.23		14.43		16.41		16.76		17.3		16.2		17.2		16.93		16.13	
Oxygen Reduction Potential (mV)	---	170		418		231		145		339		287		267		190		-193.4		260		220	
Turbidity (NTU)	---	5.1		0.63		-0.04		6.29		0.00		0.0		1.26		1.22		0		0		8.08	
Alkalinity (ppm)	---							<10		<10		<10		<10		1000		<10		10		12	
Ferrous Iron (ppm)	---							0.0		0.4		0.0		0.4		0.2		0.4		0.0		0.0	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		-	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
(1) Presents only compounds with Cleanup Goals and F
(2) FFTA-MW54S was replaced by FFTA-MW108 in Aug
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[(1)]	Cleanup Goal	FFTA-MW106																			
Date Sampled		Mar-03		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																					
Benzene	5	NA		0.11	U	0.6	U	0.3	U	0.3	U	0.3	UJ	0.3	U	0.5	U	0.5	U	0.2	U
cis-1,2-Dichloroethene	70	NA		0.24	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	0.5	U	0.3	U
Vinyl chloride	2	NA		0.23	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																					
4-Methylphenol	27	NA		0.018	U	5	U	5	U	5	U	0.4	U	0.4	U	2.5	UR	7.9	U	0.24	U
Naphthalene	16	NA		0.029	U	2	U	2	U	2	U	0.06	U	0.06	U	2.5	U	7.9	U	0.039	U
Metals (ug/L)																					
Total Arsenic	10	NA		0.52	J	1.5	U	0.8	U	0.8	UL	1.9	B	2.25	U	1.5	U	4	UL	0.5	U
Dissolved Arsenic	---					1.5	U	1.3	B	0.8	UL	1.4	B	2.25	U	1.5	U	2.25	UL	0.5	U
Total Manganese	124	NA		48.1		6.4		1.4	B	1.1	B	1.4	B	0.77	B	0.995	J	0.96	B	0.92	B
Dissolved Manganese	---					0.85	J	1.2	B	0.9	B	1.1	B	0.77	B	0.994	J	1.4	B	0.78	B
Field Parameters																					
ph (S.U.)	---			6.16		6.22		4.99		5.65		6.88		5.01		5.08		6.41		6.09	
S. Conductivity (mS/cm)	---			0.124		0.338		0.512		0.198		0.137		0.097		0.097		0.128		0.117	
Dissolved Oxygen (mg/L) - Horiba	---			6.08		4.2		8.25		>20.00		13.34		-		8.70		7.08		5.14	
Dissolved Oxygen (mg/L) - Test Kit																8		7		3	
Temperature (ºC)	---			21.31		16.6		16.38		20.7		13.94		13.8		19.25		16.78		19.06	
Oxygen Reduction Potential (mV)	---			190		228		116		104		234		127		-158		199		217	
Turbidity (NTU)	---			-3.92		2.51		1.97		0.98		0		0.53		0		0		0.70	
Alkalinity (ppm)	---					13		100		11		45		35		25		30		22	
Ferrous Iron (ppm)	---					0.0		0.0		0.0		0.5		0.3		0.4		0.0		0.6	
Hydrogen Sulfide (ppm)	---					0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---					0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---					0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[(1)] Presents only compounds with Cleanup Goals and F
[(2)] FFTA-MW54S was replaced by FFTA-MW108 in Aug
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[1]	Cleanup Goal	FFTA-MW107																					
Date Sampled		Mar-03		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	NA		2.9	J	0.3	U	0.3	U	0.3	U	0.3	UJ	4		**7.49**		**6.3**		**5.6**	
cis-1,2-Dichloroethene	70	NA		2.4	U	2		0.2	U	0.2	U	0.2	UJ	2		1.91	J	1.2		1.1	
Vinyl chloride	2	NA		2.3	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	1.25	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	NA		7.1		5	U	6	U	6	U	0.4	U	6		4.99		7.1	UR	5.5	
Naphthalene	16	NA		**19**		**27**		2	U	2	U	5		**59**	L	**73.4**		**49**		**36**	
Metals (ug/L)																							
Total Arsenic	10	NA		7.4		7.7	J	8		7.4	L	7.3		**17.6**		**19.1**		**21**		**18**	
Dissolved Arsenic	---					7	J	7.6		7.8	L	7.4		16.5		18.2		20.8		19	
Total Manganese	124	NA		**2,720**		**520**		**654**		**537**		**307**		**483**		**4,100**		**1,320**		**630**	J
Dissolved Manganese	---					512		641	J	548		338		475		4,020		1,270		610	
Field Parameters																							
ph (S.U.)	---			5.54		6.98		6.09		5.74		6.26		6.50		4.72		6.76		6.51	
S. Conductivity (mS/cm)	---			0.252		0.219		0.187		0.191		0.176		0.264		0.197		0.238		0.293	
Dissolved Oxygen (mg/L) - Horiba	---			0.81		0		0.93		2.84		1.49		4.33		2.19		0.00		0.54	
Dissolved Oxygen (mg/L) - Test Kit																1		0		0	
Temperature (ºC)	---			19.1		12.85		16.43		20.34		14.15		13.63		18.91		20.1		19.66	
Oxygen Reduction Potential (mV)	---			-56		-160		-54		-43		-32		-128		-41.7		-133		-128	
Turbidity (NTU)	---			0.17		8.99		14.3		4.04		5.12		1.64		0.55		0		3.76	
Alkalinity (ppm)	---					15		55		60		60		60		30		100		75	
Ferrous Iron (ppm)	---					4.6		5.6		5.8		2.0		3.8		2.2		3.8		5.0	
Hydrogen Sulfide (ppm)	---					0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrate (ppm)	---					0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Nitrite (ppm)	---					0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[1] Presents only compounds with Cleanup Goals and F
[2] FFTA-MW54S was replaced by FFTA-MW108 in Aug
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[1]	Cleanup Goal	FFTA -MW54S[2]				FFTA-MW108[2]																	
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	1	U	NA		0.11	U	0.3	U	0.3	U	0.3	U	0.3	UJ	0.3	U	0.5	U	0.5	U	0.2	U
cis-1,2-Dichloroethene	70	1	U	NA		0.24	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	0.5	U	0.3	U
Vinyl chloride	2	1	U	NA		0.23	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	1	U	0.3	U
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.052	J	6	U	5	U	5	U	0.4	U	0.4	U	2.78	U	7.1	U	0.24	U
Naphthalene	16	5	U	NA		0.12	J	2	U	2	U	2	U	0.06	UL	0.06	U	2.78	U	7.1	U	0.038	U
Metals (ug/L)																							
Total Arsenic	10	3	U	NA		0.14	U	1.5	U	2.3		0.8	UL	0.8	U	2.25	U	1.5	U	4	UL	0.5	U
Dissolved Arsenic	---							1.5	U	3.4	B	0.8	UL	1.2	B	2.25	U	1.5	U	2.25	UL	0.5	U
Total Manganese	124	3.4	B	NA		35.2		3.8	J	4		0.66	B	1	B	0.55	B	0.812	J	0.71	B	0.83	B
Dissolved Manganese	---							3.5	J	2.6	B	0.86	B	1.2	B	0.58	B	2.5	U	0.83	B	0.57	B
Field Parameters																							
ph (S.U.)	---	5.79				5.62		6.22		6.01		5.69		6.09		5.84		5.84		5.92		5.08	
S. Conductivity (mS/cm)	---	0.062				0.102		0.143		0.125		0.091		0.110		0.102		0.102		0.087		0.093	
Dissolved Oxygen (mg/L) - Horiba	---	8.41				6.39		6		9.82		8.4		13.97		9.29		9.29		4.81		4.33	
Dissolved Oxygen (mg/L) - Test Kit																				4		5	
Temperature (ºC)	---	15.1				20.32		14.32		16.39		19.55		10.17		15.14		15.14		18.79		20.01	
Oxygen Reduction Potential (mV)	---	234				201		203		386		201		295		239		239		211		229	
Turbidity (NTU)	---	8				-2.42		3.17		9.83		1.35		0		0.12		0.12		3.21		3.42	
Alkalinity (ppm)	---							12.5		700		10		10		11		11		13		20	
Ferrous Iron (ppm)	---							0.4		0.0		0.0		0.5		0.5		0.5		0.0		0.0	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0		0.0		0.0	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0		0.0		0.6	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0		0.0		0.0	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[1] Presents only compounds with Cleanup Goals and F
[2] FFTA-MW54S was replaced by FFTA-MW108 in Aug
Data prior to 2010

TABLE 4-3
HISTORICAL GROUNDWATER DATA - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter[1]	Cleanup Goal	14-MW04																							
Date Sampled		Mar-03		Dec-08		Aug-09		Mar-10		Jun-10		Sep-10		Dec-10		Mar-11		Sep-11		Mar-12		Sep-12	
VOCs (ug/L)																							
Benzene	5	1	U	NA		0.11	U	0.3	U	0.3	U	0.3	U	0.3	UJ	0.3	U	0.5	U	0.5	U	N/A	
cis-1,2-Dichloroethene	70	1	U	NA		0.24	U	0.2	U	0.5	J	2	U	0.4	J	0.2	U	0.5	U	0.5	U	N/A	
Vinyl chloride	2	1	U	NA		0.23	U	0.2	U	0.2	U	0.2	U	0.2	UJ	0.2	U	0.5	U	1	U	N/A	
SVOCs (ug/L)																							
4-Methylphenol	27	5	U	NA		0.019	U	6	U	5	U	5	U	0.4	U	0.5	U	2.5	U	7.8	U	N/A	
Naphthalene	16	NA		NA		0.03	U	2	U	2	U	2	U	0.06	U	0.07	U	2.5	U	7.8	U	N/A	
Metals (ug/L)																							
Total Arsenic	10	3	U	NA		0.48	J	1.5	U	2.3	B	2.3	B	0.84	B	2.25	U	1.5	U	2.5	J	N/A	
Dissolved Arsenic	---							1.5	U	0.98	B	0.81	B	1.4	B	2.25	U	1.5	U	2.25	UL	N/A	
Total Manganese	124	13.1		NA		47.6		91.4		**203**		57.4		21.8		30		23.3		38.8		N/A	
Dissolved Manganese	---							91.1		211	J	42.3		7.4		16.4		7.77		17		N/A	
Field Parameters																							
ph (S.U.)	---	5.62				4.00		5.10		4.45		4.78		5.52		5.30		5.29		4.94		N/A	
S. Conductivity (mS/cm)	---	0.075				0.188		0.147		99.9		0.154		0.112		0.211		0.101		0.237		N/A	
Dissolved Oxygen (mg/L) - Horiba	---	5.78				5.46		0		19		>20.00		0		5.63		4.22		2.92		N/A	
Dissolved Oxygen (mg/L) - Test Kit																		3		1		N/A	
Temperature (ºC)	---	10.2				20.9		9.89		16.35		19.0		14.38		11.6		19.08		13.48		N/A	
Oxygen Reduction Potential (mV)	---	245				178		197		199		146		90		275		-165.5		319		N/A	
Turbidity (NTU)	---	5.1				66.7		63.6		19		33.7		21.6		167		84.3		40.3		N/A	
Alkalinity (ppm)	---							<10		50		25		20		<10		14		<10		N/A	
Ferrous Iron (ppm)	---							0.8		0.0		0.0		0.8		0.7		0.6		0.0		N/A	
Hydrogen Sulfide (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		N/A	
Nitrate (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		N/A	
Nitrite (ppm)	---							0.0		0.0		0.0		0.0		0.0		0.0		0.0		N/A	

Notes:
NA - Not Analyzed
µg/L - micrograms per liter water
J - Estimated Value
L - Biased Low
K - Biased High
U - Analyte was not detected in the sample at a level greater than the instument detection
R - Surrogate Recovery Noncompliance
S.U. - Standard Units
mS/cm - millisiemens per centimeter
mg/L - milligrams per liter
°C - degrees Celsius
mV - millivolts
NTU - Nephelometric Turbidity Units
Bolded and shaded cells indicate exceedances of the Cleanup Goal
[1] Presents only compounds with Cleanup Goals and F
[2] FFTA-MW54S was replaced by FFTA-MW108 in Au
Data prior to 2010

TABLE 4-4
FREQUENCY OF DETECTIONS AND EXCEEDANCES DURING LONG-TERM MONITORING - FORMER FIRE TRAINING AREA
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Location of Maximum Detection	Sample ID of Maximum Detect	Minimum NonDetect	Maxium NonDetect	Average of Positive Results	Average of All Results	Standard Deviation
Volatile Organics (µg/L)										
BENZENE	36/127	0.26 J	7.49	FFTA-MW107	FFTA-MW107-20110914	0.2	0.5	1.97	0.68	1.24
CIS-1,2-DICHLOROETHENE	61/127	0.2 J	16	FFTA-MW103I	FFTA-MW103I-20100609	0.2	1.5	2.68	1.37	2.68
VINYL CHLORIDE	14/127	0.3 J	2 J	FFTA-MW061I	FFTA-MW061I-20101208	0.2	1.5	0.74	0.25	0.27
Semivolatile Organics (µg/L)										
METHYLPHENOL, 3&4-	23/115	0.37 J	140	FFTA-MW101S	FFTA-MW101S-20100316	0.24	8.3	28.60	7.14	19.92
NAPHTHALENE	46/126	0.04 J	89	FFTA-MW101S	FFTA-MW101S-20101208	0.038	8.3	22.35	8.86	16.21
Total Inorganics (µg/L)										
ARSENIC	46/127	0.36 J	51.2	FFTA-MW101S	FFTA-MW101S-20100916	0.5	4	15.92	6.39	10.83
MANGANESE	109/127	0.56 B	4100	FFTA-MW107	FFTA-MW107-20110914	0.55	6.4	469.75	403.34	686.93
Filtered Inorganics (µg/L)										
ARSENIC	44/127	0.48 J	48.1	FFTA-MW101S	FFTA-MW101S-20100916	0.5	4	15.91	6.16	10.51
MANGANESE	99/127	0.83 B	4020	FFTA-MW107	FFTA-MW107-20110914	0.38	4.4	520.02	405.59	702.22

Notes
µg/L - microgram(s) per liter
J - estimated concentration
B - blank contaminantion

TABLE 5-1
CHRONOLOGY OF EVENTS - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

EVENT / DOCUMENT	DATE
WOD Site Operations	circa 1940s-1950s
Excavation of petroleum-impacted soil (subsequent to 1986 VDEQ inspection findings)	1986
Preliminary Assessment (PA) (NASA, 1988)	1988
Site Investigation (SI) (Ebasco, 1990)	1990
Additional Monitoring well installation for adjacent FUD Site 15 (Debris Pile) revealed solvent- and petroleum-related contamination.	1998
Remedial Investigation (RI) / Feasibility Study (FS) (Versar, 2001)	1998-2000; 2001
Supplemental RI (Tt, 2004b)	2003; 2004
Chromium Speciation Study	2004
Feasibility Study (FS) (Tt, 2005b)	October 2005
Proposed Remedial Action Plan (PRAP) (Tt, 2007c)	February 2007
Record of Decision (ROD) (Tt, 2008a)	March 2008
Land Use Control (LUC) Remedial Design (RD) (Tt, 2008c)	November 2008
Pilot Study Work Plan (Tt, 2008e)	November 2008
Pilot Study Biostimulation Injection Implementation (Tt, 2008e and 2009b)	December 2008
Remedial Action Work Plan (Tt, 2009b) (Pilot Study Report appended to Remedial Action Work Plan)	September 2009
Full Biostimulation Injection Remedial Action Implementation	December 2009
Long-Term Monitoring (LTM) Plan (Tt, 2009c)	October 2009
Remedial Action Completion Report (Tt, 2011a)	April 2011
2010 Annual LTM Report	November 2011
LTM Plan – Revision 1 (Tt, 2012c)	July 2012
2011 Annual Groundwater Summary Report	August 2012
2012 Annual LTM Report (Tt, 2013b)	May 2013

Notes
LTM and enforcement of LUCs ongoing

TABLE 5-2
SUMMARY OF CHEMICALS OF CONCERN - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Exposure Scenario	Chemical of Concern (COC)	Range of Detected Concentrations During Remedial Investigation (µg/L)	Cleanup Level (µg/L)	*Basis of Cleanup Level*
Future Resident exposed to groundwater via ingestion, dermal contact, inhalation	Benzene	0.17 – 33	5	*MCL*
	Arsenic	0.94 – 58	10	*MCL*

Notes
µg/L - microgram(s) per liter
MCL - Maximum Contaminant Level

TABLE 5-3
HISTORICAL GROUNDWATER DATA - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Cleanup Goal	15-MW001																	
Sample Date		12/5/2008		3/16/2010		6/7/2010		9/14/2010		12/6/2010		3/22/2011		9/13/2011		3/12/2012		9/17/2012	
VOCs (ug/L)																			
Benzene	5	1	U	0.3	U	0.3	U	0.3	J	0.8	J	0.3	U	1.08		0.5	U	0.2	U
Metals (ug/L)																			
Total Arsenic	10	3.3		6.6		6.5	B	7.4	B	8.2		**10.9**	**J**	**13**		**11.7**		**12**	
Dissolved Arsenic	NC	NA		5.9		7.1	B	8.2	B	8.4		9.5	J	10.8		11.8		10	
Field Parameters																			
pH (S.U.)		4.66		6.39		5.32		6.17		5.65		6.06		5.82		6.13		6.10	
S. Conductivity (mS/cm)		0.191		0.200		0.074		0.254		0.200		0.290		0.218		0.192		0.199	
Dissolved Oxygen (mg/L) - Horiba		0.32		0.00		0.13		1.70		0.00		4.81		5.90		0.00		0.60	
Dissolved Oxygen (mg/L) - Test Kit														4.00		0.00		0.00	
Temperature (°C)		14.56		11.61		16.72		17.64		14.26		12.27		17.46		13.89		18.13	
Oxygen Reduction Potential (mV)		41		-45		-8		-55		-117		-57		-252.9		-16		2	
Turbidity (NTU)		0.79		3.42		56.8		2.01		0.83		1.32		1.24		0		0	

Notes:
µg/L - micrograms per liter
B - Field Blank Contamination
J - Estimated Value
L - Biased Low
U - Analyte was not detected in the sample at a level greater than the instrument detection
S.U. - Standard units
mS/cm - Millisiemens per centimeter
mg/L - Milligrams per liter
°C - Degrees celsius
mV - Millivolts
NTU - Nephelometric turbidity units
Shaded Cells indicate exceedances of the Cleanup Goal
NA - Not analyzed
NC - No criteria

TABLE 5-3
HISTORICAL GROUNDWATER DATA - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Cleanup Goal	15-MW002																	
Sample Date		12/5/2008		3/16/2010		6/8/2010		9/14/2010		12/6/2010		3/22/2011		9/12/2011		3/12/2012		9/17/2012	
VOCs (ug/L)																			
Benzene	5	1	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.5	U	0.5	U	0.2	U
Metals (ug/L)																			
Total Arsenic	10	4.8	B	3.4	J	9.3	B	7.3	B	4.4	J	3.2	J	4.87	J	3	J	5	
Dissolved Arsenic	NC	4.1	B	3.2	J	5.9	B	7.1	B	3.9	J	2.6	J	4.35	J	4	UL	6.6	
Field Parameters																			
pH (S.U.)		5.49		4.65		6.10		5.34		5.16		5.63		5.23		5.59		5.30	
S. Conductivity (mS/cm)		0.000		0.086		0.199		0.114		0.074		0.101		0.107		0.134		0.118	
Dissolved Oxygen (mg/L) - Horiba		9.01		0.00		0.00		2.98		0.00		5.51		1.88		0.00		0.63	
Dissolved Oxygen (mg/L) - Test Kit														1.00		0.00		1.00	
Temperature (°C)		12.61		9.71		15.64		19.55		13.48		10.89		19.86		11.95		23.07	
Oxygen Reduction Potential (mV)		52		-56		-31		14		-73		-13		68.3		43		9	
Turbidity (NTU)		16		36.8		1.32		3.01		17.6		21.1		8.59		27.2		9.4	

Notes:
µg/L - micrograms per liter
B - Field Blank Contamination
J - Estimated Value
L - Biased Low
U - Analyte was not detected in the sample at a level greater than the instrument detection
S.U. - Standard units
mS/cm - Millisiemens per centimeter
mg/L - Milligrams per liter
°C - Degrees celsius
mV - Millivolts
NTU - Nephelometric turbidity units
Shaded Cells indicate exceedances of the Cleanup Goal
NA - Not analyzed
NC - No criteria

TABLE 5-3
HISTORICAL GROUNDWATER DATA - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Cleanup Goal	15-MW007																	
Sample Date		12/8/2008		1/14/2009		3/16/2010		6/8/2010		6/8/2010-dup		9/15/2010		12/6/2010		12/6/2010-dup		3/21/2011	
VOCs (ug/L)																			
Benzene	5	**32**		2		0.3	U	0.3	U	0.3	J	**33**		2		1		4	
Metals (ug/L)																			
Total Arsenic	10	**26.9**		9.7		4.6	J	**15.5**	J	**27.7**	J	**54.4**		**24.5**		**23.8**		**58**	J
Dissolved Arsenic	NC	NA		NA		3.9	J	22.4	J	22.4	J	39.7		28.5		26.8		48.5	J
Field Parameters																			
pH (S.U.)		5.37		4.18		5.54		6.06		NA		6.08		5.31		NA		6.37	
S. Conductivity (mS/cm)		0.173		0.100		0.087		0.111		NA		0.446		0.142		NA		0.137	
Dissolved Oxygen (mg/L) - Horiba		0.73		4.12		0.00		2.35		NA		1.62		0.59		NA		-	
Dissolved Oxygen (mg/L) - Test Kit																			
Temperature (°C)		16.38		15.7		11.9		17.36		NA		18.6		15.4		NA		16.60	
Oxygen Reduction Potential (mV)		-192		58		-35		-132		NA		-118		-132		NA		-87.00	
Turbidity (NTU)		9.15		4.46		7.5		5.76		NA		3.19		2.75		NA		1.71	

Notes:
µg/L - micrograms per liter water
B - Field Blank Contamination
J - Estimated Value
L - Biased Low
U - Analyte was not detected in the sample at a level greater than the instrument detection
S.U. - Standard units
mS/cm - Millisiemens per centimeter
mg/L - Milligrams per liter
°C - Degrees celsius
mV - Millivolts
NTU - Nephelometric turbidity units
Shaded Cells indicate exceedances of the Cleanup Goal
NA - Not analyzed
NC - No criteria

TABLE 5-3
HISTORICAL GROUNDWATER DATA - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Cleanup Goal	15-MW007 (continued)									
Sample Date		9/12/2011		9/12/2011-dup		3/12/2012		3/12/2012-dup		9/17/2012		9/17/2012-dup	
VOCs (ug/L)													
Benzene	5	**11.1**		**14.2**		**12**		**11**		2.4	J	2.1	J
Metals (ug/L)													
Total Arsenic	10	**46.6**		**45.9**		**46.8**		**57.4**		**19**		**16**	
Dissolved Arsenic	NC	45.6		47.1		60.5		60.4		18		22	
Field Parameters													
pH (S.U.)		5.42		NA		6.00		NA		6.02		NA	
S. Conductivity (mS/cm)		0.212		NA		0.288		NA		0.163		NA	
Dissolved Oxygen (mg/L) - Horiba		2.24		NA		0.00		NA		0.72		NA	
Dissolved Oxygen (mg/L) - Test Kit		0.00		NA		1.00		NA		1.00		NA	
Temperature (°C)		19.08		NA		16.85		NA		20.24		NA	
Oxygen Reduction Potential (mV)		-237.60		NA		-110		NA		-7.6		NA	
Turbidity (NTU)		2.20		NA		1.87		NA		3.85		NA	

Notes:
µg/L - micrograms per liter water
B - Field Blank Contamination
J - Estimated Value
L - Biased Low
U - Analyte was not detected in the sample at a level greater than the instrument detection
S.U. - Standard units
mS/cm - Millisiemens per centimeter
mg/L - Milligrams per liter
°C - Degrees celsius
mV - Millivolts
NTU - Nephelometric turbidity units
Shaded Cells indicate exceedances of the Cleanup Goal
NA - Not analyzed
NC - No criteria

TABLE 5-3
HISTORICAL GROUNDWATER DATA - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Cleanup Goal	WOD-MW001															
Sample Date		3/16/2010		6/7/2010		9/15/2010		12/7/2010		3/21/2011		9/13/2011		3/12/2012		9/17/2012	
VOCs (ug/L)																	
Benzene	5	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.5	U	0.5	U	0.2	U
Metals (ug/L)																	
Total Arsenic	10	1.5	U	2.8	B	0.8	UL	0.8	U	2.25	U	1.82	J	4	UL	0.94	J
Dissolved Arsenic	NC	1.5	U	3.5	B	0.8	UL	0.8	U	2.25	U	1.5	U	4	UL	NA	
Field Parameters																	
pH (S.U.)		6.09		5.25		6.53		NA		5.49		6.4		-		NC	
S. Conductivity (mS/cm)		0.115		0.090		0.165		NA		0.198		0.466		-		NC	
Dissolved Oxygen (mg/L) - Horiba		2.93		5.66		19.99		NA		-		4.57		-		NC	
Dissolved Oxygen (mg/L) - Test Kit												-		-		NC	
Temperature (°C)		12.47		16.2		20.7		NA		15.3		21.34		-		NC	
Oxygen Reduction Potential (mV)		96		238		21		NA		17		-205.1		-		NC	
Turbidity (NTU)		1.3		0.34		<10.0		NA		10.8		brown		tan		NC	

Notes:
µg/L - micrograms per liter
B - Field Blank Contamination
J - Estimated Value
L - Biased Low
U - Analyte was not detected in the sample at a level greater than the instrument detection
S.U. - Standard units
mS/cm - Millisiemens per centimeter
mg/L - Milligrams per liter
°C - Degrees celsius
mV - Millivolts
NTU - Nephelometric turbidity units
Shaded Cells indicate exceedances of the Cleanup Goal
NA - Not analyzed
NC - No criteria

TABLE 5-3
HISTORICAL GROUNDWATER DATA - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Cleanup Goal	WOD-MW002D																	
Sample Date		12/5/2008		3/16/2010		6/7/2010		9/14/2010		12/7/2010		3/21/2011		9/13/2011		3/12/2012		9/17/2012	
VOCs (ug/L)																			
Benzene	5	3		**8**		1	J	0.6	J	0.3	U	3		2.57		2.2		1.9	
Metals (ug/L)																			
Total Arsenic	10	**12.3**		**10.9**		8.4	B	**10.6**		9.6		8.7	J	**11.2**		**11**		**14**	
Dissolved Arsenic	NC	NA		10.5		6.8	B	10		9.1		7.6	J	9.03		9.6	L	9.8	
Field Parameters																			
pH (S.U.)		6.17		7.00		5.71		7.22		6.19		6.02		4.66		6.22		6.17	
S. Conductivity (mS/cm)		0.168		0.327		62.500		0.126		0.118		0.117		0.154		0.167		0.186	
Dissolved Oxygen (mg/L) - Horiba		1.84		3.96		4.40		15.58		2.63		-		1.17		0.00		0.58	
Dissolved Oxygen (mg/L) - Test Kit														0.15		0.00		0.50	
Temperature (°C)		15.16		11.15		17.15		18.4		16.1		15.2		18.12		17.22		19	
Oxygen Reduction Potential (mV)		-19		17		-72		-65		16		-44		113.2		-39		-10	
Turbidity (NTU)		0.7		4.09		0.71		0.62		0.54		1.32		0.41		0.21		8.04	

Notes:
µg/L - micrograms per liter water
B - Field Blank Contamination
J - Estimated Value
L - Biased Low
U - Analyte was not detected in the sample at a level greater than the instrument detection
S.U. - Standard units
mS/cm - Millisiemens per centimeter
mg/L - Milligrams per liter
°C - Degrees celsius
mV - Millivolts
NTU - Nephelometric turbidity units
Shaded Cells indicate exceedances of the Cleanup Goal
NA - Not analyzed
NC - No criteria

TABLE 5-3
HISTORICAL GROUNDWATER DATA - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Cleanup Goal	WOD-MW002S																	
Sample Date		12/5/2008		3/16/2010		6/7/2010		9/15/2010		12/7/2010		3/21/2011		9/13/2011		3/12/2012		9/17/2012	
VOCs (ug/L)																			
Benzene	5	**5**		0.3	U	0.4	J	1		1	J	0.3	U	0.5	U	0.5	U	0.17	J
Metals (ug/L)																			
Total Arsenic	10	**18.4**		4.2	J	**15.3**	B	**26.9**		**18.2**		4	J	5.72		4	UL	5.3	
Dissolved Arsenic	NC	16		1.5	U	19.2	J	23.1		16		6.7	J	3	U	4	UL	11	
Field Parameters																			
pH (S.U.)		6.44		6.43		5.77		6.65		6.40		6.02		3.12		6.56		6.45	
S. Conductivity (mS/cm)		0.233		0.195		0.380		0.320		0.225		0.240		0.268		0.278		0.242	
Dissolved Oxygen (mg/L) - Horiba		5.73		0.00		10.02		3.73		0.00		-		1.91		1.45		2.86	
Dissolved Oxygen (mg/L) - Test Kit														4.00		1.00		1.50	
Temperature (°C)		13.95		11.57		17.01		20.65		13.14		14.5		20.06		15.89		21.06	
Oxygen Reduction Potential (mV)		-14		-15		-72		-101		-88		-15		697		9		-4	
Turbidity (NTU)		19		10.5		24.1		1.35		78.2		32.5		41.1		37.1		6.39	

Notes:
µg/L - micrograms per liter water
B - Field Blank Contamination
J - Estimated Value
L - Biased Low
U - Analyte was not detected in the sample at a level greater than the instrument detection
S.U. - Standard units
mS/cm - Millisiemens per centimeter
mg/L - Milligrams per liter
°C - Degrees celsius
mV - Millivolts
NTU - Nephelometric turbidity units
Shaded Cells indicate exceedances of the Cleanup Goal
NA - Not analyzed
NC - No criteria

TABLE 5-3
HISTORICAL GROUNDWATER DATA - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Cleanup Goal	WOD-MW003R																			
Sample Date		12/8/2008		1/14/2009		3/15/2010		6/8/2010		9/15/2010		12/7/2010		3/22/2011		9/13/2011		3/12/2012		9/17/2012	
VOCs (ug/L)																					
Benzene	5	1	U	1	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.5	U	0.5	U	0.2	U
Metals (ug/L)																					
Total Arsenic	10	1.45		1.45	U	1.5	U	2.2	B	1.6	B	0.8	U	2.25	U	1.5	U	4	UL	0.5	U
Dissolved Arsenic	NC	NA		NA		1.5	U	3.1	B	0.8	U	0.8	U	2.25	U	1.5	U	4	UL	0.5	U
Field Parameters																					
pH (S.U.)		6.28		5.65		6.69		6.38		5.14		5.91		6.13		4.40		6.34		5.98	
S. Conductivity (mS/cm)		0.093		0.170		0.132		0.100		0.131		0.127		0.090		0.107		0.116		0.107	
Dissolved Oxygen (mg/L) - Horiba		7.72		8.56		11.90		10.02		19.99		11.01		-		9.18		6.52		5.42	
Dissolved Oxygen (mg/L) - Test Kit																9.00		6.00		5.00	
Temperature (°C)		14.02		15.3		13.44		16.09		19.4		14.66		15.4		18.36		18.6		19.21	
Oxygen Reduction Potential (mV)		206		75		239		370		49		156		159		615.5		147		158	
Turbidity (NTU)		4.8		1.18		0.33		5.3		5.99		2.42		4.28		7.42		6.53		7.32	

Notes:
µg/L - micrograms per liter
B - Field Blank Contamination
J - Estimated Value
L - Biased Low
U - Analyte was not detected in the sample at a level greater than the instrument detection
S.U. - Standard units
mS/cm - Millisiemens per centimeter
mg/L - Milligrams per liter
°C - Degrees celsius
mV - Millivolts
NTU - Nephelometric turbidity units
Shaded Cells indicate exceedances of the Cleanup Goal
NA - Not analyzed
NC - No criteria

TABLE 5-3
HISTORICAL GROUNDWATER DATA - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Cleanup Goal	WOD-MW008																	
Sample Date		12/10/2008		3/15/2010		6/8/2010		9/14/2010		12/6/2010		3/21/2011		9/13/2011		3/12/2012		9/17/2012	
VOCs (ug/L)																			
Benzene	5	1	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.5	U	0.5	U	0.2	U
Metals (ug/L)																			
Total Arsenic	10	6.3		1.5	U	4.9	B	1	B	0.8	U	2.25	U	1.5	U	4	UL	0.5	U
Dissolved Arsenic	NC	NA		1.5	U	4.7	B	2.7	B	0.8	U	2.25	U	1.5	U	4	UL	0.5	U
Field Parameters																			
pH (S.U.)		5.77		6.29		5.70		4.35		6.09		5.61		3.26		6.00		5.74	
S. Conductivity (mS/cm)		0.120		0.098		0.090		0.094		0.104		0.096		0.081		0.085		0.102	
Dissolved Oxygen (mg/L) - Horiba		1.98		3.75		6.23		18.82		9.89		10.67		13.78		11.94		6.66	
Dissolved Oxygen (mg/L) - Test Kit														12+		10.00		6.00	
Temperature (°C)		15.17		11.87		15.01		18.8		16.71		15.04		18.00		14.78		18.48	
Oxygen Reduction Potential (mV)		84		132		358		138		294		262		-170.2		267		253	
Turbidity (NTU)		7.1		1.56		2.01		0.79		1.2		0		0.62		0		8.31	

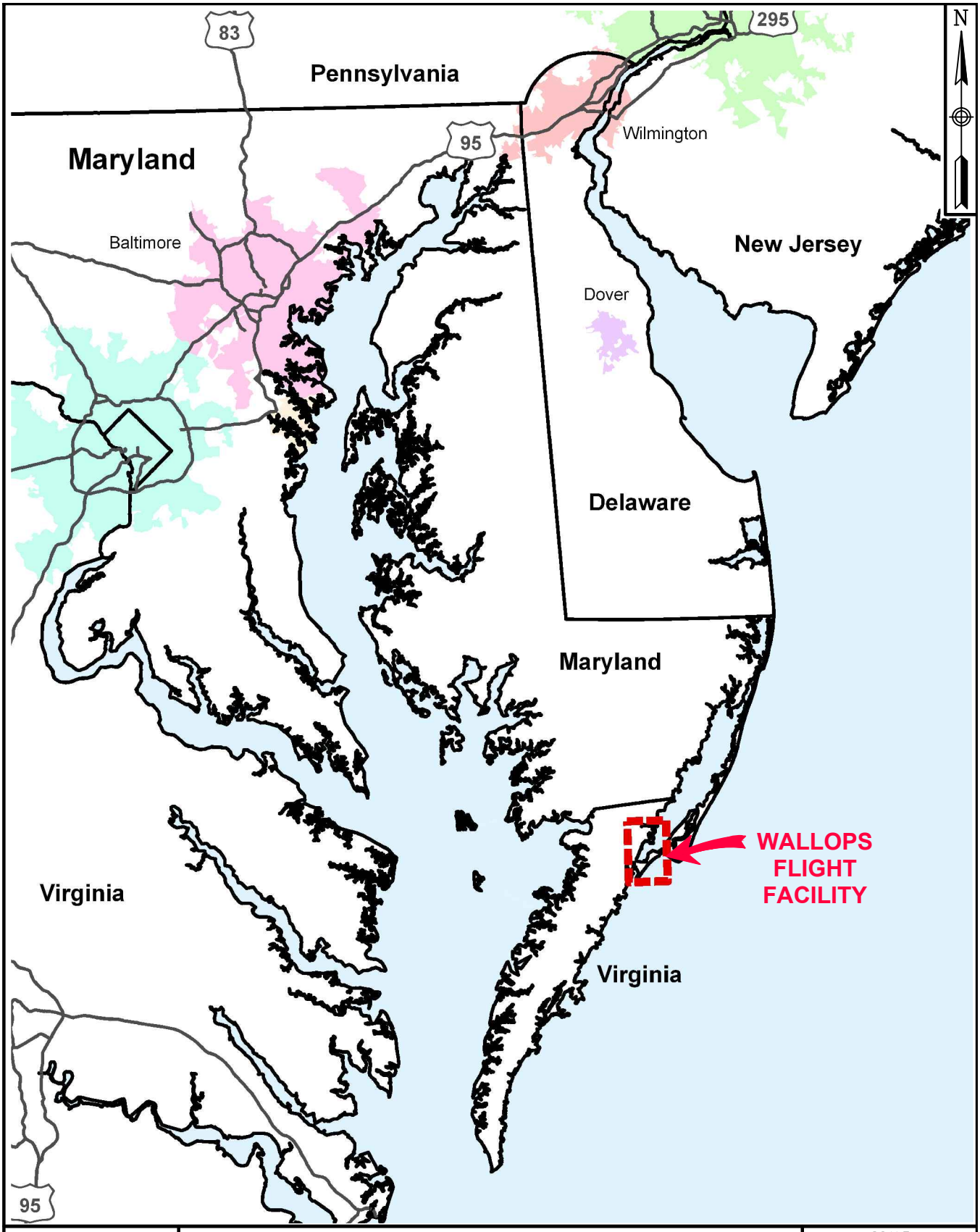
Notes:
µg/L - micrograms per liter
B - Field Blank Contamination
J - Estimated Value
L - Biased Low
U - Analyte was not detected in the sample at a level greater than the instrument detection
S.U. - Standard units
mS/cm - Millisiemens per centimeter
mg/L - Milligrams per liter
°C - Degrees celsius
mV - Millivolts
NTU - Nephelometric turbidity units
Shaded Cells indicate exceedances of the Cleanup Goal
NA - Not analyzed
NC - No criteria

TABLE 5-4
FREQUENCY OF DETECTIONS AND EXCEEDANCES DURING LONG-TERM MONITORING - WASTE OIL DUMP
FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration	Location of Maximum Detection	Sample ID of Maximum Detect	Minimum NonDetect	Maxium NonDetect	Average of Positive Results	Average of All Results	Standard Deviation
Volatile Organics (µg/L)										
BENZENE	25/78	0.17 J	33	15-MW007	15-MW007-20100915	0.2	0.5	3.67	1.29	4.23
Total Inorganics (µg/L)										
ARSENIC	37/78	0.94 J	58 J	15-MW007	15-MW07-20110321	0.5	15.3	13.52	7.26	11.64
Filtered Inorganics (µg/L)										
ARSENIC	32/77	1.4 J	60.5	15-MW007	15-MW007-20120312	0.5	8.2	15.11	7.08	11.28

Notes
µg/L - microgram(s) per liter
J - estimated concentration
B - blank contaminantion

FIGURES

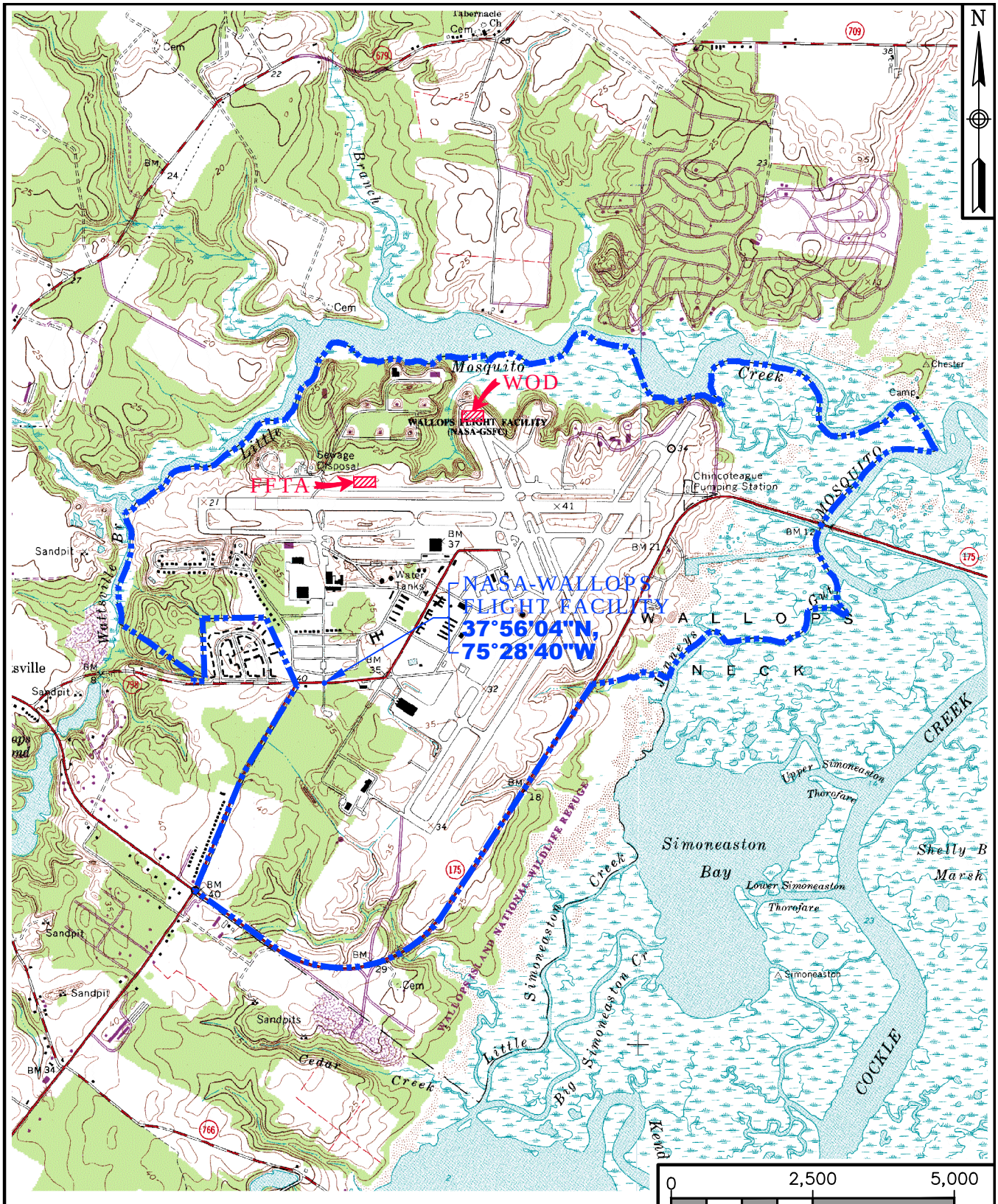


TETRA TECH

FACILITY LOCATION MAP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

SCALE	AS NOTED
FILE	112G01959BM02
REV	0
DATE	05/22/13
FIGURE NUMBER	FIGURE 1–1

112G01959/TASK 1/112G01959BM03.DWG 05/22/13 MKB



0 2,500 5,000

SCALE IN FEET

SOURCE: U.S.G.S. 7.5' QUADRANGLE MAP, CHINCOTEAGUE WEST, VA., (37075–H4–TF–024) PHOTOINSPECTED 1989.

TETRA TECH

SITE LOCATION MAP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

SCALE	AS NOTED
FILE	112G01959BM03
REV	0
DATE	05/22/13
FIGURE NUMBER	FIGURE 1–2

P:\GIS_files\NASA WI\FFTA\FireTrainingArea_fig2_3_101509.MXD 052313 MMC

Bing Maps aerial:
Aerial photograph from ESRI Bing Maps map service
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N

FFTA-MW105D
FFTA-MW102D
FFTA-MW057S
FFTA-MW103I
FFTA-MW058S
FFTA-MW056D
FFTA-MW106
FFTA-MW103D
14-MW005
FFTA-MW061I
FFTA-MW107
14-MW008
GROUNDWATER FLOW DIRECTION
FFTA-MW103S
14-MW004
FFTA-MW055D
FFTA-MW059S
14-MW007
FFTA-MW055S
FFTA-MW101S
14-MW003
14-MW006
FFTA-MW108
FFTA-MW060I
FFTA-MW002S
FFTA-MW054S
14-MW002
FFTA-MW001
FFTA-MW002D
14-MW001
FFTA-MW053S
MW029

Legend

- Monitoring Well-ACTIVE
- Monitoring Well-ABANDONED
- Monitoring Well-NOT SAMPLED
- LUC Boundary
- Site Boundary
- Structure Existing Area

0 50 100 200 Feet

DRAWN BY MMC	DATE 5/23/13	**Site Layout**	CONTRACT NUMBER 112GN1612
CHECKED BY ___	DATE ___	**Former Fire Training Area**	APPROVED BY ___ DATE ___
REVISED BY ___	DATE ___	**NASA Wallops Flight Facility**	APPROVED BY ___ DATE ___
SCALE AS NOTED		**Wallops Island, Virginia**	FIGURE NO. 4-1 REV 0

P:\GIS Files\NASA W\FFTA\FFTA qwres TAG exceedance 11192012.MXD 101613

Legend

- Monitoring Well-SAMPLED
- Monitoring Well-NOT SAMPLED
- Monitoring Well-ABANDONED
- Topo NASA 2008 (Feet MSL)
- Structure Existing Area
- Benzene
- Naphthalene
- Arsenic
- Manganese

N

FFTA-MW58S

	9/12
VOCs	µg/L
Benzene	4 J
SVOCs	µg/L
Naphthalene	**27**
Metals	µg/L
Arsenic	9.1
Manganese	**1,100 J**

FFTA-MW107

	9/12
VOCs	µg/L
Benzene	**5.6**
SVOCs	µg/L
Naphthalene	**36**
Metals	µg/L
Arsenic	**18**
Manganese	**630**

FFTA-MW102D

	9/12
VOCs	µg/L
Benzene	0.2 U
SVOCs	µg/L
Naphthalene	0.04 J
Metals	µg/L
Arsenic	0.5 U
Manganese	4.6 B

FFTA-MW61I

	9/12
VOCs	µg/L
Benzene	2
SVOCs	µg/L
Naphthalene	8.7
Metals	µg/L
Arsenic	9.9
Manganese	**1,400 J**

FFTA-MW57S

	9/12
VOCs	µg/L
Benzene	0.3 J
SVOCs	µg/L
Naphthalene	2.1
Metals	µg/L
Arsenic	0.5 U
Manganese	**430 J**

FFTA-MW106

	9/12
VOCs	µg/L
Benzene	0.2 U
SVOCs	µg/L
Naphthalene	0.039 U
Metals	µg/L
Arsenic	0.5 U
Manganese	0.92 B

FFTA-MW105D

	9/12
VOCs	µg/L
Benzene	0.2 U
SVOCs	µg/L
Naphthalene	0.038 U
Metals	µg/L
Arsenic	0.36 J
Manganese	1.7 B

FFTA-MW103I

	9/12
VOCs	µg/L
Benzene	0.2 U
SVOCs	µg/L
Naphthalene	0.043 U
Metals	µg/L
Arsenic	0.5 U
Manganese	9.3 B

FFTA-MW55S

	9/12
VOCs	µg/L
Benzene	0.36 J
SVOCs	µg/L
Naphthalene	5.2 J
Metals	µg/L
Arsenic	**21**
Manganese	**260 J**

FFTA-MW103D

	9/12
VOCs	µg/L
Benzene	0.2 U
SVOCs	µg/L
Naphthalene	0.039 U
Metals	µg/L
Arsenic	0.5 U
Manganese	4 B

FFTA-MW55D

	9/12
VOCs	µg/L
Benzene	0.2 U
SVOCs	µg/L
Naphtahlene	0.04 U
Metals	µg/L
Arsenic	0.5 U
Manganese	26 J

FFTA-MW059S

14-MW008

14-MW005

14-MW004

14-MW007

14-MW003

14-MW006

14-MW002

14-MW001

FFTA-MW002S

FFTA-MW060I

FFTA-MW002D

FFTA-MW103S

	9/12
VOCs	µg/L
Benzene	0.2 U
SVOCs	µg/L
Naphthalene	0.038 U
Metals	µg/L
Arsenic	1.1
Manganese	16 J

FFTA-MW108

	9/12
VOCs	µg/L
Benzene	0.2
SVOCs	µg/L
Naphthalene	0.038 U
Metals	µg/L
Arsenic	0.5 U
Manganese	0.83 B

FFTA-MW001

FFTA-MW054S

FFTA-MW101S

	9/12
VOCs	µg/L
Benzene	0.2 U
SVOCs	µg/L
Naphthalene	2.7
Metals	µg/L
Arsenic	0.5 U
Manganese	2.3 B

FFTA-MW053S

FFTA-MW56D

	9/12
VOCs	µg/L
Benzene	0.86 J
SVOCs	µg/L
Naphthalene	0.37
Metals	µg/L
Arsenic	1.7
Manganese	**1,000 J**

MW029

Notes:
Bolded Values Exceed Cleanup Goals
µg/L - micrograms per liter water
J - Estimated Value
L - Low Bias estimated Value
B - Field Blank contamination

0 100 200 400 Feet

DRAWN BY	MMC
DATE	10/16/13
CHECKED BY	___
DATE	___
REVISED BY	___
DATE	___
SCALE	AS NOTED

TETRA TECH

September 2012 Cleanup Goal Exceedance
Former Fire Training Area
NASA Wallops Flight Facility
Wallops Island, Virginia

CONTRACT NUMBER	112G04458
APPROVED BY	___
DATE	___
APPROVED BY	___
DATE	___
FIGURE NO.	4-2
REV	0

P:\GIS_Files\NASA WINASA WOD RI FILES\wod_LAYOUT_052313.MXD 101613

Bing Maps aerial:
Aerial photograph from ESRI Bing Maps map service
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N

WOD-MW004-2
WOD-MW003
WOD-MW008
WOD-MW006
15-MW001
WOD-MW002S
WOD-MW002D
Groundwater Flow Direction
15-MW002
15-MW007
WOD-MW001
Mosquito Creek
15-MW003
WOD-MW003R

Legend

- Monitoring Well
- Surface Water
- Site Boundary
- LUC Boundary

0 50 100 200 Feet

DRAWN BY MMC	DATE 10/16/13	**Site Layout Map**	CONTRACT NUMBER 112G04458
CHECKED BY ___	DATE ___	**Waste Oil Dump**	APPROVED BY ___ DATE ___
REVISED BY ___	DATE ___	**NASA Wallops Flight Facility**	APPROVED BY ___ DATE ___
SCALE AS NOTED		**Wallops Island, Virginia**	FIGURE NO. 5-1 REV 0

P:\GIS_Files\NASA WINASA WOD RI FILES\wod_cleanup_11192012.MXD 10162013

N

WOD-MW004-2

WOD-MW003

WOD-MW008

WOD-MW006

15-MW001	09/12
Metals	µg/L
Total Arsenic	**12**

WOD-MW002D	09/12
Metals	µg/L
Total Arsenic	**14**

WOD-MW001

15-MW002

15-MW007	09/12	09/12 (DUP)
Metals	µg/L	µg/L
Total Arsenic	**19**	**16**

15-MW003

WOD-MW003R

Notes:
Bolded Values Exceed Cleanup Goals
µg/L - micrograms per liter water

Legend

- Monitoring Well
- Topo NASA 2008 (feet msl)
- Arsenic

0 25 50 100 Feet

DRAWN BY: MMC	DATE: 101613
CHECKED BY:	DATE:
REVISED BY:	DATE:
SCALE: AS NOTED	

TETRA TECH

September 2012 Cleanup Goal Exceedance
Waste Oil Dump
NASA Wallops Flight Facility
Wallops Island, Virginia

CONTRACT NUMBER: 112G04458	
APPROVED BY:	DATE:
APPROVED BY:	DATE:
FIGURE NO.: **5-2**	REV: 0