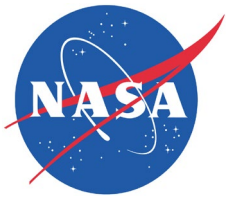
National Aeronautics and Space Administration



Final

Second Five-Year Review Report

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia

December 2018

FINAL

SECOND FIVE-YEAR REVIEW REPORT

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
Building F-160, Room C167
Wallops Island, Virginia 23337

DECEMBER 2018

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: 

Name: Mr. David Liu

Title: NASA Project Coordinator

EXECUTIVE SUMMARY

The National Aeronautics and Space Administration (NASA) conducted this Five-Year Review (FYR) 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)* (U.S. Environmental Protection Agency [EPA] and NASA, 2004) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121. WFF is not on the National Priorities List (NPL); however, by agreement with EPA, NASA addresses the "AAOC sites" under the CERCLA regulatory framework. This is the second FYR conducted at WFF by NASA under the AAOC. The first FYR was completed in 2013 (NASA, 2014).

This report is consistent with the EPA (2001) *Comprehensive Five-Year Review Guidance* and generally follows the EPA (2016) *Five-Year Review Recommended Template*. 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 CERCLA FYR:

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

The objective of the FYR 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. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them. 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*.

WOD: The first FYR did not identify any issues for the WOD. This second FYR reached the same finding. The remedy at WOD remains protective. Land Use Controls (LUCs) are in place preventing the use of site groundwater for drinking or other purposes and monitoring will continue.

FFTA: The first FYR identified the per- and polyfluoroalkyl substances (PFAS) as emerging contaminants as being likely present at the FFTA based on historical site use and proximity to the airfield runway. This necessitated a protectiveness-deferred determination for the FFTA. The report recommended determining the presence of PFAS before this second FYR. Groundwater samples were collected at FFTA in 2016 and analyzed for several PFAS compounds, including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). One or more PFAS were detected in 13 of the 14 monitoring wells at concentrations exceeding available comparison values (EPA Lifetime Health Advisory [LHA] and Regional Screening Level [RSL] values). A facility-wide PFAS study is ongoing at the time of this FYR. The protectiveness determination will be deferred again for FFTA. PFAS will be evaluated again for FFTA by the next FYR, when promulgated criteria are anticipated for at least PFOA and PFOS and when the facility-wide study is complete. LUCs are in place preventing the use of site groundwater for drinking or other purposes.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: NASA Wallops Flight Facility		
EPA ID: VA8800010763		
Region: 3	**State:** VA	**City/County:** Wallops Island / Accomack County

SITE STATUS	
NPL Status: To date this facility has not been proposed for NPL listing; CERCLA response actions at the subject sites are addressed under the RCRA 7003 Administrative Agreement on Consent (AAOC) that was executed between EPA and NASA.	
Multiple OUs? Yes	**Has the site achieved construction completion?** No

REVIEW STATUS
Lead agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** National Aeronautics and Space Administration (NASA)
Author name (Federal or State Project Manager): David Liu, Project Coordinator
Author affiliation: NASA, Environmental Compliance and Restoration Program
Review period: January 2014 – December 2018
Date of site inspection: July 10, 2018
Type of review: Statutory
Review number: 2
Triggering action date: December 2013 (completion of previous FYR)
Due date *(five years after triggering action date)*: December 2018

Issues/Recommendations				
OU(s) without Issues/Recommendations Identified in the Five-Year Review:				
Waste Oil Dump (WOD)				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): Former Fire Training Area (FFTA)	**Issue Category: Changed Site Conditions**			
	Issue: PFAS were detected in site monitoring wells at concentrations exceeding the available comparison values: PFOA and PFOS were detected above the EPA Lifetime Health Advisory, and PFBS was detected above the EPA Regional Screening Level.			
	Recommendation: NASA will work with EPA and VDEQ to determine the most appropriate path forward for the presence of these PFAS emerging contaminants at the site.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	2023 (next FYR)

Protectiveness Statement(s)		
The Protectiveness Statements for the Sites are summarized below.		
Operable Unit: FFTA	*Protectiveness Determination:* Protectiveness Deferred	*Planned Addendum Completion Date:* 12/31/2023 (Next FYR)
Protectiveness Statement: A protectiveness determination of the remedy at FFTA cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions: Compare site concentrations of PFOA and PFOS to promulgated regulatory criteria when available. It is expected that federal regulatory criteria will be published for PFOA and PFOS before the next review in 2023, at which time a protectiveness determination will be made.		
Operable Unit: WOD	*Protectiveness Determination:* Protective	*Planned Addendum Completion Date:* *NA*
Protectiveness Statement: The remedy at WOD is protective of human health and the environment.		

The signature below acknowledges NASA's review and acceptance of the enclosed Five-Year Review document findings for the Wallops Flight Facility Sites summarized herein. The findings of these Five-Year Reviews, acknowledged by this signature, are summarized in this Five-Year Review Summary Form, and are detailed in the pages that follow.

Raymond J. Rubilotta

8 Feb 19

Raymond J. Rubilotta, Director
Management Operations
Goddard Space Flight Center

Date

TABLE OF CONTENTS

APPENDICES

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

µg	Microgram(s)
µg/kg	Microgram(s) per kilogram
µg/L	Microgram(s) per liter
AFFF	Aqueous film forming foams
AOC	Area of Concern
AAOC	Administrative Agreement on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
COC	Chemical of Concern
DCE	Dichloroethene
EPA	U.S. Environmental Protection Agency
FFTA	Former Fire Training Area
FMB	Facilities Management Branch
FS	Feasibility Study
FUDS	Formerly Used Defense Site
FYR	Five-Year Review
GIS	Geographic Information System
HHRA	Human health risk assessment
HI	Hazard Index
IC	Institutional control
kg	Kilogram(s)
L	Liter
LHA	Lifetime Health Advisory
LTM	Long-term monitoring
LUC	Land use control
MB	Main Base [parcel of WFF facility]
MCL	Maximum Contaminant Level
mg	Milligram(s)
mg/kg	Milligram(s) per kilogram
mg/L	Milligram(s) per liter
ML	Main Land [parcel of WFF facility]
NAAS	[Chincoteague] Naval Auxiliary Air Station
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances and Contingency Plan (i.e., National Contingency Plan)
ng	Nanogram(s)
ng/L	Nanogram(s) per liter
NPL	National Priorities List

ORC	Oxygen-release compound
PFAS	Per- and Polyfluoroalkyl Substances
PFBS	Perfluorobutanesulfonic acid
PFHpA	Perfluoroheptanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
ppt	Parts per trillion
PRP	Potentially Responsible Party
RACR	Remedial Action Completion Report
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
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]
SMP	Site Management Plan
SI	Site Investigation
UCMR3	[EPA's] Unregulated Contaminant Monitoring Rule 3
U.S.	United States
USACE	U.S. Army Corps of Engineers
UST	Underground storage tank
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 [parcel of WFF]

1.0 INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of remedies to determine if the remedies are and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The National Aeronautics and Space Administration (NASA) is preparing this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, as amended, consistent with the National Contingency Plan (NCP) (40 CFR Section 300.430[f][4][ii]), and considering U.S. Environmental Protection Agency (EPA) policy. NASA is the potentially responsible party (PRP) for the subject sites in the FYR.

This is the second FYR for NASA Goddard Space Flight Center's Wallops Flight Facility (WFF) (the Site or facility) located in Wallops Island, Virginia (Figure 1–1). To date WFF has not been proposed for addition to the National Priorities List (NPL); however, by agreement the obligations of the Administrative Agreement on Consent (AAOC) (EPA and NASA, 2004) are met using the CERCLA process. The triggering action for this statutory review is the completion of the previous FYR (NASA, 2014). The FYR has been prepared because hazardous substances, pollutants, or contaminants remain at the facility above levels that allow for unlimited use and unrestricted exposure (UU/UE).

Two sites under the AAOC require a CERCLA FYR: The Former Fire Training Area (FFTA) and the Waste Oil Dump (WOD) (Figure 1–2). Other environmental restoration sites or Areas of Concern (AOCs) at the facility (Table 1–1) are not included in the FYR, because they are still under investigation or have been closed out under the AAOC, they are being addressed by the U.S. Army Corps of Engineers (USACE) under the Formerly Used Defense Sites (FUDS) Program, or they are under other regulatory programs (e.g., Virginia's underground storage tank [UST] program) (Tetra Tech, 2018a).

The FYR was led by David Liu, the NASA Project Coordinator for the Environmental Compliance and Restoration Program. Participants included Lorie Baker, the Remedial Project Manager (RPM) for EPA, Michelle Payne, the RPM for Virginia Department of Environmental Quality (VDEQ), and NASA contractor participants from Tetra Tech (under prime contractor, LJT & Associates). The regulatory agencies were notified of the initiation of the five-year review in January 2018 during the quarterly RPM meeting associated with the AAOC sites. The review began on January 30, 2018.

1.1 FACILITY BACKGROUND

WFF (Figure 1–1) is 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.

NASA, and its predecessor organization, the National Advisory Committee for Aeronautics (NACA), have had a presence at WFF since 1945. NACA commenced operations 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. 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; 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. Additional information regarding the facility is available in the *WFF Site Management Plan (SMP)* (Tetra Tech, 2018a).

A facility-wide investigation for per- and polyfluoroalkyl substances (PFAS) is ongoing at the time of this second FYR. The investigation includes evaluating potential impacts to production wells used by the facility and by the Town of Chincoteague. Groundwater at FFTA was evaluated for the presence of PFAS in 2017 as recommended by the first FYR (NASA, 2014; Tetra Tech, 2017b and 2017d) (see Section 2.0).

1.2 REPORT ORGANIZATION

The Executive Summary and FYR Summary Form are provided in the front matter. The report generally follows the EPA (2016) FYR recommended template. Section 1.0 provides the FYR introduction and general facility background. FYR content for the FFTA is provided in Section 2.0. The content for the WOD is provided in Section 3.0. Tables and figures are provided after Section 3.0. For reference, Appendix A includes a list of documents reviewed during this FYR. Other relevant content and supporting information is provided in appendices as indicated in the Table of Contents.

2.0 FORMER FIRE TRAINING AREA

2.1 SITE BACKGROUND

The FFTA is located along Runway 10–28 in the northern portion of the MB (Figure 2–1). 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 because of a removal order from VDEQ (Tetra Tech, 2018a). The area was identified as an AOC because of the site use history as well as visible staining.

FFTA is 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 because it is adjacent to an active runway—which is an important part of the facility's mission. Shallow groundwater flows northeast and east through the site. 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 and exposure to groundwater are restricted as required by the Record of Decision (ROD) (Tetra Tech, 2007c). Effective implementation of the Institutional Controls (ICs) by the *Land Use Control (LUC) Remedial Design (RD)* (Tetra Tech, 2008c) prevents site development and exposure to site groundwater.

The Town of Chincoteague shallow and deep groundwater supply wells are located more than 4,500 feet east of the FFTA-impacted shallow groundwater (Tetra Tech, 2017c, 2018c, and 2018d). The four active, deep production wells for WFF are located more than 2,500 feet south of FFTA.

2.2 RESPONSE ACTION SUMMARY

2.2.1 Basis for Taking Action

Action was needed at FFTA to mitigate human health risks from exposure to Chemicals of Concern (COCs) in groundwater.

The COCs were identified initially by the baseline human health risk assessment (HHRA) in the *Supplemental Remedial Investigation (RI) Report* (Tetra Tech, 2004b). The cleanup goals were developed in the Feasibility Study (FS) (Tetra Tech, 2005a) and finalized in the ROD (Tetra Tech, 2007c). There are no COCs associated with ecological risk at FFTA. The groundwater to surface water pathway was evaluated during the RI. COCs were identified in groundwater based on a future resident exposed to groundwater via ingestion, dermal contact, or inhalation. No action was required for other media. The COCs in groundwater consist of benzene, cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride (VC), 4-methylphenol, naphthalene, arsenic, and manganese (Table 2-1). A chronology of events for the FFTA is presented in Table 2-2.

2.2.2 Response Actions

Prior to the ROD (and any CERCLA response), approximately 120 cubic yards of petroleum-contaminated soils were excavated and removed from the site by NASA in 1986 because of a removal order from VDEQ under the UST Program (Tetra Tech, 2018a).

2.2.2.1 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 remedial action objectives (RAOs) were finalized in the ROD for FFTA (Tetra Tech, 2007c):

- 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.

No RAO was developed specific to soil vapor or potential vapor intrusion issues at the time of the FS and ROD. See Section 2.5.2 for a discussion of potential vapor intrusion at FFTA.

2.2.2.2 Remedy Components

The selected remedy for FFTA consists of the following components:

- In-Situ Biological Treatment (Biostimulation) via injection
- Institutional Controls
- Long-term groundwater monitoring

The COCs and associated cleanup levels from the ROD are provided in Table 2-1.

2.2.3 Status of Implementation

The remedial action has been fully implemented. The *Pilot Study Work Plan* was finalized and approved in 2008 (Tetra Tech, 2008b). The pilot study, conducted in December 2008, involved injections of biostimulation substrate within the contaminant plume area and performance monitoring. The monitoring results were presented in the *Pilot Study Report for FFTA* (Tetra Tech, 2009b). Concentrations were reduced within the plume area sufficiently such that EPA and VDEQ concurred that full-scale implementation of biostimulation was not necessary. Groundwater performance monitoring was initiated in August 2009 and the long-term monitoring (LTM) program was approved and implemented in 2010 (Tetra Tech, 2009b and 2010c). Groundwater LTM is ongoing. Institutional controls were implemented in 2008 (see Section 2.2.3.1). The *Remedial Action Completion Report (RACR)* documenting that all components of the remedy had been implemented and were functioning was finalized in 2011 (Tetra Tech, 2011a).

2.2.3.1 Institutional Controls (ICs)

The LUC boundary within which ICs are enforced at FFTA is shown on Figure 2-1. The ICs for FFTA are linked to the restricted area and are included in the Facilities Master Plan and Tool used by the WFF Facilities Management Branch (FMB). The FMB reviews the Tool to issue dig permits and review/evaluate proposed land use activities. The IC objectives from the LUC RD are listed in Table 2-3 (Tetra Tech, 2008c). LUC inspections are performed annually by NASA. These restrictions will remain in place until concentrations of hazardous substances in shallow groundwater are reduced to allow for UU/UE.

2.2.3.2 Systems Operation & Maintenance (O&M)

NASA currently performs groundwater LTM sampling activities for FFTA. LTM events occur every 9 months at the time of this FYR. Contractors evaluate the data, document LTM activities, and provide the reports to NASA, EPA, and VDEQ. The LTM Program is updated (e.g., sampling frequency and wells to sample) as needed by NASA with concurrence from EPA and VDEQ. See Section 2.4.2 for additional information regarding groundwater monitoring at FFTA.

2.3 PROGRESS SINCE THE LAST REVIEW

2.3.1 Protectiveness Statement from the 2013 FYR

The following are the protectiveness determination and statements for FFTA from the previous (2013) FYR (NASA, 2014):

> Protectiveness for this operable unit is being deferred. [Per- and polyfluoroalkyl substances (PFAS) 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 [PFAS] 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 [PFAS] will be conducted prior to the next [Five-Year Review] in 2018 to determine the presence/absence of [PFAS] 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.

2.3.2 Issues Identified in the 2013 FYR

The only issue identified for FFTA during the first FYR in 2013 was the potential for the presence of PFAS in groundwater. PFAS is a known component of AFFF, which is used to combat petroleum fires. PFAS-based AFFF was known to be used for fire training activities and for emergency responses on the runway.

2.3.3 Recommendations Proposed in the 2013 FYR

The 2013 FYR recommended sampling groundwater at FFTA for PFAS (specifically, perfluorooctanoic acid [PFOA] and perfluorooctane sulfonate [PFOS]) by December 31, 2018 (i.e., prior to the 2018 FYR). NASA would work with EPA and VDEQ to develop a work plan and perform the sampling and evaluation.

2.3.4 Status of Recommendations from the 2013 FYR

A groundwater sampling event for PFAS was conducted in November/December 2016 at FFTA in accordance with the work plan developed by NASA with EPA and VDEQ (NASA, 2016). FFTA monitoring wells were sampled and analyzed for PFOA, PFOS, and other PFAS chemicals (see Section 2.4.2). All the analyzed PFAS chemicals were detected, with results of PFOA and PFOS above the current EPA Lifetime Health Advisory (LHA) level of 70 parts per trillion (ppt) (effectively equivalent to 70 nanograms per liter [ng/L]). The sampling approach and results are discussed in detail in the *Data Summary Report, Groundwater Investigation for PFAS at FFTA* (Tetra Tech, 2017d). The evaluation also included sampling of the WFF finished drinking water. PFAS was not detected in the finished water.

2.4 FIVE-YEAR REVIEW PROCESS

2.4.1 Community Notification, Involvement, & Site Interviews

A public notice was posted in the *Eastern Shore News* and the *Chincoteague Beacon* on March 21 and 22, 2018, indicating the initiation of the second FYR and inviting the public to submit any questions or comments to NASA. The notice indicated that results of the review and the report will be made available at the following Information Repositories:

Eastern Shore Public Library
23610 Front Street
Accomac, Virginia 23301

Island Library
4077 Main Street
Chincoteague, Virginia 23336

During the FYR process, interviews were conducted to document any perceived problems or successes with the remedy that has been implemented to date**.** Interviews were conducted via questionnaire with the RPMs (Appendix B). No issues were identified by the RPMs. There were no public responses or inquiries for interviews.

2.4.2 Data Review

LTM groundwater data have been collected since the implementation of the remedial action. The monitoring locations and constituents were identified in the ROD as part of the Performance Standards. The ROD also required the preparation of an LTM Plan. An LTM Plan was developed in 2010 to comply with the groundwater monitoring requirements specified in the ROD for FFTA (Tetra Tech, 2010c). Revised LTM Plans Rev-1, Rev-2, and Rev-3 were issued in 2012 (Tetra Tech, 2012e), 2014 (2014a), and 2015 (2015e), respectively, to optimize the LTM Program. Optimization included removing wells and monitoring parameters from the LTM Program considering performance monitoring results.

The current groundwater monitoring program at FFTA consists of the analysis of benzene, naphthalene, 4-methylphenol, total and dissolved arsenic, and total and dissolved manganese. LTM sampling events at FFTA occur every 9 months (semiannual frequency stopped after 2015). The analytical data is presented in Appendix C. The LTM groundwater data collected since the previous FYR (i.e., March 2013 through June 2017) are provided in Table C-1. The PFAS data are provided in Table C-2. Frequency of detection information is summarized in Table C-3.

This FYR Report also serves to document the LTM events at FFTA since the *2014 Annual LTM Report for FFTA* (Tetra Tech, 2015a). The following four events were reported via data summary reports:

- March 2015 Event – March 17 through 18, 2015 (Tetra Tech, 2015c)
- December 2015 Event – December 1 through 2, 2015 (Tetra Tech, 2016a)
- September 2016 Event – September 26 through 28, 2016 (Tetra Tech, 2016e)
- June 2017 Event – June 20 through 23, 2017 (Tetra Tech, 2017f)

Each event included water level gauging of 20 vicinity monitoring wells and sampling from 12 monitoring wells specific to the LTM Program at FFTA. The analytical data are compared to cleanup levels for each event in Appendix C. Groundwater elevations and flow maps associated with each event are provided in Appendix C. In addition, isoconcentration contour figures showing exceedances of cleanup levels for each

event are provided in Appendix C. Temporal analytical data trend graphs for the COCs are provided in Appendix D. The most recent data from the June 2017 monitoring event is shown on Figure 2-2, with exceedances shown on Figure 2-3.

Compared to the site conditions prior to the biostimulation injection in 2009, the maximum concentrations of benzene, 4-methyphenol, naphthalene, and manganese have decreased and the contaminant plume(s) has(have) decreased in size. Arsenic concentrations appear to have stabilized over time. The concentrations of benzene and 4-methylphenol are below the cleanup goals in the latest (June 2017) sampling event. The concentrations of arsenic, manganese, and naphthalene remain above the cleanup goals; however, the exceedances are limited to the central portion of the site.

To fulfill the recommendation of the previous FYR, a groundwater sampling event was conducted in 2016 to determine the presence/absence of PFAS at the FFTA. Samples were collected at the FFTA monitoring wells and the drinking water treatment building (Building D-4). The PFAS detections (see Table C-2 and Figure 2-4) indicate that PFOA and PFOS are present in groundwater at concentrations exceeding the available comparison values. The comparison values used for the PFAS study are the EPA drinking water LHA of 70 ng/L for PFOA and PFOS (individually or combined) and the EPA Regional Screening Level (RSL) for tap water of 400,000 ng/L for perfluorobutanesulfonic acid (PFBS). PFBS also was detected at the site, but at concentrations below the RSL. The other PFAS compounds detected at the site (perfluoroheptanoic acid [PFHpA], perfluorohexanesulfonic acid [PFHxS], and perfluorononanoic acid [PFNA]) do not have comparison values. PFAS was not detected at the drinking water treatment building. A facility-wide Preliminary Assessment (PA) and Site Investigation (SI) for PFAS is ongoing at the time of this FYR (Tetra Tech, 2018d). Additional characterization of PFAS at FFTA will be conducted during the subject SI.

2.4.3 Site Inspection

The FYR inspection of FFTA was conducted on July 10, 2018. The purpose of the inspection was to assess the monitoring well network and the protectiveness of the remedy. Appendix E contains the completed site inspection form and photograph log. No substantive issues were identified at FFTA during the 5YR site inspection. The site is located within the controlled federal property of NASA WFF; both facility and site access are restricted and controlled. Groundwater at the site is not used or accessed other than for environmental monitoring. The inspector noted all wells are in good condition, except that the protective casing cover for well FFTA-MW101S has rusted.

2.5 TECHNICAL ASSESSMENT

2.5.1 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 biostimulation, LUCs, and LTM, is functioning as intended by the ROD. No signs of intrusion, invasive development of the site, or activities that would have violated the ICs were observed. In summary, the remedy is in place to successfully prevent exposure to the site-related contaminants.

Remedial Action Performance: LTM groundwater data indicate the concentrations of the majority of the site contaminants in groundwater are decreasing over time (refer to Section 2.4.2, Appendix C, and Appendix D). However, manganese concentrations show recent increasing trends in wells FFTA-MW55D, MW061I, 101S and MW102D.

System Operations/O&M: Site inspections and periodic sampling events indicate the LTM well network is intact.

Implementation of ICs and Other Measures: The LUCs responsible for the remedial action are functioning as intended. The FFTA is identified on the base-wide geographic information system (GIS). The site inspection did not identify any exposure problems and found no damage to the LTM well network.

2.5.2 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 FYR requirement.

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, except for the criteria for 4-methylphenol and naphthalene. An oral reference dose of 0.005 milligram per kilogram (mg/kg) per day was used to derive the cleanup goal of 27 micrograms per liter (µg/L) for 4-methylphenol. The current oral reference dose of 0.1 mg/kg per day and current exposure assumptions would result in a remedial goal of 927 µg/L. The cleanup goal of 16 µg/L for naphthalene was based on noncarcinogenic effects to an adult resident. At the time the risk assessment was performed during the RI, there were no carcinogenic toxicity criteria available for naphthalene. An inhalation unit risk of 3.4×10^{-5} (µg per cubic meter)$^{-1}$ is available from the California EPA. The remedial goal for naphthalene based on carcinogenic effects and current EPA exposure assumptions would be 1.9 µg/L for a target cancer risk of 1×10^{-6}. The cancer risk associated with the current remedial goal of 16 µg/L would be 8×10^{-6}. This value is within EPA's target risk range of 1×10^{-4} to 1×10^{-6}, so the current remedial goal is still protective of human health.

Changes in Risk Assessment Methods: There have been several changes in EPA risk assessment methodology since the risk assessment in the Tetra Tech (2004b) *Supplemental RI Report;* although, none of the changes would impact the protectiveness of the remedy. Among these changes are the following:

- The implementation of EPA's Dermal Guidance (Risk Assessment Guidance for Superfund [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, EPA provided general direction on implementing 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 VC was the only mutagenic chemical detected in groundwater at FFTA, VC was retained as a COC, and the Maximum Contaminant Level (MCL) was selected as the cleanup goal.

- 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.

- In 2014, EPA updated standard exposure factors for human health (EPA, 2014). For most chemicals the changes in exposure assumptions result in lower risks. However, the reduction in risks would not change the conclusions of the HHRA and the remedy for FFTA would not change.

Changes in Exposure Pathways: There have been no changes in land use at the FFTA that would have resulted in new exposure pathways to human or ecological receptors or impact the protectiveness of the remedy. No new contaminants or new sources were identified as part of this FYR.

As noted in the first FYR, potential exposures from vapor intrusion into buildings were not evaluated during the RI/FS and was not included in the ROD for FFTA. 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 VC) meet cleanup levels. There is no RAO to minimize human health risk due to potential vapor issue; however, there are no buildings on the site, and the LUCs portion of the remedy prohibits the development of commercial or residential buildings at the site to avoid vapor intrusion issues (Tetra Tech, 2008c). The LUCs have been implemented and are enforced by NASA.

PFAS compounds (emerging contaminant) have been detected in FFTA groundwater since the 2013 FYR; however, evaluation of PFAS in facility-wide groundwater is ongoing at the time of this FYR (see below).

Expected Progress Towards Meeting RAOs: The LUCs prevent exposure to and use of the FFTA groundwater for hypothetical future resident use of shallow groundwater. LTM groundwater data indicate the concentrations of the majority of the COCs in groundwater were decreasing over time.

A new site condition that may impact the remedy protectiveness is the presence of an emerging contaminant. 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 (SWDA) of 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. Six of the unregulated chemicals detailed in EPA's third Unregulated Contaminant Monitoring Rule (UCMR3) (May 2, 2012) are the following PFAS compounds: PFOS, PFOA, PFNA, PFHxS, PFHpA, and PFBS. PFAS were a component of AFFF used for firefighting responses and/or for training exercises. PFAS are

not included in the fourth UCMR (UCMR4; December 20, 2016), because they were confirmed by the UCMR3 effort.

PFOA and PFOS are included on EPA's fourth Contaminant Candidate List (CCL4) (November 17, 2016). The CCL is a list of contaminants that are currently not subject to any proposed or promulgated national primary drinking water regulations, but are known or anticipated to occur in public water systems. Contaminants listed on the CCL may require future regulation under the SDWA.

As discussed in Section 2.4.2, groundwater samples were collected at FFTA in 2016 and analyzed for PFAS. PFAS was detected in 13 of the 14 monitoring wells at concentrations exceeding the comparison values (Table C-2 and Figure 2-4). Groundwater COCs at the FFTA site are currently being addressed by the selected remedial action. While PFAS were detected throughout FFTA groundwater at concentrations exceeding reference comparison values, LUCs are in place preventing the use of site groundwater for drinking or other purposes.

Other than the presence of PFAS in the groundwater, no other site conditions are known to impact the RAOs or remedy protectiveness.

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

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

No other information has been made available that calls into question the protectiveness of the remedial action.

2.6 ISSUES/RECOMMENDATIONS

Issues and Recommendations Identified in the Five-Year Review:				
OU(s): FFTA	**Issue Category: Changed Site Conditions**			
	Issue: PFAS were detected in site monitoring wells at concentrations exceeding the available comparison values: PFOA and PFOS were detected above the EPA LHA, and PFBS was detected above the EPA RSL.			
	Recommendation: NASA will work with EPA and VDEQ to determine the most appropriate path forward for the presence of these PFAS emerging contaminants at the site.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	2023 (next FYR)

2.7 OTHER FINDINGS

The March 2018 LTM sampling was not included in the data review for this FYR because the monitoring report was not complete at the time of the review. However, the preliminary analytical results indicate that the LTM can be optimized by the removal of benzene and monitoring well FFTA-MW101S from the LTM

program. Benzene has not been detected above the cleanup level in any monitoring well in the last five rounds (refer to Section 2.4.2, Appendix C, and Appendix D). Contaminants of concern have not been detected above the cleanup levels in FFTA-MW101S in the last seven rounds. Although cleanup levels have not been exceeded in samples collected from wells FFTA-MW102D, FFTAMW105D, FFTA-MW106 and FFTA-MW108 for multiple rounds, these monitoring wells should remain in the sampling program to provide data from upgradient and downgradient of the contaminant plume. NASA will present the March 2018 data and recommended LTM changes for the FFTA to the EPA and VDEQ in the data summary report for the March 2018 event. NASA will work with EPA and VDEQ to revise the LTM Plan to incorporate this recommendation.

During the FYR site inspection in July 2018, the protective casing cover for monitoring well FFTA-MW101S was noted as needing replacement. This will be addressed during the next monitoring event.

2.8 PROTECTIVENESS STATEMENT

Protectiveness Statement(s)		
Operable Unit: FFTA	*Protectiveness Determination:* Protectiveness Deferred	*Planned Addendum Completion Date:* 12/31/2023 (next FYR)
Protectiveness Statement: A protectiveness determination of the remedy at FFTA cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions: Compare site concentrations of PFOA and PFOS to promulgated regulatory criteria when available. It is expected that federal regulatory criteria will be published for PFOA and PFOS before the next review in 2023, at which time a protectiveness determination will be made.		

2.9 NEXT REVIEW

The next FYR report for FFTA is required five years from the completion date of this review.

3.0 WASTE OIL DUMP

3.1 SITE BACKGROUND

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.

The WOD is at the north end of the runway 17/35 and is currently maintained as an open space (Figure 3-1). 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 and exposure to groundwater are restricted as required by the ROD (Tetra Tech, 2008b). Effective implementation of the ICs by the LUC RD (Tetra Tech, 2008d) prevents site development and exposure to site groundwater.

The Town of Chincoteague shallow and deep groundwater supply wells are located more than 3,500 feet east of the WOD-impacted shallow groundwater (Tetra Tech, 2017c, 2018c, and 2018d). The four active, deep production wells for WFF are located more than 4,500 feet south of WOD.

3.2 RESPONSE ACTION SUMMARY

3.2.1 Basis for Taking Action

Action was needed at WOD to mitigate human health risks from exposure to COCs in groundwater.

The COCs were identified initially by the baseline HHRA in the *Supplemental Remedial Investigation (RI) Report* (Tetra Tech, 2004c). The cleanup goals were developed in the FS (Tetra Tech, 2005b), and finalized in the ROD (Tetra Tech, 2008b). There are no COCs associated with ecological risk at WOD. The groundwater to surface water pathway was evaluated during the RI. COCs were identified only in groundwater based on a future resident exposed to groundwater via ingestion, dermal contact, or inhalation. No action was required for other media. The COCs in groundwater consist of benzene and arsenic (Table 3-1). A chronology of events for the WOD is presented in Table 3-2.

3.2.2 Response Actions

Prior to the ROD (and any CERCLA response), approximately 180 cubic yards of petroleum-contaminated soils were excavated and removed from the site by NASA in 1986, because of a removal order from VDEQ under the UST Program (Tetra Tech, 2018a).

3.2.2.1 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 (Tetra Tech, 2008b):

- 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).

No RAO was developed specific to soil vapor or potential vapor intrusion issues at the time of the FS and ROD. See Section 3.5.2 for a discussion of potential vapor intrusion at WOD.

3.2.2.2 Remedy Components

The selected remedy for WOD consists of the following components:

- In-Situ Biological Treatment (Biostimulation)
- Institutional Controls
- Long-term groundwater monitoring

The COCs and associated cleanup levels from the ROD are provided in Table 3-1.

3.2.3 Status of Implementation

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 (Tetra Tech, 2008e). The pilot study injections were conducted in December 2008 followed by full-scale injection planning. The pilot study report and monitoring results were included as an appendix to the *Remedial Action Work Plan* (Tetra Tech, 2009d). The *LTM Plan* for WOD was finalized and approved in 2009 (Tetra Tech, 2009e). The full-scale biostimulation injection was conducted in December 2009 and the first round of post-injection monitoring was conducted in March 2010. Groundwater LTM has continued since the initial performance monitoring. Institutional controls were implemented in 2008 (see Section 3.2.3.1). The *RACR* documenting that all components of the remedy had been implemented and were functioning was finalized in 2011 (Tetra Tech, 2011a).

3.2.3.1 Institutional Controls

The LUC boundary within which ICs are enforced at WOD is shown on Figure 3-1. The ICs for WOD are linked to the restricted area and are included in the Facilities Master Plan and Tool used by the WFF FMB. The FMB reviews the Tool to issue dig permits and review/evaluate proposed land use activities. The IC objectives from the LUC RD are listed in Table 3-3 (Tetra Tech, 2008d). LUC inspections are performed annually by NASA. These restrictions will remain in place until concentrations of hazardous substances in shallow groundwater are reduced to allow for UU/UE.

3.2.3.2 Systems Operation & Maintenance (O&M)

NASA currently performs groundwater LTM sampling activities for WOD. LTM event frequency has decreased since performance monitoring started in 2010. Based on recommendations from the 2017 Data Summary Report (Tetra Tech, 2018b), the next sampling events will occur in spring 2020 and fall 2022. Frequency of sampling events after 2022 will be recommended in either the respective fall 2022 LTM report or the third FYR. Contractors evaluate the data, document LTM activities, and provide the reports to NASA, EPA, and VDEQ. The LTM Program is updated (e.g., sampling frequency and wells to sample) as needed

by NASA with concurrence from EPA and VDEQ. See Section 3.4.2 for additional information regarding groundwater monitoring at WOD.

3.3 PROGRESS SINCE THE LAST REVIEW

3.3.1 Protectiveness Statement from 2013 FYR

The following are the protectiveness determination and statements for WOD from the previous (2013) FYR (NASA, 2014):

> 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.

3.3.2 Issues Identified in the 2013 FYR

No issues were identified for the WOD during the 2013 FYR.

3.3.3 Recommendations Proposed in the 2013 FYR

No recommendations were made for the WOD during the 2013 FYR.

3.3.4 Status of Recommendations from the 2013 FYR

Not applicable for WOD.

3.4 FIVE-YEAR REVIEW PROCESS

3.4.1 Community Notification, Involvement, & Site Interviews

Refer to Section 2.4.1. A public notice was posted in local newspapers indicating the start of the second FYR and that the results will be made available at the Information Repositories. Interviews were conducted via questionnaire with the EPA RPM (Appendix B). No issues were identified by EPA or the other RPMs. There were no public responses or inquiries for interviews.

3.4.2 Data Review

Monitoring data has been collected since the implementation of the remedial action, which was a pilot test followed by a full-scale 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 (Tetra Tech, 2009e) was developed in 2009 to comply with the groundwater monitoring requirements of the ROD for WOD. Revised LTM Plans were issued in 2012 (Tetra Tech, 2012f), 2014 (Tetra Tech, 2014b), and 2015 (Tetra Tech, 2015f) to optimize the LTM Program (e.g., to remove wells and/or monitoring parameters from the LTM Program) considering performance monitoring results.

The current groundwater monitoring program at WOD consists of the analysis of total and dissolved arsenic. Benzene was removed from the LTM program by the RPMs in June 2014 after concentrations were observed below the cleanup level for four consecutive events (Tetra Tech, 2015b). The most recent data from the October 2017 monitoring event is shown on Figure 3-2. Concentrations of arsenic are below the

cleanup level at the majority of the LTM monitoring wells. However, exceedances of arsenic remain above the cleanup goal in an isolated area on the western boundary of the site at monitoring wells 15-MW001 and WOD-MW002D. Temporal analytical data trend graphs for the COCs are provided in Appendix D. Arsenic concentrations in these two wells have fluctuated just above and below the cleanup level since monitoring began. While the arsenic exceedances in October 2017 (21 µg/L and 11 µg/L) are above the cleanup level established in the ROD (MCL of 10 µg/L), it is noted that these concentrations closely span the WFF representative background value of 17 µg/L (Tetra Tech, 2004a).

Based on recommendations from the 2017 Data Summary Report (Tetra Tech, 2018b) and agreed by the RPMs in January 2018, future sampling events at WOD will occur in spring 2020 and fall 2022. The frequency of sampling events after the fall 2022 event will be recommended in the respective LTM report and the next (third) FYR. The analytical data is presented in Appendix C. The LTM groundwater data collected since the previous FYR (i.e., March 2013 through October 2017) are provided in Table C-4. Frequency of detection information is summarized in Table C-5.

3.4.3 Site Inspection

The FYR inspection of WOD was conducted on July 10, 2018. The purpose of the inspection was to assess the monitoring well network and the protectiveness of the remedy. Appendix E contains the completed site inspection form and photograph log. No substantive issues were identified at WOD during the 5YR site inspection. The site is located within the controlled federal property of NASA WFF; both facility and site access are restricted and controlled. Groundwater at the site is not used or accessed other than for environmental monitoring. The inspector noted all wells are in good condition, except that the protective casing cover for well WOD-MW003R has rusted.

3.5 TECHNICAL ASSESSMENT

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

Question A Summary:

The review of documents, monitoring results, and site inspection indicate the final remedy, which includes biostimulation, LUCs, and LTM, is functioning as intended by the ROD. No signs of intrusion, invasive development of the site, or activities that would have violated the ICs were observed. In summary, the remedy is in place to successfully prevent exposure to the site-related contaminants.

Remedial Action Performance: LTM groundwater data indicate the concentrations of arsenic are below the cleanup level in most of the monitoring wells. Arsenic levels fluctuate closely above and below the cleanup level in two wells on the western portion of the site; however, the cleanup value of 10 µg/L is less than the background value of 17 µg/L. Benzene cleanup was demonstrated in 2014 when the analyte was removed from monitoring after its concentrations were below the cleanup level during four consecutive monitoring events.

System Operations/O&M: Site inspections and periodic sampling events indicate the LTM well network is intact.

Implementation of ICs and Other Measures: The LUCs responsible for the remedial action are functioning as intended. The WOD is identified on the base-wide GIS. The site inspection did not identify any exposure problems and found no damage to the LTM well network.

3.5.2 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.

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 FYR requirement.

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 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 or effect the protectiveness of the remedy at WOD.

Changes in Risk Assessment Methods: There have been several changes in EPA risk assessment methodology since the risk assessment in the Tetra Tech (2004c) *Supplemental RI Report;* although, none of the changes would impact the protectiveness of the remedy. Among these changes 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. 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 affects risks calculated for children and adolescents. However, there were no chemicals considered to act via a mutagenic mode of action detected in groundwater at WOD. Therefore, using the new guidance would not affect the results of the risk assessment for groundwater or the remedy for the site.

- 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.

- In 2014, EPA updated standard exposure factors for human health (EPA, 2014). For most chemicals the changes in exposure assumptions result in lower risks. However, the reduction in risks would not change the conclusions of the HHRA and the remedy for WOD would not change.

Changes in Exposure Pathways: 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). There have been no changes in land use at the WOD that would have resulted in new exposure pathways to human or ecological receptors or impact the protectiveness of the remedy.

Expected Progress Towards Meeting RAOs: The LUCs prevent exposure to and use of the WOD groundwater for hypothetical future resident use of shallow groundwater. LTM groundwater data indicate the concentrations of benzene in groundwater decreased until the concentrations were consistently below the cleanup goal. The concentrations of arsenic are also below the cleanup goal at the majority of the monitoring wells. Exceedances of the arsenic cleanup goal are at concentrations (11 to 21 µg/L) similar to background (17 µg/L) and are isolated to an area on the western boundary of the site.

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

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

No other information has been made available that calls into question the protectiveness of the remedial action.

3.6 ISSUES AND RECOMENDATIONS

No issues with the remedy for WOD were identified during this review. Based on the results of this FYR, no recommendations or follow-up actions are required for WOD at this time.

3.7 OTHER FINDINGS

During the FYR site inspection in July 2018, the protective casing cover for monitoring well WOD-MW003R was noted as needing replacement. This will be addressed during by the next monitoring event.

The October 2017 LTM data indicate that arsenic is below the cleanup level of 10 µg/L (MCL) in all but two monitoring wells, where the concentrations were 11 and 21 µg/L. Considering the background arsenic groundwater value for the facility is 17 µg/L, the arsenic cleanup value might be considered for revision via an Explanation of Significant Difference (ESD) to expedite site closeout.

3.8 PROTECTIVENESS STATEMENT

Protectiveness Statement(s)		
Operable Unit: WOD	*Protectiveness Determination:* Protective	*Planned Addendum Completion Date: NA*
Protectiveness Statement: The remedy at WOD is protective of human health and the environment.		

3.9 NEXT REVIEW

The next FYR report for the WFF is required five years from the completion date of this review.

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

AOC No.	AOC Name	Location	Status / 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***	***Closed Out under AAOC / 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 Dump	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***	***Closed Out under AAOC/ 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.
(none)	**Waste Oil Dump (WOD)**	**MB**	**Remedial Action Complete; Long-Term Monitoring / Site 16, Pits at end of Runway 17-35.**
(none)	Old Aviation Fuel Tank Farm	MB	Deferred to UST Program.
(none)	***Scrapyard***	***MB***	***Closed Out under AAOC / Building N-222.***
(none)	PCB Transformer Pad	MB	Closed Out under TSCA and CERCLA / N-161C.
(none)	***Photographic Tank***	***MB***	***Closed Out under AAOC/ M-15 Photo Tank, Building M-15.***
(none)	**Former Fire Training Area (FFTA)**	**MB**	**Remedial Action Complete; Long-Term Monitoring.**
(none)	Industrial/Sanitary Landfill	MB	Deferred to FUDS Program.

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

AOC No.	AOC Name	Location	Status / Alias
(none)	Construction Debris Landfill	MB	Deferred to FUDS Program.
(none)	***Pistol/Rifle Range***	***MB***	***Closed out under AAOC.***
(none)	***South End Disposal Area (SEDA)***	***WI***	***Closed Out under AAOC.***
(none)	***Area of Interest – 20 Transformer (AI-20)***	***WI***	***Closed Out under AAOC.***
(none)	***North Island Transformer***	**WI**	***Closed Out under AAOC***
(none)	**F-10A/F-10B – Paint Locker and Battery Shop**	**MB**	**Under investigation.**
(none)	**N-166 – Alcohol Storage Building**	**MB**	**Under investigation.**

Notes:
This table was adapted from Table 2-1 in the *Site Management Plan for Fiscal Years 2018 and 2019* (NASA, 2018).
Land parcel where the AOC is located: Main Base (MB), Mainland (ML), or Wallops Island (WI).
AAOC – Administrative Agreement On Consent
AOC – Area of Concern
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
FUDS – Formerly Utilized Defense Sites
USACE – U.S. Army Corps of Engineers
UST – Underground Storage Tank
TSCA – Toxic Substance Control Act
Bold, shaded entry indicates the AOC is considered a NASA Site with response actions under the AAOC (versus a FUDS lead by the USACE). ***Bold, Italicized, shaded entry indicates the AOC has been closed under the AAOC.***

TABLE 2-1
CHEMICALS OF CONCERN–FORMER FIRE TRAINING AREA
SECOND 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
Table/information adapted from *Record of Decision (ROD) for FFTA* (Tetra Tech, 2007a).
µg/L - microgram(s) per liter
DCE - dichloroethene
MCL - Maximum Contaminant Level
HI = [non-cancer] Hazard Index

TABLE 2-2
CHRONOLOGY OF EVENTS–FORMER FIRE TRAINING AREA
SECOND 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) / Feasibility Study (FS) Work Plan (Metcalf & Eddy, 1993)	March 1993
Remedial Investigation (RI) (Metcalf & Eddy, 1996)	1993-1994; 1996
Risk Assessment Update (Versar, 2000)	March 2000
Supplemental RI Work Plan (Tetra Tech, 2003a)	January 2003
Supplemental RI (Revised Final Supplemental RI Report dated 2004) (Tetra Tech, 2004b)	2000-2003; 2004
Feasibility Study (FS) (Tetra Tech, 2005a)	September 2005
Proposed Remedial Action Plan (PRAP) (Tetra Tech, 2007a)	January 2007
Record of Decision (ROD) (Tetra Tech, 2007c)	December 2007
Pilot Study Work Plan (Tetra Tech, 2008a)	November 2008
Land Use Control (LUC) Remedial Design (RD) (Tetra Tech, 2008c)	October 2008
Free Product Monitoring Plan (Tetra Tech, 2009a)	April 2009
Remedial Action Implementation (including Pilot Test)	2008-2010
Pilot Study Report (Tetra Tech, 2009b)	July 2009
Supplemental Sampling Report (Tetra Tech, 2010a and 2010b)	April-June 2010
Long-Term Monitoring (LTM) Plan (Tetra Tech, 2010c)	July 2010
Data Summary Report - June 2010 Groundwater Investigation (Tetra Tech, 2010d)	August 2010
Data Summary Report - September 2010 Groundwater Investigation (Tetra Tech, 2010f)	December 2010
2010 Annual LTM Report (Tetra Tech, 2011b)	November 2011
Remedial Action Completion Report (RACR) (Tetra Tech, 2011d)	December 2011
2011 Annual Groundwater Summary Report (Tetra Tech, 2012a)	May 2012
Data Summary Report - March 2012 Groundwater Monitoring (Tetra Tech, 2012c)	May 2012
LTM Plan – Revision 1 (Tetra Tech, 2012e)	July 2012
2012 Annual LTM Report (Tetra Tech, 2013a)	May 2013
First Five-Year Review (NASA, 2014)	2013; January 2014
LTM Plan – Revision 2 (Tetra Tech, 2014a)	February 2014
2013 Annual LTM Report (Tetra Tech, 2014c)	February 2014
Data Summary Report - March 2014 Groundwater Monitoring (Tetra Tech, 2014e)	June 2014
2014 Annual LTM Report (Tetra Tech, 2015a)	April 2015
Data Summary Report - March 2015 Groundwater Monitoring (Tetra Tech, 2015c)	May 2015
LTM Plan – Revision 3 (Tetra Tech, 2015e)	September 2015
Data Summary Report - December 2015 Groundwater Monitoring (Tetra Tech, 2016a)	February 2016
Work Plan – Groundwater Investigation for PFCs at FFTA (NASA, 2016)	October 2016
Letter Work Plan for Monitoring Well Installation at FFTA (Tetra Tech, 2016d)	August 2016
Data Summary Report - September 2016 Groundwater Monitoring (Tetra Tech, 2016e)	December 2016
Data Summary Report – Groundwater Investigation for PFAS at FFTA (Tetra Tech, 2017b)	May 2017
Data Summary Report – June 2017 Groundwater Sampling Event (NASA, 2017)	November 2017

Notes
LTM and enforcement of LUCs ongoing

TABLE 2-3
SUMMARY OF IMPLEMENTED INSTITUTIONAL CONTROLS–FORMER FIRE TRAINING AREA
SECOND FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed?	ICs Called for in the Decision Documents?	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater	Yes	Yes	FFTA	No use of groundwater as a source of drinking water is permitted until concentrations of hazardous substances in groundwater are at such levels to allow for unrestricted use and exposure.	*Remedial Design for LUCs at FFTA, NASA WFF, Wallops Island, Virginia.* (Tetra Tech, October 2008).
				No use of groundwater other than for environmental testing is permitted without an approved plan.	
				Construction and/or development of commercial or residential buildings is prohibited.	
				This is a controlled area undergoing Environmental Remediation. Any planned use or activity in this area must be approved by the Environmental Office, Code 250.	

Notes

UU/UE - Unlimited Use and unrestricted exposure

IC - Institutional Control

TABLE 3-1
CHEMICALS OF CONCERN (COCs) - WASTE OIL DUMP (WOD)
SECOND 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
Table/information adapted from *Record of Decision (ROD) for WOD* (Tetra Tech, 2008c).
µg/L - microgram(s) per liter

TABLE 3-2
CHRONOLOGY OF EVENTS - WASTE OIL DUMP
SECOND 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 (Tetra Tech, 2004c)	2003-2004
Chromium Speciation Study (NASA, 2004)	2004
Feasibility Study (FS) (Tetra Tech, 2005b)	October 2005
Proposed Remedial Action Plan (PRAP) (Tetra Tech, 2007b)	January 2007
Record of Decision (ROD) (Tetra Tech, 2008b)	March 2008
Land Use Control (LUC) Remedial Design (RD) (Tetra Tech, 2008d)	October 2008
Pilot Study Work Plan (Tetra Tech, 2008e)	November 2008
Pilot Study Biostimulation Injection Implementation (Tetra Tech, 2008e and 2009b)	December 2008
Remedial Action Work Plan (Tetra Tech, 2009d) (Note - Pilot Study Report appended to Remedial Action Work Plan)	September 2009
Full Biostimulation Injection Remedial Action Implementation	December 2009
Long-Term Monitoring (LTM) Plan (Tetra Tech, 2009e)	October 2009
Data Summary Report – 6-month Post-Injection Sampling Event (Tetra Tech, 2010e)	August 2010
Remedial Action Completion Report (Tetra Tech, 2011a)	April 2011
2010 Annual LTM Report (Tetra Tech, 2011c)	November 2011
2011 Annual LTM Report (Tetra Tech, 2012b)	July 2012
Data Summary Report - March 2012 Groundwater Monitoring Event (Tetra Tech, 2012d)	May 2012
LTM Plan – Revision 1 (Tetra Tech, 2012f)	July 2012
2012 Annual LTM Report (Tetra Tech, 2013b)	May 2013
First Five-Year Review (NASA, 2014)	2013; January 2014
Data Summary Report - March 2013 Groundwater Monitoring Event (Tetra Tech, 2013c)	June 2013
LTM Plan – Revision 2 (Tetra Tech, 2014b)	February 2014
2013 Annual LTM Report (Tetra Tech, 2014d)	February 2014
Data Summary Report - March 2014 Groundwater Monitoring Event (Tetra Tech, 2014f)	June 2014
2014 Annual LTM Report (Tetra Tech, 2015b)	April 2015
Data Summary Report - March 2015 Groundwater Monitoring Event (Tetra Tech, 2015d)	May 2015
LTM Plan – Revision 3 (Tetra Tech, 2015)	September 2015
2015 Annual LTM Report (Tetra Tech, 2016b)	April 2016
Data Summary Report - April 2016 Groundwater Monitoring Event (Tetra Tech, 2016c)	June 2016
2016 Annual LTM Report (Tetra Tech, 2017a)	February 2017
Data Summary Report – October 2017 Groundwater Sampling Event (Tetra Tech, 2018b)	March 2018

Notes
LTM and enforcement of LUCs ongoing

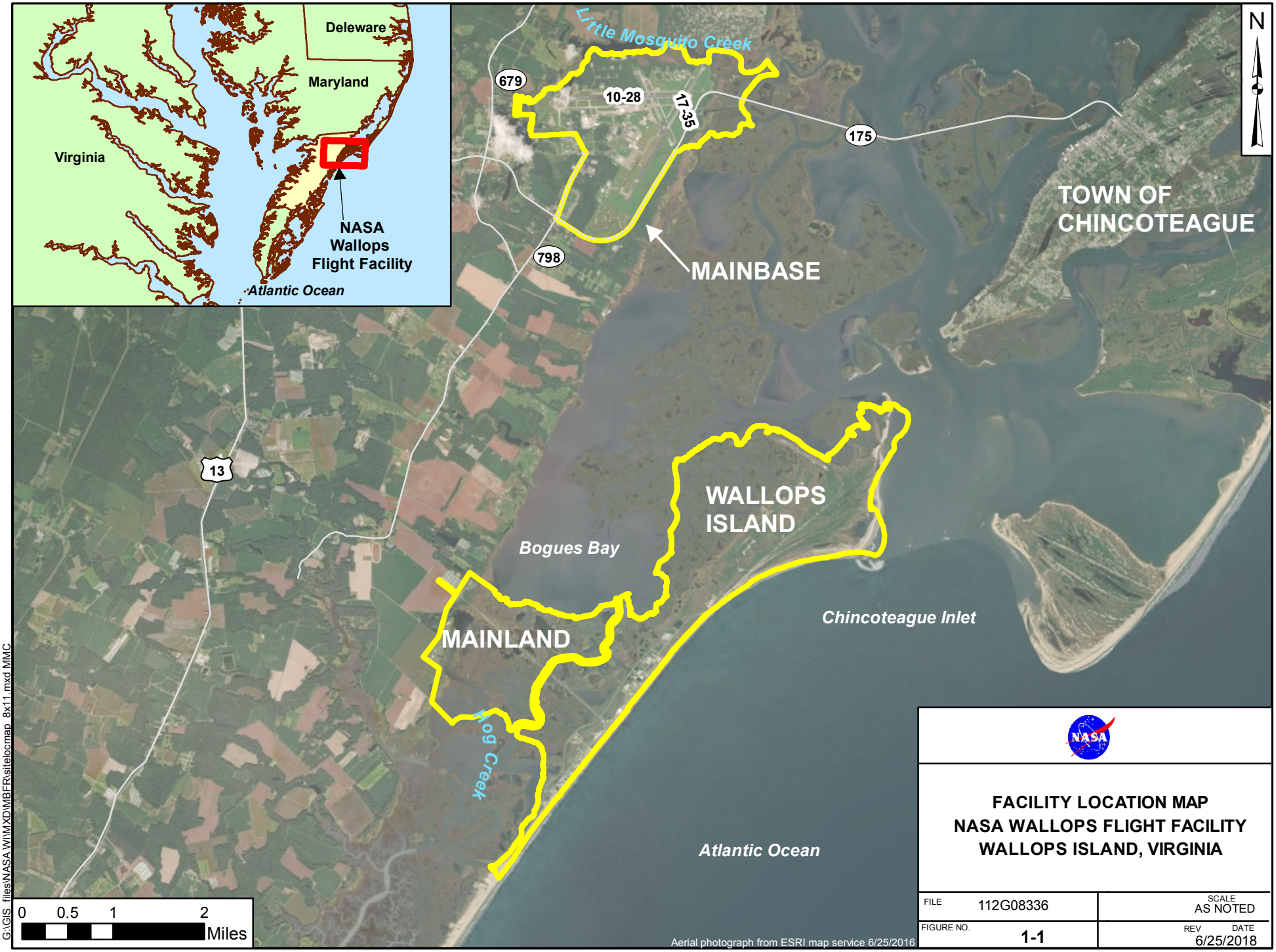
TABLE 3-3
SUMMARY OF IMPLEMENTED INSTITUTIONAL CONTROLS–WASTE OIL DUMP
SECOND FIVE-YEAR REVIEW
NASA WALLOPS FLIGHT FACILITY, WALLOPS ISLAND, VIRGINIA

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed?	ICs Called for in the Decision Documents?	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater	Yes	Yes	WOD	No use of groundwater as a source of drinking water is permitted until concentrations of hazardous substances in groundwater are at such levels to allow for unrestricted use and exposure.	*Remedial Design for LUCs at WOD, NASA WFF, Wallops Island, Virginia.* (Tetra Tech, October 2008).
				No use of groundwater other than for environmental testing is permitted without an approved plan.	
				Construction and/or development of commercial or residential buildings is prohibited.	
				This is a controlled area undergoing Environmental Remediation. Any planned use or activity in this area must be approved by the Environmental Office, Code 250.	

Notes

UU/UE - Unlimited Use and unrestricted exposure

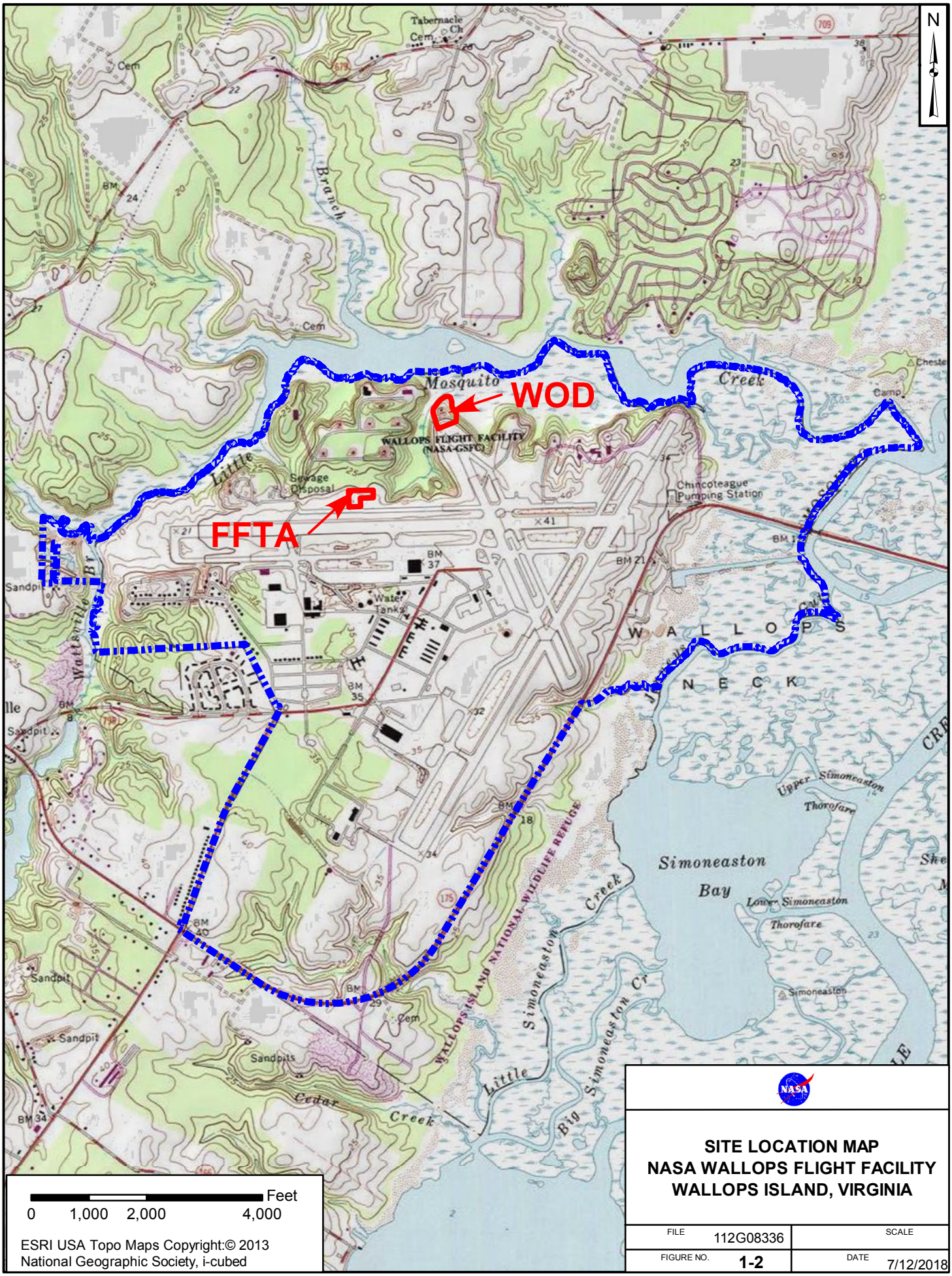
IC - Institutional Control

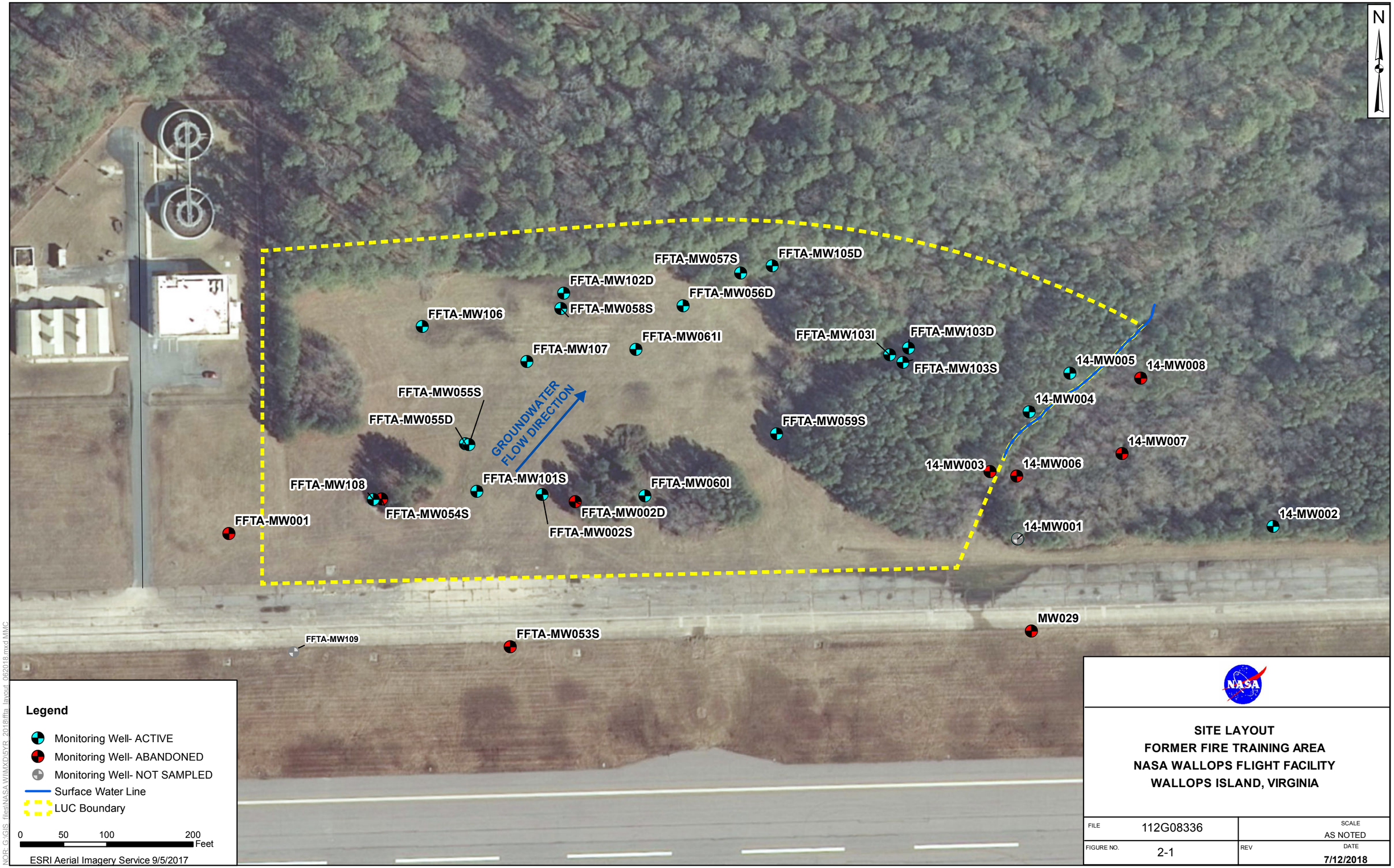


G:\GIS_files\NASA WI\MXD\MBFR\sitelocmap_8x11.mxd MMC

FACILITY LOCATION MAP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

FILE	112G08336	SCALE	AS NOTED
FIGURE NO.	1-1	REV DATE	6/25/2018

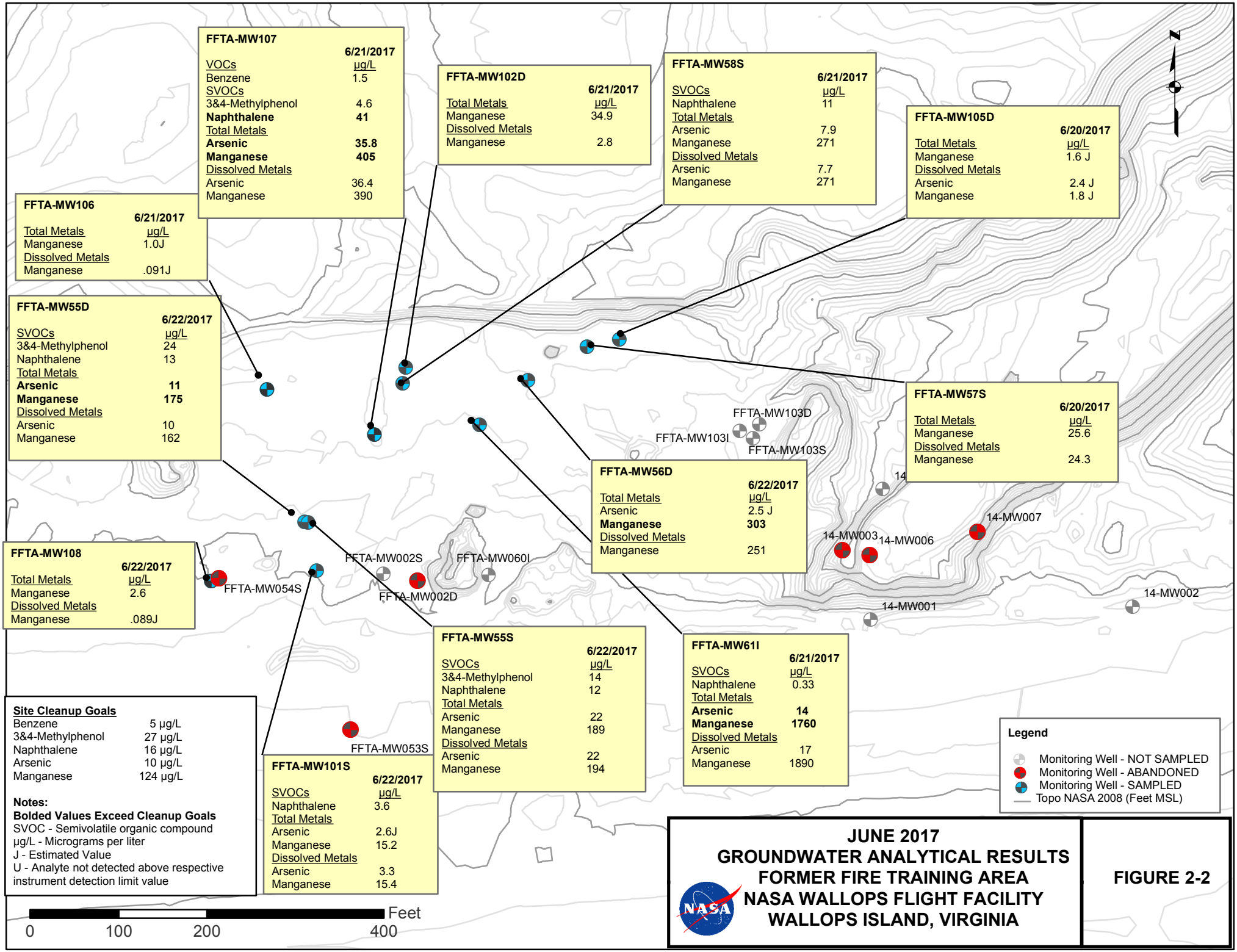

N
WOD
FFTA
WALLOPS FLIGHT FACILITY (NASA-GSFC)
Sewage Disposal
Chincoteague Pumping Station
Water Tanks
WALLOPS NECK
Mosquito Creek
Little Wattsville Br
Wattsville Br
Simoneaston Bay
Upper Simoneaston
Thorofare
Lower Simoneaston
Thorofare
Simoneaston Creek
Simoneaston Cr
Little Big Simoneaston Cr
Cedar Creek
WALLOPS ISLAND NATIONAL WILDLIFE REFUGE
Tabernacle Ch Cem
Cem
Sandpit
Sandpits
Camp
Simoneaston
Feet
0 1,000 2,000 4,000
ESRI USA Topo Maps Copyright:© 2013 National Geographic Society, i-cubed
SITE LOCATION MAP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA
FILE 112G08336
SCALE
FIGURE NO. 1-2
DATE 7/12/2018
Document Path: G:\GIS_files\NASA WIM\MXD\5YR_2018\site_loc_topo.mxd

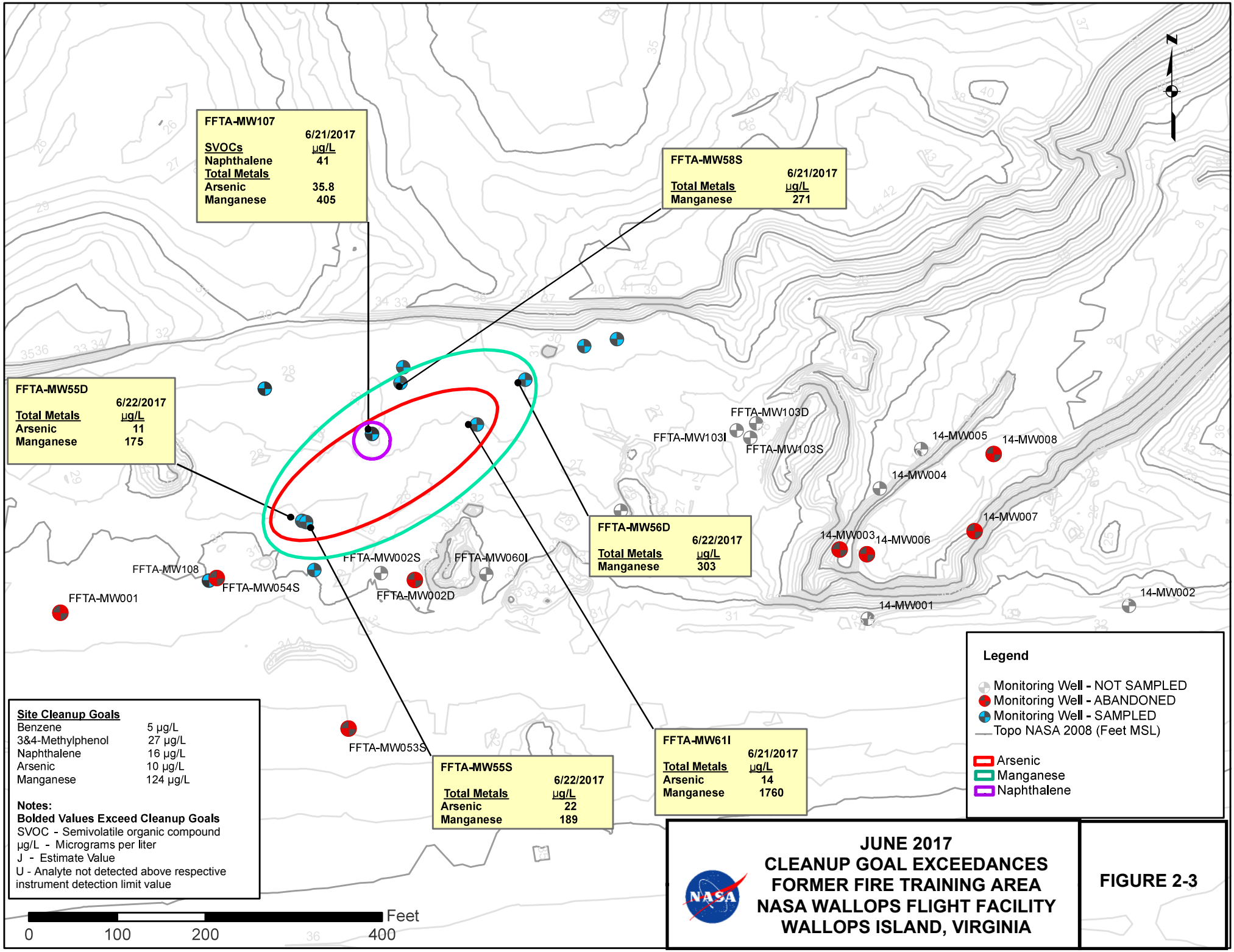


NOR: G:\GIS_files\NASA.WIMXD\SYR_2018\ffta_layout_062018.mxd MMC

SITE LAYOUT
FORMER FIRE TRAINING AREA
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

FILE	112G08336	SCALE	AS NOTED
FIGURE NO.	2-1	REV / DATE	**7/12/2018**


FFTA-MW107
6/21/2017
VOCs µg/L
Benzene 1.5
SVOCs
3&4-Methylphenol 4.6
Naphthalene 41
Total Metals
Arsenic 35.8
Manganese 405
Dissolved Metals
Arsenic 36.4
Manganese 390
FFTA-MW102D
6/21/2017
Total Metals µg/L
Manganese 34.9
Dissolved Metals
Manganese 2.8
FFTA-MW58S
6/21/2017
SVOCs µg/L
Naphthalene 11
Total Metals
Arsenic 7.9
Manganese 271
Dissolved Metals
Arsenic 7.7
Manganese 271
FFTA-MW105D
6/20/2017
Total Metals µg/L
Manganese 1.6 J
Dissolved Metals
Arsenic 2.4 J
Manganese 1.8 J
FFTA-MW106
6/21/2017
Total Metals µg/L
Manganese 1.0J
Dissolved Metals
Manganese .091J
FFTA-MW55D
6/22/2017
SVOCs µg/L
3&4-Methylphenol 24
Naphthalene 13
Total Metals
Arsenic 11
Manganese 175
Dissolved Metals
Arsenic 10
Manganese 162
FFTA-MW103D
FFTA-MW103I
FFTA-MW103S
FFTA-MW57S
6/20/2017
Total Metals µg/L
Manganese 25.6
Dissolved Metals
Manganese 24.3
FFTA-MW56D
6/22/2017
Total Metals µg/L
Arsenic 2.5 J
Manganese 303
Dissolved Metals
Manganese 251
14
14-MW007
14-MW003
14-MW006
FFTA-MW108
6/22/2017
Total Metals µg/L
Manganese 2.6
Dissolved Metals
Manganese .089J
FFTA-MW002S
FFTA-MW060I
FFTA-MW054S
FFTA-MW002D
14-MW001
14-MW002
FFTA-MW55S
6/22/2017
SVOCs µg/L
3&4-Methylphenol 14
Naphthalene 12
Total Metals
Arsenic 22
Manganese 189
Dissolved Metals
Arsenic 22
Manganese 194
FFTA-MW61I
6/21/2017
SVOCs µg/L
Naphthalene 0.33
Total Metals
Arsenic 14
Manganese 1760
Dissolved Metals
Arsenic 17
Manganese 1890
FFTA-MW053S
FFTA-MW101S
6/22/2017
SVOCs µg/L
Naphthalene 3.6
Total Metals
Arsenic 2.6J
Manganese 15.2
Dissolved Metals
Arsenic 3.3
Manganese 15.4
Site Cleanup Goals
Benzene 5 µg/L
3&4-Methylphenol 27 µg/L
Naphthalene 16 µg/L
Arsenic 10 µg/L
Manganese 124 µg/L
Notes:
Bolded Values Exceed Cleanup Goals
SVOC - Semivolatile organic compound
µg/L - Micrograms per liter
J - Estimated Value
U - Analyte not detected above respective instrument detection limit value
Legend
Monitoring Well - NOT SAMPLED
Monitoring Well - ABANDONED
Monitoring Well - SAMPLED
Topo NASA 2008 (Feet MSL)
Feet
0
100
200
400
JUNE 2017
GROUNDWATER ANALYTICAL RESULTS
FORMER FIRE TRAINING AREA
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA
FIGURE 2-2


FFTA-MW107
6/21/2017
SVOCs µg/L
Naphthalene 41
Total Metals
Arsenic 35.8
Manganese 405
FFTA-MW58S
6/21/2017
Total Metals µg/L
Manganese 271
FFTA-MW55D
6/22/2017
Total Metals µg/L
Arsenic 11
Manganese 175
FFTA-MW56D
6/22/2017
Total Metals µg/L
Manganese 303
FFTA-MW55S
6/22/2017
Total Metals µg/L
Arsenic 22
Manganese 189
FFTA-MW61I
6/21/2017
Total Metals µg/L
Arsenic 14
Manganese 1760
FFTA-MW103D
FFTA-MW103I
FFTA-MW103S
14-MW005
14-MW008
14-MW004
14-MW007
14-MW003
14-MW006
14-MW001
14-MW002
FFTA-MW002S
FFTA-MW060I
FFTA-MW002D
FFTA-MW108
FFTA-MW054S
FFTA-MW001
FFTA-MW053S
Site Cleanup Goals
Benzene 5 µg/L
3&4-Methylphenol 27 µg/L
Naphthalene 16 µg/L
Arsenic 10 µg/L
Manganese 124 µg/L
Notes:
Bolded Values Exceed Cleanup Goals
SVOC - Semivolatile organic compound
µg/L - Micrograms per liter
J - Estimate Value
U - Analyte not detected above respective instrument detection limit value
Legend
Monitoring Well - NOT SAMPLED
Monitoring Well - ABANDONED
Monitoring Well - SAMPLED
Topo NASA 2008 (Feet MSL)
Arsenic
Manganese
Naphthalene
0 100 200 400 Feet
JUNE 2017
CLEANUP GOAL EXCEEDANCES
FORMER FIRE TRAINING AREA
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA
FIGURE 2-3

Legend

- Monitoring Well (Sampled for PFAS Groundwater Investigation)
- Monitoring Well (Not Sampled)
- Surface Water Line
- Topo NASA 2008 (Feet MSL)

ESRI Aerial Imagery 9/5/2017

N

FFTA-MW057S 12/1/16

PFAS	ng/L
PFOA	12
PFOS	35
PFBS	12

FFTA-MW105D 12/1/16

PFAS	ng/L
PFOA	17
PFOS	**170**
PFBS	4.8

FFTA-MW058S 12/1/16

PFAS	ng/L
PFOA	**520**
PFOS	**3,500**
PFBS	18

FFTA-MW056D 12/1/16

PFAS	ng/L
PFOA	**870**
PFOS	**24,000**
PFBS	110

FFTA-MW055S

	11/30/16	11/30/2016 DUPLICATE
PFAS	ng/L	ng/L
PFOA	2,700	2,800
PFOS	20,000	20,000
PFBS	25	26

FFTA-MW107 12/1/16

PFAS	ng/L
PFOA	**2,300**
PFOS	**10,000**
PFBS	40

FFTA-MW061I 12/1/16

PFAS	ng/L
PFOA	**780**
PFOS	**19,000**
PFBS	120

FFTA-MW103I 12/1/16

PFAS	ng/L
PFOA	**1,100**
PFOS	**23,000**
PFBS	300

FFTA-MW103S 12/1/16

PFAS	ng/L
PFOA	20
PFOS	**570**
PFBS	61

FFTA-MW055D 11/30/16

PFAS	ng/L
PFOA	**3,100**
PFOS	**18,000**
PFBS	8

FFTA-MW108 11/30/16

PFAS	ng/L
PFOA	**140**
PFOS	**490**
PFBS	2.7

FFTA-MW101S 11/30/16

PFAS	ng/L
PFOA	**3,600**
PFOS	**20,000**
PFBS	54

FFTA-MW002S 11/30/16

PFAS	ng/L
PFOA	**1,500**
PFOS	**10,000**
PFBS	52

FFTA-MW109 11/30/16

PFAS	ng/L
PFOA	**76**
PFOS	**7,000**
PFBS	1.2 J

FFTA-MW102D
FFTA-MW058S
FFTA-MW057S
FFTA-MW105D
FFTA-MW056D
FFTA-MW106
FFTA-MW107
FFTA-MW061I
FFTA-MW103I
FFTA-MW103D
FFTA-MW103S
14-MW005
14-MW004
FFTA-MW055D
FFTA-MW055S
FFTA-MW059S
FFTA-MW108
FFTA-MW101S
FFTA-MW002S
FFTA-MW060I
14-MW001
FFTA-MW109

Former Fire Training Pit Area

Former Fire Training Tank & Airplane Area

0 37.5 75 150 Feet

Comparison Criteria
USEPA drinking water Lifetime HA for PFOA, PFOS, and combined concentrations of PFOA and PFOS is 70 ng/L (May 2016)

USEPA RSL for tap water for PFBS is 400,000 ng/L (May 2018)

Bolded value indicates an exceedance of the comparison values

Only PFAS with comparison values are presented in this figure.

Notes:
HA - Health Advisory
J - Estimated Value
ng/L - Nanograms per liter
MSL- Mean sea level
PFAS - Per- and polyfluoroalkyl substances
PFBS - Perfluorobutanesulfonic Acid
PFOA - Perfluorooctanoic Acid
PFOS - Pefluorooctanesulfonic Acid
USEPA - U.S. Environmental Protection Agency
RSL - Regional Screening Level

PFAS ANALYTICAL RESULTS FOR GROUNDWATER NOVEMBER 30 AND DECEMBER 1, 2016 FORMER FIRE TRAINING AREA NASA WALLOPS FLIGHT FACILITY WALLOPS ISLAND, VIRGINIA

FILE	112G08336	SCALE	AS NOTED
FIGURE NO.	2-4	REV	DATE 8/31/2018

N:\DR_G\GIS_files\NASA,WIMXD\5YR_2018\ffta_tag_map_112616.mxd MMC

N

FFTA-MW104S

WOD-MW004-1

WOD-MW004-2

WOD-MW005

WOD-MW003

WOD-MW008

WOD-MW006

15-MW001

WOD-MW002S

WOD-MW002D

WOD-MW007

Groundwater Flow Direction

WOD-MW001

15-MW002

15-MW007

Mosquito Creek

15-MW003

WOD-MW003A

WOD-MW003R

15-MW004

15-MW005

15-MW006

Legend

- Monitoring Well- ACTIVE
- Monitoring Well- ABANDONED
- Surface Water
- Waste Oil Dump Boundary
- LUC Boundary

0 50 100 200 Feet

ESRI Aerial Imagery 9/5/2017

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

NASA

SITE LAYOUT MAP
WASTE OIL DUMP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

FILE	112G08336	SCALE	AS NOTED
FIGURE NO.	3-1	REV	DATE 7/12/2018

N

EFTA-MW104S

WOD-MW004-1

WOD-MW004-2

WOD-MW005

WOD-MW003

WOD-MW006

WOD-MW007

WOD-MW001

WOD-MW003A

15-MW001

15-MW002

15-MW003

15-MW004

15-MW005

WOD-MW008

	10/17/17
Metals	µg/L
Total Arsenic	2.3 U
Dissolved Arsenic	2.3 U

15-MW001

	10/17/17
Metals	µg/L
Total Arsenic	**21**
Dissolved Arsenic	21

WOD-MW002D

	10/17/17
Metals	µg/L
Total Arsenic	**11**
Dissolved Arsenic	9.4

WOD-MW002S

	10/17/17
Metals	µg/L
Total Arsenic	2.3 U
Dissolved Arsenic	2.3 U

15-MW002

	10/17/17
Metals	µg/L
Total Arsenic	5.5
Dissolved Arsenic	4.4 J

WOD-MW003R

	9/26/16
Metals	µg/L
Total Arsenic	2.3 U
Dissolved Arsenic	2.3 U

15-MW007

	10/17/17	10/17/17 DUP
Metals	µg/L	µg/L
Total Arsenic	6.4	5.6
Dissolved Arsenic	4.4 J	4.9 J

Site Cleanup Goals
Arsenic - 10 µg/L

BOLDED VALUES EXCEED CLEANUP GOALS

Notes:
DUP - Duplicate sample
msl - Mean sea level
µg/L - Micrograms per liter
J - Estimated Value
U - Analyte not detected above the respective instrument detection limit

Legend

- Monitoring Well- NOT SAMPLED
- Monitoring Well- ABANDONED
- Monitoring Well- SAMPLED
- Topo NASA 2008 (feet msl)
- Waste Oil Dump Boundary
- Arsenic Cleanup Goal Exceedance

0 37.5 75 150 Feet

NOR: G:\GIS_files\NASA WI\MXD\5YR_2018\wod_TAG_map_oct2017.mxd MMC

NASA

OCTOBER 2017
GROUNDWATER ANALYTICAL RESULTS
WASTE OIL DUMP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

FILE	112G08336	SCALE	AS NOTED
FIGURE NO.	3-2	REV / DATE	7/12/2018

APPENDIX A

REFERENCES

Ebasco (Ebasco Services, Inc.), 1990. *Final Report of Site Investigation, Wallops Flight Facility, Wallops Island, Virginia*. January.

EPA (United States Environmental Protection Agency), 1988. *Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites*. EPA/540/G-88-003, OSWER Directive 9283.1-2, Office of Emergency and Remedial Response, Washington, D.C. December.

EPA, 1991a. *OSWER (Office of Solid Waste and emergency Response) Directive 9355.0-30: Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*. April 22.

EPA, 1991b. *Risk Assessment Guidance for Superfund: Volume I (Human Health Evaluation Manual) Part B (Development of Risk-Based Preliminary Remediation Goals).* EPA/540/R-92/003. December.

EPA, 1995a. *Guidelines for Carcinogen Risk Assessment.* EPA/630/P-03/001F. March.

EPA, 1995b. *Land Use in the CERCLA Remedy Selection Process.* OSWER Directive No. 9355.7-04. May.

EPA, 2001a. *Comprehensive Five-Year Review Guidance.* EPA 540-R-01-007, OSWER No. 9355.7-03B-P, Office of Emergency and Remedial Response. June.

EPA, 2001b. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment*. EPA/540/R/99/005. OSWER 9285.7-02EP. September.

EPA, 2004. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part E, Supplemental Guidance for Dermal Risk Assessment), Final*. EPA/540/R/99/005, Office of Emergency and Remedial Response, Washington, D.C. July.

EPA, 2005. *Guidelines for Carcinogen Risk Assessment and Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*. EPA/630/R-03/003F. March.

EPA, 2009a. *Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual (Part F)*. OSWER 9285.7-82. January.

EPA, 2009b. *Five-Year Reviews, Frequently Asked Questions (FAQs) and Answers*. September.

EPA, 2011. *Recommended Evaluation of Institutional Controls: Supplement to "Comprehensive Five-Year Review Guidance"*. OSWER 9355.7-18. September.

EPA, 2012a. *Clarifying the Use of Protectiveness Determinations for CERCLA Five-Year Reviews*. OSWER 9200.2-111. September.

EPA, 2012b. *Assessing Protectiveness at Sites for Vapor Intrusion. Supplement to the "Comprehensive Five-Year Review Guidance"*. OSWER 9200.2-84. November.

EPA, 2012. *Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil* and *Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil*. OSWER Directive 9200.1-113. December.

EPA, 2014. *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*. OSWER 9200.1-120. February 6.

EPA, 2015. *ProUCL Version 5.1.002 User Guide.* EPA/600/R 07/041. October.

EPA, 2016. *Five-Year Review Recommended Template.* OLEM 9200.0-89. Amends Appendix E of EPA (2001a) Comprehensive Five-Year Review Guidance. Transmitted via memorandum from Office of Superfund Remediation and Technology Innovation. January 20.

EPA, 2017. *Regional Screening Levels for Chemical Contaminants at Superfund Sites*. https://www.epa.gov/risk/regional-screening-levels-rsls. November.

EPA, 2018. *Cleanups at Federal Facilities: Emerging Contaminants and Federal Facility Contaminants of Concern*. https://www.epa.gov/fedfac/emerging-contaminants-and-federal-facility-contaminants-concern. Accessed on July 3, 2018.

EPA and NASA (National Aeronautics and Space Administration), 2004. *Administrative Agreement on Consent (AAOC), United States Environmental Protection Agency Region 3 in the Matter of National Aeronautics and Space Administration Wallops Island, Virginia*. Docket Number: RCRA-03-2004-0201TH. September.

Metcalf & Eddy, 1992. *Site Investigation at Wallops Flight Facility, Wallops Island, Virginia. Final Report Revision*. August.

Metcalf & Eddy, 1993. *Fire Training Area Remedial Investigation/Feasibility Study Final Work Plan, Wallops Flight Facility Wallops Island, Virginia*. March.

Metcalf & Eddy, 1996. *Remedial Investigation for Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. February.

NASA (National Aeronautics and Space Administration), 1988. *Preliminary Assessment Report for Wallops Flight Facility, Wallops Island, Virginia*. April.

NASA, 2004. Letter Report–*Waste Oil Dump (WOD) Groundwater Sampling Results*. From Sue Fields to Michelle Price-Fay and Paul Herman. November.

NASA, 2014. *First Five-Year Review, NASA Wallops Flight Facility, Wallops Island, Virginia*. Finalized December 2013. Signed January 30.

NASA, 2016. *Work Plan Groundwater Investigation for Perfluorinated Compounds at Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. October.

NASA, 2017. *Data Summary Report, June 2017 Groundwater Monitoring Former Fire Training Area, Wallops Flight Facility, Wallops Island, Virginia*. November.

Occu-Health, 1999. *Environmental Resources Document, NASA Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Virginia*. October.

Tetra Tech, 2003a. *Work Plan for Supplemental Remedial Investigation Activities at the Former Fire Training Area and Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia.* January.

Tetra Tech, 2003b. *Community Involvement Plan for NASA Wallops Flight Facility, Wallops Island, Virginia*. March.

Tetra Tech, 2004a. *Background Soil and Groundwater Investigation Report for the Main Base, NASA Wallops Flight Facility, Wallops Island, Virginia*. Revised Final. July.

Tetra Tech, 2004b. *Supplemental Remedial Investigation for Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. Revised Final. May.

Tetra Tech, 2004c. *Supplemental Remedial Investigation for Waste Oil Dump Site, NASA Wallops Flight Facility, Wallops Island, Virginia.* Revised Final. December.

Tetra Tech, 2005a. *Feasibility Study for Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. September.

Tetra Tech, 2005b. *Feasibility Study for Waste Oil Dump Site, NASA Wallops Flight Facility, Wallops Island, Virginia*. October.

Tetra Tech, 2007a. *Proposed Remedial Action Plan, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. January.

Tetra Tech, 2007b. *Proposed Remedial Action Plan, Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. January.

Tetra Tech, 2007c. *Record of Decision, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. December.

Tetra Tech, 2008a. *Pilot Study Work Plan, Former Fire Training Area, NASA Wallops Flight Facility, Virginia*. February.

Tetra Tech, 2008b. *Record of Decision, Waste Oil Dump Site, NASA Wallops Flight Facility, Wallops Island, Virginia*. March.

Tetra Tech, 2008c. *Remedial Design for Land Use Controls, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. October.

Tetra Tech, 2008d. *Remedial Design for Land Use Controls, Waste Oil Dump Site, NASA Wallops Flight Facility, Wallops Island, Virginia*. October.

Tetra Tech, 2008e. *Pilot Study Work Plan, Waste Oil Dump, NASA Wallops Flight Facility, Virginia*. November.

Tetra Tech, 2009a. *Free Product Monitoring Plan, Former Fire Training Area Site, NASA Wallops Flight Facility, Wallops Island, Virginia*. April.

Tetra Tech, 2009b. *Pilot Study Report, Former Fire Training Area. NASA Wallops Flight Facility, Virginia*. July.

Tetra Tech, 2009c. *Supplemental Groundwater Sampling Letter Work Plan, Former Fire Training Area Site, NASA Wallops Flight Facility, Wallops Island, Virginia*. July

Tetra Tech, 2009d. *Remedial Action Work Plan, Waste Oil Dump Site, NASA Wallops Flight Facility, Virginia*. (Includes Pilot Study Report for Waste Oil Dump). September.

Tetra Tech, 2009e. *Long-Term Monitoring Plan, Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. October.

Tetra Tech, 2010a. *March 2010 Groundwater Investigation Activities, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. March.

Tetra Tech, 2010b. *Data Summary Report for Additional Groundwater Investigation at Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virgini*a. June.

Tetra Tech, 2010c. *Long-Term Monitoring Plan, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. July.

Tetra Tech, 2010d. *Data Summary Report for June 2010 Groundwater Investigation at Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. August.

Tetra Tech, 2010e. *Data Summary Report for 6-Month Post-Injection Sampling at Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. August.

Tetra Tech, 2010f. *Data Summary Report for September 2010 Groundwater Investigations at Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. December.

Tetra Tech, 2011a. *Remedial Action Completion Report, Waste Oil Dump Site, NASA Wallops Flight Facility, Virginia*. April.

Tetra Tech, 2011b. *Annual Groundwater Monitoring Report for Year 2010, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. November.

Tetra Tech, 2011c. *Annual Groundwater Monitoring Report for Year 2010, Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. November.

Tetra Tech. 2011d, *Remedial Action Completion Report, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. December.

Tetra Tech, 2012a. *Annual Groundwater Monitoring Report for Year 2011, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. May.

Tetra Tech, 2012b. *Annual Groundwater Monitoring Report for Year 2011, Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. July.

Tetra Tech, 2012c. *Data Summary Report for March 2012 Groundwater Monitoring at Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. May.

Tetra Tech, 2012d. *Data Summary Report for March 2012 Groundwater Monitoring at Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. May.

Tetra Tech, 2012e. *Long-Term Monitoring Plan–Rev 1, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. July

Tetra Tech, 2012f. *Long-Term Monitoring Plan–Rev 1, Waste Oil Dump Site, NASA Wallops Flight Facility, Virginia*. July.

Tetra Tech, 2013a. *Annual Groundwater Monitoring Report for Year 2012 for Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. May.

Tetra Tech, 2013b. *Annual Groundwater Monitoring Report for Year 2012 for Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. May.

Tetra Tech, 2013c. *Data Summary Report for March 2013 Groundwater Monitoring at Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. June.

Tetra Tech, 2014a. *Long-Term Monitoring Plan–Rev 2, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. February.

Tetra Tech, 2014b. *Long-Term Monitoring Plan–Rev 2, Waste Oil Dump Site, NASA Wallops Flight Facility, Virginia*. February.

Tetra Tech, 2014c. *Annual Groundwater Monitoring Report for Year 2013, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. February.

Tetra Tech, 2014d. *Annual Groundwater Monitoring Report for Year 2013, Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. February.

Tetra Tech, 2014e. *Data Summary Report for March 2014 Groundwater Monitoring for Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. June.

Tetra Tech, 2014f. *Data Summary Report for March 2014 Groundwater Monitoring for Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. June.

Tetra Tech, 2015a. *Annual Groundwater Monitoring Report for Year 2014, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. April.

Tetra Tech, 2015b. *Annual Groundwater Monitoring Report for Year 2014, Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. April.

Tetra Tech, 2015c. *Data Summary Report for March 2015 Groundwater Monitoring at Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. May.

Tetra Tech, 2015d. *Data Summary Report for March 2015 Groundwater Monitoring for Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. May.

Tetra Tech, 2015e. *Long-Term Monitoring Plan–Rev 3, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. September

Tetra Tech, 2015f. *Long-Term Monitoring Plan–Rev 3, Waste Oil Dump Site, NASA Wallops Flight Facility, Virginia*. September.

Tetra Tech, 2016a. *Data Summary Report December 2015 Groundwater Monitoring Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. February.

Tetra Tech, 2016b. *Annual Groundwater Monitoring Report for Year 2015 for Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. April.

Tetra Tech, 2016c. *Data Summary Report for April 2016 Groundwater Monitoring Activities at Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. June.

Tetra Tech, 2016d. *Letter Work Plan–Monitoring Well Installation, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. August 17.

Tetra Tech, 2016e. *Data Summary Report for September 2016 Groundwater Monitoring, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. December.

Tetra Tech, 2017a. *Annual Groundwater Monitoring Report for the Year 2016 for Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia*. February.

Tetra Tech, 2017b. *Final Data Summary Report, Groundwater Investigation for Per- and Polyfluoroalkyl Substances at Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. May.

Tetra Tech, 2017c. *Letter Work Plan Perimeter Well Monitoring and PFAS Sampling, NASA Wallops Flight Facility, Wallops Island, Virginia*. August.

Tetra Tech, 2017d. *PFAS Sampling Letter Report, NASA Wallops Flight Facility, Wallops Island, Virginia*. October.

Tetra Tech, 2017e. *Letter Work Plan Production Well Aquifer Testing, NASA Wallops Flight Facility, Wallops Island, Virginia*. October.

Tetra Tech, 2017f. *Data Summary Report for June 2017 Groundwater Monitoring, Former Fire Training Area, NASA Wallops Flight Facility, Wallops Island, Virginia*. November.

Tetra Tech, 2018a. *Final Site Management Plan for Fiscal Years 2018 and 2019, NASA Wallops Flight Facility, Wallops Island, Virginia*. March.

Tetra Tech, 2018b. *Data Summary Report for October 2017 Groundwater Monitoring Activities at Waste Oil Dump, NASA Wallops Flight Facility, Wallops Island, Virginia.* March.

Tetra Tech, 2018c. *Draft Data Summary Report, PFAS Perimeter Monitoring Well and Observation Well Installation and Sampling, NASA Wallops Flight Facility, Wallops Island, Virginia.* March.

Tetra Tech, 2018d. *Draft Preliminary Assessment and Site Investigation Work Plan for Per- and Polyfluoroalkyl Substances, NASA Wallops Flight Facility, Wallops Island, Virginia.* May.

USACE (United States Army Corps of Engineers), 2000. W*allops Flight Facility – Main Base – GIS-Based Historical Photographic Analysis. 1938–1940*. November.

Versar, 2000. *Risk Assessment Update Former Fire Training Area. Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Virginia*. March.

Versar, 2001. *Remedial Investigation/Feasibility Study Site 16 Waste Oil Dump Goddard Space Flight Center Wallops Flight Facility Wallops Island, Virginia*. March.

APPENDIX B

SITE INTERVIEWS

FIVE-YEAR REVIEW QUESTIONNAIRE

Facility:	NASA Wallops Flight Facility, Wallops Island, Virginia
EPA ID:	VA8800010763
Five-Year Review No.:	Five-Year Review No. 2 (Second); Year 2018
Site(s):	1. Former Fire Training Area (FFTA) 2. Waste Oil Dump (WOD)
Format:	Questionnaire / Email
Interviewee:	**Lorie Baker**
Agency/Title/etc:	**US EPA Region III/Project Manager**
Date:	**7/30/18**

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 notified the public and/or held public meetings at the appropriate points in the CERCLA process. They also held a public availability session to discuss the PFAS issue when it was discovered in the Town of Chincoteague municipal wells.

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

Generally, cleanup actions and investigations have not had an effect on the surrounding community. With the discovery of PFAS in the public wells, local stakeholders, such as the Town of Chincoteague and the VA Dept. of Health, have become more involved and are kept in the loop with respect to the PFAS investigation.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.
Other than the PFAS concern, which is really not a community concern because the drinking water was never above health advisory levels and is now non-detect for PFAS, EPA is not aware of any community concerns regarding the site or its 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.

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?

EPA is not aware of any intrusive activities being conducted at the site or uses of the site other than monitoring or maintenance.

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

TOC uses groundwater wells on the NASA facility and NASA also has public wells on the site. However, the TOC wells are not that close to the FFTA or the WOD

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. NASA and EPA meeting quarterly to discuss these and other 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?

While there is not an established cleanup level, there are health advisories established for PFOA and PFOS, both of which have been found in groundwater at the FFTA.

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 intended by the decision documents for FFTA and WOD.

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. However, at the FFTA, further action may be necessary once the PFAS investigation is completed and/or cleanup levels or MCLs are established for PFAS compounds.

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

The sites are well-managed by NASA. No further comments at this time.

FIVE-YEAR REVIEW QUESTIONNAIRE

Facility:	NASA Wallops Flight Facility, Wallops Island, Virginia
EPA ID:	VA8800010763
Five-Year Review No.:	Five-Year Review No. 2 (Second); Year 2018
Site(s):	1. Former Fire Training Area (FFTA) 2. Waste Oil Dump (WOD)
Format:	Questionnaire / Email
Interviewee:	**David Liu**
Agency/Title/etc:	**NASA WFF Project Coordinator**
Date:	**9/21/2018**

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.

NASA has solicited public comment from other site-related actions not associated with the FFTA or WOD [Action Memorandum for the Main Base Firing Range Complex had a public comment period, April 2016; Public Notice for removal action at NIT-1, NIT-7, NIT-14, and NIT-17, January 2016; Public notice for AI-20 removal action July 2015; Project 13 (Old WWTP), Project 15 (Sites 9, 14, and 15) Proposed Plan public comment period September 2016].

In coordination with EPA, Virginia DEQ, VDH, ATSDR, and other stakeholders, NASA has had several interactions with the public and media on actions related to PFAS at WFF (PFAS Public Information Session to discuss the sampling and results was held on June 17, 2017, Wallops Open House/Public Information Session August 20, 2018, and several local and Associated Press inquiries and interviews regarding PFAS). In addition, NASA issued fact sheets and provided PFAS updates on the Wallops website.

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

Site operations related to remediation of the FFTA and WOD have not affected the surrounding community. The presence of PFAS raised concern with the local residents and Town of Chincoteague officials and residents. NASA continues to monitor the drinking water and is implementing a facility-wide site investigation for PFAS.

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

There are no known community concerns regarding the sites. NASA is addressing concerns associated with PFAS.

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.

Wallops is a secure facility with 24-hr security and restricted access. No incidents have been reported.

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

No intrusive activities have been conducted at the two sites other than monitoring and maintenance. Land use controls are in place to prevent intrusive activities.

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

No. Land Use Controls are in place to prevent groundwater use at the 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.

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.

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

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 intended and the remedy is showing site improvements.

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.

LTM activities are completed by both on-site and off-site contractors Site inspections are completed and Land Use Controls are monitored by on-site contractors.

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.

For both the FFTA and the WOD sites, there has been a reduction in the number of monitoring wells and the frequency of the analyses.

Two revisions to the FFTA LTM were issued in the timeframe. Groundwater monitoring at the FFTA was reduced from 15 monitoring wells to 12, and the sampling frequency changed from semi-annual in 2013 to sampling every 9 months in 2018. These changes did not affect the protectiveness or effectiveness of the remedy.

Two revisions to the WOD LTM Plan were issued in the timeframe. Groundwater monitoring at the WOD was reduced from sampling 10 monitoring wells for benzene and arsenic semi-annually in 2013 to sampling from 7 monitoring wells for arsenic only twice every 5 years.

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?

The implemented remedy and monitoring frequency is adequate for both sites. Further action for PFAS at the FFTA may be necessary when regulatory criteria are available.

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

No additional comments.

APPENDIX C

ANALYTICAL DATA AND HISTORICAL INFORMATION

Tables:

C-1 LTM Data Summary Table–FFTA
C-2 2016 PFAS Data Summary Table–FFTA
C-3 Frequency of Detections–FFTA
C-4 LTM Data Summary Table–WOD
C-5 Frequency of Detections–WOD
C-6 Figures from Events Since Last Annual Report-FFTA
- March 2015 Event
- December 2015 Event
- September 2016 Event
- June 2017 Event

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION SAMPLE ID SAMPLE DATE SAMPLE CODE MATRIX	Range of Detected Concentrations During Remedial Investigation (µg/L)	Cleanup Level (µg/L)	FFTA-MW055D						
			FFTA-MW055D-20130320 20130320 NORMAL GW	FFTA-MW055D-20130905 20130905 NORMAL GW	FFTA-MW055D-20140318 20140318 NORMAL GW	FFTA-MW055D-20140924 20140924 NORMAL GW	FFTA-MW055D-20150318 20150318 NORMAL GW	FFTA-MW055D-20151202 20151202 NORMAL GW	FFTA-MW055D-20160927 20160927 NORMAL GW
VOLATILES (µg/L)									
BENZENE	0.26 – 7.49	5	0.11 U	0.25 U	0.25 U	0.11 U	0.11 U	0.26 U	0.26 U
CIS-1,2-DICHLOROETHENE	0.3 – 16	70	0.24 U	NA	NA	NA	0.24 U	NA	NA
SEMIVOLATILES (µg/L)									
3&4-METHYLPHENOL	0.37 – 140	27	1.5	16	10 U	NA	NA	5.4 U	0.46 U
4-METHYLPHENOL	0.37 – 140	27	NA	NA	NA	0.61 J	0.21 U	NA	NA
NAPHTHALENE	0.04 – 89	16	0.013 U	13	5 U	0.024 U	0.06 J	2.1 U	0.067 U
METALS (µg/L)									
ARSENIC	0.36 – 51.2	10	3.8	**12**	3.2 J	0.29 U	0.47 J	2.3 U	2.3 U
MANGANESE	0.812 – 4,100	124	50	65	31	30	29	9.32	15.8
DISSOLVED METALS (µg/L)									
ARSENIC	0.36 – 51.2	10	3.1	11	1.4 J	0.29 U	0.37 J	2.3 U	2.3 U
MANGANESE	0.812 – 4,100	124	57	66	23	29	31	7.88	15
FIELD (MG/L)									
ALKALINITY	NA	NA	10 <	10 <	10	NA	NA	NA	NA
DISSOLVED OXYGEN	NA	NA	5	0.1	4	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	2.19	0	6.54	NA	NA	NA	NA
FERROUS IRON	NA	NA	1	5	1	NA	NA	NA	NA
HYDROGEN SULFIDE	NA	NA	0	1.5	0	NA	NA	NA	NA
NITRATE	NA	NA	0	0	0	NA	NA	NA	NA
NITRITE	NA	NA	0	0	0	NA	NA	NA	NA
SALINITY (%)	NA	NA	NA	NA	0	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	14.1	20.89	10.82	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	0.72	0.072	0.076	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	224	-79	133	NA	NA	NA	NA
TURBIDITY (ntu)	NA	NA	1.4	0.41	5.35	NA	NA	NA	NA
PH (s.u.)	NA	NA	4.42	5.81	5.53	NA	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW055D			FFTA-MW055S				
SAMPLE ID	FFTA-MW55D-20170622	FFTA-MW55D-20170622-AVG	FFTA-MW55D-20170622-D	FFTA-MW055S-20130320	FFTA-MW055S-20130320-AVG	FFTA-MW055S-20130320-D	FFTA-MW055S-20130905	FFTA-MW055S-20130905-AVG
SAMPLE DATE	20170622	20170622	20170622	20130320	20130320	20130320	20130905	20130905
SAMPLE CODE	ORIG	AVG	DUP	ORIG	AVG	DUP	ORIG	AVG
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.26 U	0.26 U	0.26 U	0.19 J	0.21	0.23 J	0.42 J	0.47
CIS-1,2-DICHLOROETHENE	NA	NA	NA	0.26 J	0.19	0.24 U	NA	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	24	24	24	**50**	**55.5**	**61**	**44**	**44**
4-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	13	13.5	14	12	13.5	15	**46**	**46.5**
METALS (µg/L)								
ARSENIC	**11**	**12**	**13**	**23**	**22**	**21**	**24**	**23.5**
MANGANESE	**175**	**174**	**173**	**350**	**340**	**330**	**430**	**430**
DISSOLVED METALS (µg/L)								
ARSENIC	10	11	12	24	24.5	25	24	23
MANGANESE	162	165	168	370	375	380	410	405
FIELD (MG/L)								
ALKALINITY	NA	NA	NA	35	35	NA	12	12
DISSOLVED OXYGEN	NA	NA	NA	0.2	0.2	NA	2	2
DISSOLVED OXYGEN - HORIBA	NA	NA	NA	0.1	0.1	NA	1.78	1.78
FERROUS IRON	NA	NA	NA	2.6	2.6	NA	4.6	4.6
HYDROGEN SULFIDE	NA	NA	NA	0	0	NA	0.3	0.3
NITRATE	NA	NA	NA	0	0	NA	0	0
NITRITE	NA	NA	NA	0	0	NA	0	0
SALINITY (%)	NA	NA	NA	NA	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	NA	14.26	14.26	NA	18.23	18.23
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA	0.107	0.107	NA	0.058	0.058
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA	49	49	NA	-28	-28
TURBIDITY (ntu)	NA	NA	NA	2.95	2.95	NA	9.26	9.26
PH (s.u.)	NA	NA	NA	5.09	5.09	NA	5.68	5.68

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW055S							
SAMPLE ID	FFTA-MW055S-20130905-D	FFTA-MW055S-20140318	FFTA-MW055S-20140318-AVG	FFTA-MW055S-20140318-D	FFTA-MW055S-20140924	FFTA-MW055S-20140924-AVG	FFTA-MW055S-20140924-D	FFTA-MW055S-20150318
SAMPLE DATE	20130905	20140318	20140318	20140318	20140924	20140924	20140924	20150318
SAMPLE CODE	DUP	ORIG	AVG	DUP	ORIG	AVG	DUP	ORIG
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.52 J	0.5 J	0.485	0.47 J	0.31 J	0.31	0.31 J	0.28 J
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA	0.28 J
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	**44**	**49 J**	**49**	**49**	NA	NA	NA	NA
4-METHYLPHENOL	NA	NA	NA	NA	9.7	9.75	9.8	24
NAPHTHALENE	**47**	**44 J**	**44**	**44 J**	15	15	15	1.4 J
METALS (µg/L)								
ARSENIC	**23**	**28**	**27**	**26**	**16**	**16.5**	**17**	**26**
MANGANESE	**430**	**440**	**430**	**420**	**200**	**205**	**210**	**300**
DISSOLVED METALS (µg/L)								
ARSENIC	22	23	23	23	15	15.5	16	27
MANGANESE	400	410	410	410	210	210	210	320
FIELD (MG/L)								
ALKALINITY	NA	20	20	NA	NA	NA	NA	NA
DISSOLVED OXYGEN	NA	0.2	0.2	NA	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	0.31	0.31	NA	NA	NA	NA	NA
FERROUS IRON	NA	1.2	1.2	NA	NA	NA	NA	NA
HYDROGEN SULFIDE	NA	0	0	NA	NA	NA	NA	NA
NITRATE	NA	0	0	NA	NA	NA	NA	NA
NITRITE	NA	0	0	NA	NA	NA	NA	NA
SALINITY (%)	NA	0	0	NA	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	11.49	11.49	NA	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	0.179	0.179	NA	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	-39	-39	NA	NA	NA	NA	NA
TURBIDITY (ntu)	NA	0.69	0.69	NA	NA	NA	NA	NA
PH (s.u.)	NA	5.41	5.41	NA	NA	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW055S							
SAMPLE ID	FFTA-MW055S-20150318-AVG	FFTA-MW055S-20150318-D	FFTA-MW055S-20151202	FFTA-MW055S-20151202-AVG	FFTA-MW055S-20151202-D	FFTA-MW055S-20160927	FFTA-MW055S-20160927-AVG	FFTA-MW055S-20160927-D
SAMPLE DATE	20150318	20150318	20151202	20151202	20151202	20160927	20160927	20160927
SAMPLE CODE	AVG	DUP	ORIG	AVG	DUP	ORIG	AVG	DUP
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.285	0.29 J	0.26 U	0.235	0.34 J	0.26 U	0.26 U	0.26 U
CIS-1,2-DICHLOROETHENE	0.28	0.28 J	NA	NA	NA	NA	NA	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	NA	NA	15	17	19	**28 J**	23	18 J
4-METHYLPHENOL	21.5	19	NA	NA	NA	NA	NA	NA
NAPHTHALENE	1.17	0.94 J	**29 J**	**35**	**41 J**	**27 J**	**25.5**	**24 J**
METALS (µg/L)								
ARSENIC	**26.5**	**27**	**27.8**	**28.85**	**29.9**	**23**	**23.2**	**23.4**
MANGANESE	**300**	**300**	**294**	**303**	**312**	**270**	**265**	**260**
DISSOLVED METALS (µg/L)								
ARSENIC	27	27	25.3	26.7	28.1	22	21.5	21
MANGANESE	315	310	268	284	300	294	283.5	273
FIELD (MG/L)								
ALKALINITY	NA	NA	NA	NA	NA	NA	NA	NA
DISSOLVED OXYGEN	NA	NA	NA	NA	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	NA	NA	NA	NA	NA	NA
FERROUS IRON	NA	NA	NA	NA	NA	NA	NA	NA
HYDROGEN SULFIDE	NA	NA	NA	NA	NA	NA	NA	NA
NITRATE	NA	NA	NA	NA	NA	NA	NA	NA
NITRITE	NA	NA	NA	NA	NA	NA	NA	NA
SALINITY (%)	NA	NA	NA	NA	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	NA	NA	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA	NA	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA	NA	NA	NA	NA	NA
TURBIDITY (ntu)	NA	NA	NA	NA	NA	NA	NA	NA
PH (s.u.)	NA	NA	NA	NA	NA	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW055S	FFTA-MW056D						
SAMPLE ID	FFTA-MW55S-20170622	FFTA-MW056D-20130319	FFTA-MW056D-20130904	FFTA-MW056D-20140317	FFTA-MW056D-20140923	FFTA-MW056D-20150317	FFTA-MW056D-20151201	FFTA-MW056D-20160928
SAMPLE DATE	20170622	20130319	20130904	20140317	20140923	20150317	20151201	20160928
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.26 U	0.42 J	0.8 J	0.91 J	0.49 J	0.36 J	0.26 U	0.26 U
CIS-1,2-DICHLOROETHENE	NA	2.8	NA	NA	NA	1.9	NA	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	14 J-	0.099 U	2 U	9.6 U	NA	NA	5.6 U	0.44 U
4-METHYLPHENOL	NA	NA	NA	NA	0.21 U	0.22 U	NA	NA
NAPHTHALENE	12 J-	0.015 U	1 U	4.8 U	0.023 U	0.1 J	2.2 U	0.064 U
METALS (µg/L)								
ARSENIC	**22**	3.3	1.2 U	1.2 U	2.7	0.93 J	3.8 U	2.3 U
MANGANESE	**189**	**700**	**940**	**930**	**910**	**790**	**650**	**560**
DISSOLVED METALS (µg/L)								
ARSENIC	22	3.3	1.2 U	1.3 J	2.4	0.88 J	2.3 U	2.3 U
MANGANESE	194	710	950	920	850	780	644	520
FIELD (MG/L)								
ALKALINITY	NA	27	14	25	NA	NA	NA	NA
DISSOLVED OXYGEN	NA	1	1	0.8	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	1.6	0.55	0.43	NA	NA	NA	NA
FERROUS IRON	NA	0.2	0	0.2	NA	NA	NA	NA
HYDROGEN SULFIDE	NA	0	0	0	NA	NA	NA	NA
NITRATE	NA	0	0	0	NA	NA	NA	NA
NITRITE	NA	0	0	0	NA	NA	NA	NA
SALINITY (%)	NA	NA	NA	0	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	15.54	16.04	12.12	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	0.084	0.082	0.122	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	115	45	52	NA	NA	NA	NA
TURBIDITY (ntu)	NA	0.21	0.35	0.05	NA	NA	NA	NA
PH (s.u.)	NA	5.99	6	6.14	NA	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW056D	FFTA-MW057S						
SAMPLE ID	FFTA-MW56D-20170621	FFTA-MW057S-20130319	FFTA-MW057S-20130904	FFTA-MW057S-20140317	FFTA-MW057S-20140923	FFTA-MW057S-20150317	FFTA-MW057S-20151201	FFTA-MW057S-20160928
SAMPLE DATE	20170621	20130319	20130904	20140317	20140923	20150317	20151201	20160928
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.26 U	0.11 U	0.45 J	0.32 J	0.11 U	0.11 U	0.26 U	0.26 U
CIS-1,2-DICHLOROETHENE	NA	0.24 U	NA	NA	NA	0.24 U	NA	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	0.42 U	0.088 U	1.9 U	10 U	NA	NA	5.5 U	0.45 U
4-METHYLPHENOL	NA	NA	NA	NA	0.19 U	0.21 U	NA	NA
NAPHTHALENE	0.06 U	0.22	4.1 J	5.1 U	0.49	0.33	2.2 U	0.065 U
METALS (µg/L)								
ARSENIC	2.5 J	2.2	1.2 U	1.2 U	0.29 U	0.48 J	2.3 U	2.3 U
MANGANESE	**303**	20	**140**	**220**	**250**	**320**	**188**	**156**
DISSOLVED METALS (µg/L)								
ARSENIC	4 U	3.2	1.2 U	1.2 U	0.29 U	0.49 J	2.3 U	2.3 U
MANGANESE	251	7.1	130	160	250	280	181	153
FIELD (MG/L)								
ALKALINITY	NA	10 <	15	20	NA	NA	NA	NA
DISSOLVED OXYGEN	NA	5	1	2	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	5.08	0	1.53	NA	NA	NA	NA
FERROUS IRON	NA	0	0	0	NA	NA	NA	NA
HYDROGEN SULFIDE	NA	0	0.6	0	NA	NA	NA	NA
NITRATE	NA	0	0	0	NA	NA	NA	NA
NITRITE	NA	0	0	0	NA	NA	NA	NA
SALINITY (%)	NA	NA	NA	0	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	15.78	16.07	11.58	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	0.116	0.75	0.081	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	232	301	226	NA	NA	NA	NA
TURBIDITY (ntu)	NA	0.72	0.62	3.05	NA	NA	NA	NA
PH (s.u.)	NA	5.65	5.4	5.45	NA	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW057S	FFTA-MW058S						
SAMPLE ID	FFTA-MW57S-20170620	FFTA-MW058S-20130319	FFTA-MW058S-20130904	FFTA-MW058S-20140318	FFTA-MW058S-20140923	FFTA-MW058S-20150317	FFTA-MW058S-20151201	FFTA-MW058S-20160927
SAMPLE DATE	20170620	20130319	20130904	20140318	20140923	20150317	20151201	20160927
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.26 U	1.1	1.6 J	2.6 J	1.4	1.1	0.44 J	0.79 J
CIS-1,2-DICHLOROETHENE	NA	0.34 J	NA	NA	NA	0.24 U	NA	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	0.42 U	1	1.9 U	10 U	NA	NA	5.8 U	1.1 J
4-METHYLPHENOL	NA	NA	NA	NA	1.5	0.23 U	NA	NA
NAPHTHALENE	0.06 U	**21**	16	**40 J**	11	**17**	12	15
METALS (µg/L)								
ARSENIC	4 U	5.7	6.7 J	10	9.6	8.3	**13**	**17**
MANGANESE	25.6	**490**	**1100**	**1800**	**1000**	**1100**	**580**	**425**
DISSOLVED METALS (µg/L)								
ARSENIC	4 U	5.7	7.2 J	9.9 J	8.7	8.5	13	20
MANGANESE	24.3	510	1100	1700	1000	1100	553	420
FIELD (MG/L)								
ALKALINITY	NA	60	25	50	NA	NA	NA	NA
DISSOLVED OXYGEN	NA	1	0.4	0	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	0.88	0	0.55	NA	NA	NA	NA
FERROUS IRON	NA	2	0	3.2	NA	NA	NA	NA
HYDROGEN SULFIDE	NA	0	0	0	NA	NA	NA	NA
NITRATE	NA	0	0	0	NA	NA	NA	NA
NITRITE	NA	0	0	0	NA	NA	NA	NA
SALINITY (%)	NA	NA	NA	0.1	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	13.1	22.32	11.07	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	0.138	0.154	0.2	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	-55	66	-85	NA	NA	NA	NA
TURBIDITY (ntu)	NA	3.3	0.6	0.61	NA	NA	NA	NA
PH (s.u.)	NA	6.27	5.77	6.08	NA	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW058S	FFTA-MW061I						
SAMPLE ID	FFTA-MW58S-20170621	FFTA-MW061I-20130319	FFTA-MW061I-20130521	FFTA-MW061I-20130521-AVG	FFTA-MW061I-20130521-D	FFTA-MW061I-20130905	FFTA-MW061I-20140317	FFTA-MW061I-20140923
SAMPLE DATE	20170621	20130319	20130521	20130521	20130521	20130905	20140317	20140923
SAMPLE CODE	NORMAL	NORMAL	ORIG	AVG	DUP	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.26 U	1.3	NA	NA	NA	1.1 J	0.25 U	0.11 U
CIS-1,2-DICHLOROETHENE	NA	0.59 J	NA	NA	NA	NA	NA	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	0.42 U	0.087 U	NA	NA	NA	1.9 U	9.7 U	NA
4-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA	0.22 U
NAPHTHALENE	11	11	NA	NA	NA	6.8 J	4.9 U	0.41
METALS (µg/L)								
ARSENIC	7.9	**370**	6	6.15	6.3	**18**	**23**	9
MANGANESE	**271**	**1400**	**1700**	**1650**	**1600**	**1100**	**960**	**540**
DISSOLVED METALS (µg/L)								
ARSENIC	7.7	11	6.1	6.05	6	8.5 J	8.4 J	7.7
MANGANESE	271	1600	1600	1600	1600	1100	960	590
FIELD (MG/L)								
ALKALINITY	NA	32	NA	NA	NA	30	14	NA
DISSOLVED OXYGEN	NA	0	NA	NA	NA	0	0.05	NA
DISSOLVED OXYGEN - HORIBA	NA	0.41	NA	NA	NA	0	0.29	NA
FERROUS IRON	NA	3	NA	NA	NA	1.2	2.8	NA
HYDROGEN SULFIDE	NA	0	NA	NA	NA	0	0	NA
NITRATE	NA	0	NA	NA	NA	0	0	NA
NITRITE	NA	0	NA	NA	NA	0	0	NA
SALINITY (%)	NA	NA	NA	NA	NA	NA	0	NA
TEMPERATURE (deg C)	NA	14.5	NA	NA	NA	17.54	10.53	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	0.28	NA	NA	NA	0.096	0.117	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	-41	NA	NA	NA	40	-56	NA
TURBIDITY (ntu)	NA	0.84	NA	NA	NA	5.32	9.31	NA
PH (s.u.)	NA	6.2	NA	NA	NA	6.1	6.45	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW061I				FFTA-MW101S			
SAMPLE ID	FFTA-MW061I-20150317	FFTA-MW061I-20151201	FFTA-MW061I-20160928	FFTA-MW61I-20170621	FFTA-MW101S-20130320	FFTA-MW101S-20130905	FFTA-MW101S-20140318	FFTA-MW101S-20140924
SAMPLE DATE	20150317	20151201	20160928	20170621	20130320	20130905	20140318	20140924
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.11 U	0.26 U	0.26 U	0.26 U	0.11 U	0.25 U	0.25 U	0.11 U
CIS-1,2-DICHLOROETHENE	0.24 U	NA	NA	NA	0.24 U	NA	NA	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	NA	5.5 U	0.43 U	0.42 U	5.3	8.5 J	9.5 U	NA
4-METHYLPHENOL	0.22 U	NA	NA	NA	NA	NA	NA	0.21 U
NAPHTHALENE	0.22	2.2 U	0.32	0.33	13	**36**	11 J	0.023 U
METALS (µg/L)								
ARSENIC	7.5	5.9 U	3.5 J	**14**	5.4	**11**	2.1 J	0.29 U
MANGANESE	**740**	**664**	**508**	**1760**	15	35	11	0.92 J
DISSOLVED METALS (µg/L)								
ARSENIC	7	5 U	4.3 J	17	6.3	9.9 J	2.1 J	0.29 U
MANGANESE	740	655	502	1890	16	34	12	1.1 J
FIELD (MG/L)								
ALKALINITY	NA	NA	NA	NA	12	15	14	NA
DISSOLVED OXYGEN	NA	NA	NA	NA	3	3	4	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	NA	NA	3.83	1.77	-1.02	NA
FERROUS IRON	NA	NA	NA	NA	2	1	1.3	NA
HYDROGEN SULFIDE	NA	NA	NA	NA	0	0.1	0	NA
NITRATE	NA	NA	NA	NA	0	0	0	NA
NITRITE	NA	NA	NA	NA	0	0	0	NA
SALINITY (%)	NA	NA	NA	NA	NA	NA	0	NA
TEMPERATURE (deg C)	NA	NA	NA	NA	13.99	23.9	13.82	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA	NA	0.103	0.088	0.102	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA	NA	82	152	77	NA
TURBIDITY (ntu)	NA	NA	NA	NA	0.44	2.52	0.09	NA
PH (s.u.)	NA	NA	NA	NA	4.82	5.52	5.71	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW101S				FFTA-MW102D			
SAMPLE ID	FFTA-MW101S-20150318	FFTA-MW101S-20151202	FFTA-MW101S-20160927	FFTA-MW101S-20170622	FFTA-MW102D-20130319	FFTA-MW102D-20130904	FFTA-MW102D-20140318	FFTA-MW102D-20140923
SAMPLE DATE	20150318	20151202	20160927	20170622	20130319	20130904	20140318	20140923
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.11 U	0.26 U	0.26 U	0.26 U	0.11 U	0.25 U	0.25 U	0.11 U
CIS-1,2-DICHLOROETHENE	0.24 U	NA	NA	NA	0.24 U	NA	NA	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	NA	6.2 U	0.49 U	0.42 U	0.094 U	1.9 U	9.8 U	NA
4-METHYLPHENOL	0.2 U	NA	NA	NA	NA	NA	NA	0.22 U
NAPHTHALENE	0.2	2.4 U	0.071 U	3.6	0.015 U	0.95 U	4.9 U	0.03 J
METALS (µg/L)								
ARSENIC	0.45 J	2.3 U	2.9 J	2.6 J	2.6	1.2 U	1.2 U	1.7
MANGANESE	0.77 U	2.5	4.41	15.2	5.8 B	7.9	2.7	2.4 J
DISSOLVED METALS (µg/L)								
ARSENIC	0.36 J	2.3 U	2.3 U	3.3 J	3.1	1.2 U	1.2 U	1.9
MANGANESE	1 U	1 U	4.75	15.4	2.2 B	1.6 J	1.6 J	0.97 J
FIELD (MG/L)								
ALKALINITY	NA	NA	NA	NA	10 <	14	10 <	NA
DISSOLVED OXYGEN	NA	NA	NA	NA	3	5	2	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	NA	NA	4.14	3.26	2.22	NA
FERROUS IRON	NA	NA	NA	NA	0.2	0.2	0	NA
HYDROGEN SULFIDE	NA	NA	NA	NA	0	0	0	NA
NITRATE	NA	NA	NA	NA	0	0	0	NA
NITRITE	NA	NA	NA	NA	0	0	0	NA
SALINITY (%)	NA	NA	NA	NA	NA	NA	0	NA
TEMPERATURE (deg C)	NA	NA	NA	NA	14.34	18.07	12.99	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA	NA	0.098	0.09	0.094	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA	NA	254	265	279	NA
TURBIDITY (ntu)	NA	NA	NA	NA	0.12	0.18	0	NA
PH (s.u.)	NA	NA	NA	NA	5.73	5.55	4.92	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW102D				FFTA-MW103D		FFTA-MW103I	
SAMPLE ID	FFTA-MW102D-20150317	FFTA-MW102D-20151201	FFTA-MW102D-20160927	FFTA-MW102D-20170621	FFTA-MW103D-20130320	FFTA-MW103D-20130904	FFTA-MW103I-20130320	FFTA-MW103I-20130904
SAMPLE DATE	20150317	20151201	20160927	20170621	20130320	20130904	20130320	20130904
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.11 U	0.26 U	0.26 U	0.26 U	0.11 U	0.25 U	0.11 U	0.25 U
CIS-1,2-DICHLOROETHENE	0.24 U	NA	NA	NA	0.41 J	NA	1.2	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	NA	5.4 U	0.43 U	0.42 U	0.085 U	1.9 U	0.085 U	1.9 U
4-METHYLPHENOL	0.22 U	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	0.024 U	2.1 U	0.062 U	0.06 U	0.013 U	0.95 U	0.013 U	0.96 U
METALS (µg/L)								
ARSENIC	0.29 U	2.3 U	2.3 U	4 U	1.5	1.2 U	1.9	1.2 U
MANGANESE	3 J	2.4	2.6	34.9	2.9 B	3.7	21	43
DISSOLVED METALS (µg/L)								
ARSENIC	0.29 U	2.3 U	2.3 U	4 U	3.2	1.2 U	3	1.2 U
MANGANESE	2.1 J	1.7 U	1.5 U	2.8	3.1 B	4.1	0.68 B	0.31 J
FIELD (MG/L)								
ALKALINITY	NA	NA	NA	NA	10 <	10 <	22	0
DISSOLVED OXYGEN	NA	NA	NA	NA	1	1.5	3	4
DISSOLVED OXYGEN - HORIBA	NA	NA	NA	NA	1.43	3.03	4.59	2.67
FERROUS IRON	NA	NA	NA	NA	0.2	0	0.2	0
HYDROGEN SULFIDE	NA	NA	NA	NA	0	0	0	0
NITRATE	NA	NA	NA	NA	0	0	0	0
NITRITE	NA	NA	NA	NA	0	0	0	0
SALINITY (%)	NA	NA	NA	NA	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	NA	NA	14.08	16.52	13.92	18.61
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA	NA	0.103	0.071	0.141	0.098
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA	NA	260	243	230	196
TURBIDITY (ntu)	NA	NA	NA	NA	0.25	0	0.7	0.3
PH (s.u.)	NA	NA	NA	NA	5.49	5.54	5.76	6.01

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW103S		FFTA-MW105D					
SAMPLE ID	FFTA-MW103S-20130320	FFTA-MW103S-20130904	FFTA-MW105D-20130319	FFTA-MW105D-20130904	FFTA-MW105D-20140317	FFTA-MW105D-20140923	FFTA-MW105D-20150317	FFTA-MW105D-20151201
SAMPLE DATE	20130320	20130904	20130319	20130904	20140317	20140923	20150317	20151201
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.11 U	0.25 U	0.11 U	0.25 U	0.25 U	0.11 U	0.11 U	0.26 U
CIS-1,2-DICHLOROETHENE	0.24 U	NA	0.24 U	NA	NA	NA	0.24 U	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	0.085 U	1.9 U	0.086 U	1.9 U	9.6 U	NA	NA	5.8 U
4-METHYLPHENOL	NA	NA	NA	NA	NA	0.2 U	0.22 U	NA
NAPHTHALENE	0.1 J	0.95 U	0.013 U	0.95 U	4.8 U	0.022 U	0.03 J	2.3 U
METALS (µg/L)								
ARSENIC	1.8	1.2 U	2.5	1.2 U	1.2 U	0.29 U	0.29 U	2.3 U
MANGANESE	0.5 B	1.1 J	1.6 B	1.3 J	1.6 J	1.4 J	1.2 U	2.2
DISSOLVED METALS (µg/L)								
ARSENIC	2.1	1.2 U	3.3	1.2 U	1.2 U	0.94 J	0.29 U	2.3 U
MANGANESE	0.59 B	0.89 J	1.4 B	2.8	7.5	1.2 J	1.2 U	1.7 U
FIELD (MG/L)								
ALKALINITY	15	0	10 <	10	10	NA	NA	NA
DISSOLVED OXYGEN	4	4	3	2	1	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	7.27	2.98	3.95	2.72	2.47	NA	NA	NA
FERROUS IRON	0.2	0	0.2	0	0	NA	NA	NA
HYDROGEN SULFIDE	0	0	0	0	0	NA	NA	NA
NITRATE	0	0	0	0	0	NA	NA	NA
NITRITE	0	0	0	0	0	NA	NA	NA
SALINITY (%)	NA	NA	NA	NA	0	NA	NA	NA
TEMPERATURE (deg C)	10.66	18.05	15.67	16.72	10.07	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	0.084	0.225	0.081	0.07	0.081	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	262	191	285	338	305	NA	NA	NA
TURBIDITY (ntu)	2.79	2.31	0.03	0.39	3.08	NA	NA	NA
PH (s.u.)	5.36	6.16	5.32	5.18	5.05	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW105D		FFTA-MW106					
SAMPLE ID	FFTA-MW105D-20160928	FFTA-MW105D-20170620	FFTA-MW106-20130320	FFTA-MW106-20130904	FFTA-MW106-20140317	FFTA-MW106-20140923	FFTA-MW106-20150317	FFTA-MW106-20151201
SAMPLE DATE	20160928	20170620	20130320	20130904	20140317	20140923	20150317	20151201
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.26 U	0.26 U	0.11 U	0.25 U	0.25 U	0.11 U	0.11 U	0.26 U
CIS-1,2-DICHLOROETHENE	NA	NA	0.24 U	NA	NA	NA	0.24 U	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	0.43 UJ	0.42 U	0.086 U	1.9 U	10 U	NA	NA	6.2 U
4-METHYLPHENOL	NA	NA	NA	NA	NA	0.22 U	0.22 U	NA
NAPHTHALENE	0.063 UJ	0.06 U	0.013 U	0.95 U	5.1 U	0.024 U	0.024 U	2.4 U
METALS (µg/L)								
ARSENIC	2.3 U	4 U	1.3	1.2 U	1.2 U	1.6 U	0.29 U	2.3 U
MANGANESE	1.6 U	1.6 J	0.44 B	1 J	0.87 J	0.7 J	1.2 U	0.92 J
DISSOLVED METALS (µg/L)								
ARSENIC	2.3 U	2.4 J	2.4	1.2 U	1.2 U	1.5 U	0.29 U	2.3 U
MANGANESE	2.4	1.8 U	0.69 B	0.74 J	0.65 J	0.78 J	0.88 U	1 U
FIELD (MG/L)								
ALKALINITY	NA	NA	5	12	24	NA	NA	NA
DISSOLVED OXYGEN	NA	NA	8	7	8	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	6.2	9.14	10.25	NA	NA	NA
FERROUS IRON	NA	NA	0.6	0	0	NA	NA	NA
HYDROGEN SULFIDE	NA	NA	0	0.1	0	NA	NA	NA
NITRATE	NA	NA	0	0	0	NA	NA	NA
NITRITE	NA	NA	0	0	0	NA	NA	NA
SALINITY (%)	NA	NA	NA	NA	0	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	14.57	19.09	8.67	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	0.143	0.077	0.086	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	204	195	314	NA	NA	NA
TURBIDITY (ntu)	NA	NA	0.32	0.18	1.69	NA	NA	NA
PH (s.u.)	NA	NA	6.22	6.19	5.81	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW106		FFTA-MW107					
SAMPLE ID	FFTA-MW106-20160927	FFTA-MW106-20170621	FFTA-MW107-20130320	FFTA-MW107-20130905	FFTA-MW107-20140317	FFTA-MW107-20140923	FFTA-MW107-20150317	FFTA-MW107-20151201
SAMPLE DATE	20160927	20170621	20130320	20130905	20140317	20140923	20150317	20151201
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.26 U	0.26 U	**6.6**	4.7 J	3.5 J	**5.2**	3.3	2.7
CIS-1,2-DICHLOROETHENE	NA	NA	1.6	NA	NA	NA	0.24 U	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	0.44 U	0.42 U	7.1	7.9 J	11 U	NA	NA	9.2 J
4-METHYLPHENOL	NA	NA	NA	NA	NA	20	6	NA
NAPHTHALENE	0.063 U	0.06 U	**72**	**40**	**83**	**41**	**39**	**80**
METALS (µg/L)								
ARSENIC	2.3 U	4 U	**27**	**35**	**27**	**30**	**28**	**36.6**
MANGANESE	1.3 U	1 J	**520**	**500**	**620**	**510**	**490**	**407**
DISSOLVED METALS (µg/L)								
ARSENIC	2.3 U	4 U	26	35	25	26	26	38.3
MANGANESE	1.4 U	0.91 J	510	480	580	520	500	411
FIELD (MG/L)								
ALKALINITY	NA	NA	100	35	45	NA	NA	NA
DISSOLVED OXYGEN	NA	NA	0	0	0	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	0	0	0	NA	NA	NA
FERROUS IRON	NA	NA	7	2	2.2	NA	NA	NA
HYDROGEN SULFIDE	NA	NA	0	0	0	NA	NA	NA
NITRATE	NA	NA	0	0	0	NA	NA	NA
NITRITE	NA	NA	0	0	0	NA	NA	NA
SALINITY (%)	NA	NA	NA	NA	0.1	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	14.77	21.67	11.4	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	0.185	0.299	0.278	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	-121	-75	-116	NA	NA	NA
TURBIDITY (ntu)	NA	NA	3.85	0.52	0.37	NA	NA	NA
PH (s.u.)	NA	NA	6.48	6.35	6.45	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW107		FFTA-MW108					
SAMPLE ID	FFTA-MW107-20160927	FFTA-MW107-20170621	FFTA-MW108-20130320	FFTA-MW108-20130905	FFTA-MW108-20140318	FFTA-MW108-20140924	FFTA-MW108-20150318	FFTA-MW108-20151202
SAMPLE DATE	20160927	20170621	20130320	20130905	20140318	20140924	20150318	20151202
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	2.3	1.5	0.11 U	0.25 U	0.25 U	0.11 U	0.11 U	0.26 U
CIS-1,2-DICHLOROETHENE	NA	NA	0.24 U	NA	NA	NA	0.24 U	NA
SEMIVOLATILES (µg/L)								
3&4-METHYLPHENOL	4.6	4.6 J-	0.09 U	1.9 U	10 U	NA	NA	5.3 U
4-METHYLPHENOL	NA	NA	NA	NA	NA	0.23 U	0.21 U	NA
NAPHTHALENE	**66**	**41 J-**	0.014 U	0.97 U	5.1 U	0.025 U	0.023 U	2.1 U
METALS (µg/L)								
ARSENIC	**35.8**	**35.8**	3.3	1.2 U	1.2 U	0.29 U	0.29 U	2.3 U
MANGANESE	**515**	**405**	0.56 B	0.39 J	0.25 J	0.4 U	0.48 U	1.9 U
DISSOLVED METALS (µg/L)								
ARSENIC	41.6	36.4	3.2	1.2 U	1.2 U	0.29 U	0.29 U	2.3 U
MANGANESE	354	390	0.77 B	0.39 J	0.35 J	0.32 U	0.63 U	1.2 J
FIELD (MG/L)								
ALKALINITY	NA	NA	11	12	10 <	NA	NA	NA
DISSOLVED OXYGEN	NA	NA	2	6	4	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	6.9	4.55	4.5	NA	NA	NA
FERROUS IRON	NA	NA	0.2	0	0	NA	NA	NA
HYDROGEN SULFIDE	NA	NA	0	0	0	NA	NA	NA
NITRATE	NA	NA	0	0	0	NA	NA	NA
NITRITE	NA	NA	0	0	0	NA	NA	NA
SALINITY (%)	NA	NA	NA	NA	0	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	13.61	17.02	13.33	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	0.089	0.065	0.066	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	212	219	293	NA	NA	NA
TURBIDITY (ntu)	NA	NA	0.62	0.35	0	NA	NA	NA
PH (s.u.)	NA	NA	5.55	5.83	5.03	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-1
Data Summary Table - Long-Term Monitoring
Former Fire Training Area
Second Five-Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW108		
SAMPLE ID	FFTA-MW108-20160927	FFTA-MW108-20161130	FFTA-MW108-20170622
SAMPLE DATE	20160927	20161130	20170622
SAMPLE CODE	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW
VOLATILES (µg/L)			
BENZENE	0.26 U	NA	0.26 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA
SEMIVOLATILES (µg/L)			
3&4-METHYLPHENOL	0.42 U	NA	0.42 U
4-METHYLPHENOL	NA	NA	NA
NAPHTHALENE	0.061 U	NA	0.06 U
METALS (µg/L)			
ARSENIC	2.3 U	NA	4 U
MANGANESE	1.2 U	NA	2.6
DISSOLVED METALS (µg/L)			
ARSENIC	2.3 U	NA	4 U
MANGANESE	1.5 U	NA	0.89 J
FIELD (MG/L)			
ALKALINITY	NA	NA	NA
DISSOLVED OXYGEN	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	NA
FERROUS IRON	NA	NA	NA
HYDROGEN SULFIDE	NA	NA	NA
NITRATE	NA	NA	NA
NITRITE	NA	NA	NA
SALINITY (%)	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA
TURBIDITY (ntu)	NA	NA	NA
PH (s.u.)	NA	NA	NA

GW- groundwater
µg/L- micrograms per liter
mg/L- micrograms per liter

Notes:
1. Cleanup levels were defined for the COCs at the Former Fire Training Area in the ROD.
2. Shaded and **bolded** values indicate a result exceeding the appropriate cleanup level.

Table C-2
2016 PFAS Data Summary Table
Former Fire Training Area
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION SAMPLE ID SAMPLE DATE SAMPLE CODE MATRIX	PFAS Screening Value (ng/L)	FFTA-MW002S FFTA-MW002S-20161130 20161130 NORMAL GW	FFTA-MW055D FFTA-MW055D-20161130 20161130 NORMAL GW	FFTA-MW055S FFTA-MW055S-20161130 20161130 ORIG GW	 FFTA-MW055S-20161130-AVG 20161130 AVG GW
POLYFLUOROALKYL SUBSTANCES (NG/L)					
PENTADECAFLUOROOCTANOIC ACID (PFOA)	70	**1500**	**3100**	**2700**	**2750**
PERFLUOROBUTANESULFONIC ACID (PFBS)	400,000	52	8	25	25.5
PERFLUOROHEPTANOIC ACID (PFHPA)	NA	670	2600	3100	3150
PERFLUOROHEXANE SULFONATE (PFHxS)	NA	820	800	1700	1750
PERFLUORONONANOIC ACID (PFNA)	NA	340	3200	1200	1250
PERFLUOROOCTANESULFONIC ACID (PFOS)	70	**10000**	**18000**	**20000**	**20000**

ng/L- nanograms per liter
GW- groundwater

Notes:

1. The U.S. EPA has issued a Lifetime Health Advisory (LHA) of 70 ng/L for PFOA and PFOS in drinking water (individually or combined). The U.S. EPA Regional Screening Level for PFBS in tap water is 400,000 ng/L.
2. Shaded and **bolded** values indicate an exceedance of the appropriate EPA HA.

Table C-2
2016 PFAS Data Summary Table
Former Fire Training Area
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW055S	FFTA-MW056D	FFTA-MW057S	FFTA-MW058S	FFTA-MW061I
SAMPLE ID	FFTA-MW055S-20161130-20161130	FFTA-MW056D-20161201	FFTA-MW057S-20161201	FFTA-MW058S-20161201	FFTA-MW061I-20161201
SAMPLE DATE	DUP	20161201	20161201	20161201	20161201
SAMPLE CODE	GW	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX		GW	GW	GW	GW
POLYFLUOROALKYL SUBSTANCES (NG/L)					
PENTADECAFLUOROOCTANOIC ACID (PFOA)	**2800**	**870**	12	**520**	**780**
PERFLUOROBUTANESULFONIC ACID (PFBS)	26	110	12	18	120
PERFLUOROHEPTANOIC ACID (PFHPA)	3200	830	9.2	430	740
PERFLUOROHEXANE SULFONATE (PFHxS)	1800	1800	97	500	2000
PERFLUORONONANOIC ACID (PFNA)	1300	930	0.61 U	230	910
PERFLUOROOCTANESULFONIC ACID (PFOS)	**20000**	**24000**	35	**3500**	**19000**

ng/L- nanograms per liter
GW- groundwater

Notes:
1. The U.S. EPA has issued a Lifetime Health Advisory (LHA) of 70 ng/L for PFOA and PFOS in drinking water (individually or combined). The U.S. EPA Regional Screening Level for PFBS in tap water is 400,000 ng/L.
2. Shaded and **bolded** values indicate an exceedance of the appropriate EPA HA.

Table C-2
2016 PFAS Data Summary Table
Former Fire Training Area
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW101S	FFTA-MW103D	FFTA-MW103S	FFTA-MW105D	FFTA-MW107
SAMPLE ID	FFTA-MW101S-20161130	FFTA-MW103I-20161201	FFTA-MW103S-20161201	FFTA-MW105D-20161201	FFTA-MW107-20161201
SAMPLE DATE	20161130	20161201	20161201	20161201	20161201
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW
POLYFLUOROALKYL SUBSTANCES (NG/L)					
PENTADECAFLUOROOCTANOIC ACID (PFOA)	**3600**	**1100**	20	17	**2300**
PERFLUOROBUTANESULFONIC ACID (PFBS)	54	300	61	4.8	40
PERFLUOROHEPTANOIC ACID (PFHPA)	3900	1000	45	13	1500
PERFLUOROHEXANE SULFONATE (PFHxS)	2200	2700	440	63	1300
PERFLUORONONANOIC ACID (PFNA)	940	440	10	6.4	1100
PERFLUOROOCTANESULFONIC ACID (PFOS)	**20000**	**23000**	**570**	**170**	**10000**

ng/L- nanograms per liter
GW- groundwater

Notes:
1. The U.S. EPA has issued a Lifetime Health Advisory (LHA) of 70 ng/L for PFOA and PFOS in drinking water (individually or combined). The U.S. EPA Regional Screening Level for PFBS in tap water is 400,000 ng/L.
2. Shaded and **bolded** values indicate an exceedance of the appropriate EPA HA.

Table C-2
2016 PFAS Data Summary Table
Former Fire Training Area
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	FFTA-MW108	FFTA-MW109
SAMPLE ID	FFTA-MW108-20161130	FFTA-MW109-20161130
SAMPLE DATE	20161130	20161130
SAMPLE CODE	NORMAL	NORMAL
MATRIX	GW	GW
POLYFLUOROALKYL SUBSTANCES (NG/L)		
PENTADECAFLUOROOCTANOIC ACID (PFOA)	**140**	**76**
PERFLUOROBUTANESULFONIC ACID (PFBS)	2.7	1.2 J
PERFLUOROHEPTANOIC ACID (PFHPA)	110	44
PERFLUOROHEXANE SULFONATE (PFHxS)	110	26
PERFLUORONONANOIC ACID (PFNA)	67	79
PERFLUOROOCTANESULFONIC ACID (PFOS)	**490**	**7000**

ng/L- nanograms per liter
GW- groundwater

Notes:
1. The U.S. EPA has issued a Lifetime Health Advisory (LHA) of 70 ng/L for PFOA and PFOS in drinking water (individually or combined). The U.S. EPA Regional Screening Level for PFBS in tap water is 400,000 ng/L.
2. Shaded and **bolded** values indicate an exceedance of the appropriate EPA HA.

Table C-3
Frequency of Detections
Long Term Monitoring and PFAS Investigation
Former Fire Training Area
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

Chemical of Concern (COC)	Cleanup Level (µg/L)	Frequency of Detections	Total Criteria Exceedances [4]	Range of Detections
Volatile Organics (ug/L)				
BENZENE	5	30/102	2	0.19 - 6.6
CIS-1,2-DICHLOROETHENE	70	9/27	0	0.26 - 2.8
Semivolatile Organics (ug/L)				
3&4-METHYLPHENOL	27	18/78	4	1 - 61
4-METHYLPHENOL	27	6/24	0	0.61 - 24
NAPHTHALENE	16	46/102	16	0.03 - 83
Metals, Total (ug/L)				
ARSENIC	10	57/103	25	0.45 - 370
MANGANESE	124	88/103	48	0.25 - 1800
Metals, Dissolved (ug/L)				
ARSENIC	NA	58/103	--	0.36 - 41.6
MANGANESE	NA	83/103	--	0.31 - 1890
PFAS (ng/L)				
PENTADECAFLUOROOCTANOIC ACID (PFOA)	70 [(2)]	14/14	11	12 - 3600
PERFLUOROBUTANESULFONIC ACID (PFBS)	40000 [(2)]	14/14	0	1.2 - 300
PERFLUOROHEPTANOIC ACID (PFHPA)	NA	14/14	--	9.2 - 3900
PERFLUOROHEXANE SULFONATE	NA	14/14	--	26 - 2700
PERFLUORONONANOIC ACID (PFNA)	NA	13/14	--	6.4 - 3200
PERFLUOROOCTANESULFONIC ACID (PFOS)	70 [(2)]	14/14	13	35 - 24000

µg/L- micrograms per liter
PFAS- Perfluoroalkyl Substances
ng/L- nanograms per liter

1. PFAS are under initial investiation at the facility and are not COCs at this time.

2. US EPA Health Advisory (HA) for PFAS compounds in Drinking Water. No regulatory groundwater standards are currently in effect.

3. Frequency, number of exceedances, and range of detections were calculated for long term montiroing data from 2013-2017. PFAS frequency, exceedances, and range of detections were calcualted based on data from one sampling event (2016).

4. Criteria for VOCs, SVOCs, and Metals are ROD Cleanup Goals. PFAS criteria are EPA HAs.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	Range of Detected Concentrations During Remedial Investigation (µg/L)	Cleanup Level (µg/L)	15-MW001						
SAMPLE ID			15-MW001-20130319	15-MW001-20130903	15-MW001-20140319	15-MW001_20140922	15-MW001-20150316	15-MW001-20150923	15-MW001-20160412
SAMPLE DATE			20130319	20130903	20140319	20140922	20150316	20150923	20160412
SAMPLE CODE			NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX			GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)									
BENZENE	0.17 – 33	5	0.11 U	0.25 U	0.25 U	NA	NA	NA	NA
METALS (µg/L)									
ARSENIC	0.94 – 58	10	**11**	**13**	**11**	8 J	**12**	**15**	**18**
DISSOLVED METALS (µg/L)									
ARSENIC	0.94 – 58	10	11	11	10	9.8	11	14	17
FIELD (MG/L)									
DISSOLVED OXYGEN	NA	NA	1	0.1	0.4	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	0.59	0	0	NA	NA	NA	NA
SALINITY (%)	NA	NA	NA	NA	0.1	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	11.2	20.58	10.86	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	0.16	0.122	0.135	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	-32	175	4	NA	NA	NA	NA
TURBIDITY (ntu)	NA	NA	2.1	2.3	1.06	NA	NA	NA	NA
PH (s.u.)	NA	NA	5.99	5.55	5.79	NA	NA	NA	NA

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sample

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	15-MW001		15-MW002						
SAMPLE ID	15-MW001-20160926	15-MW001-20171017	15-MW002-20130319	15-MW002-20130903	15-MW002-20140319	15-MW002_20140922	15-MW002-20150316	15-MW002-20150923	15-MW002-20160412
SAMPLE DATE	20160926	20171017	20130319	20130903	20140319	20140922	20150316	20150923	20160412
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)									
BENZENE	NA	NA	0.11 U	0.25 U	0.25 U	NA	NA	NA	NA
METALS (µg/L)									
ARSENIC	**20**	**21**	1.9	5.1 J	2.8 J	3.2 J	1.6	4.3 J	5 U
DISSOLVED METALS (µg/L)									
ARSENIC	19	21	1.7	4.8 J	2.5 U	4	3.1	4 J	2.9 U
FIELD (MG/L)									
DISSOLVED OXYGEN	NA	NA	0.2	0.1	0.6	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	0.12	0	0	NA	NA	NA	NA
SALINITY (%)	NA	NA	NA	NA	0	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	10.8	20.41	8.31	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	0.125	0.093	0.085	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	64	260	19	NA	NA	NA	NA
TURBIDITY (ntu)	NA	NA	81.7	3.72	52.9	NA	NA	NA	NA
PH (s.u.)	NA	NA	4.53	5	5.55	NA	NA	NA	NA

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sampl

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	15-MW002		15-MW007					
SAMPLE ID	15-MW002-20160926	15-MW002-20171017	15-MW007-20130318	15-MW007-20130318-AVG	15-MW007-20130318-D	15-MW007-20130903	15-MW007-20130903-AVG	15-MW007-20130903-D
SAMPLE DATE	20160926	20171017	20130318	20130318	20130318	20130903	20130903	20130903
SAMPLE CODE	NORMAL	NORMAL	ORIG	AVG	DUP	ORIG	AVG	DUP
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	NA	NA	0.11 U	0.11 U	0.11 U	0.51 J	0.525	0.54 J
METALS (µg/L)								
ARSENIC	4.8 J	5.5	0.29 U	0.3275	0.51 J	3.3 J	3.05	2.8 J
DISSOLVED METALS (µg/L)								
ARSENIC	7	4.4 J	1.9	1.0225	0.29 U	3.2 J	3.05	2.9 J
FIELD (MG/L)								
DISSOLVED OXYGEN	NA	NA	0.4	0.4	NA	4	4	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	0.55	0.55	NA	5.09	5.09	NA
SALINITY (%)	NA	NA	NA	NA	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	12.67	12.67	NA	21.71	21.71	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	0.096	0.096	NA	0.074	0.074	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	101	101	NA	-122	-122	NA
TURBIDITY (ntu)	NA	NA	23.8	23.8	NA	3.02	3.02	NA
PH (s.u.)	NA	NA	4.61	4.61	NA	4.95	4.95	NA

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sampl

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	15-MW007							
SAMPLE ID	15-MW007-20140319	15-MW007-20140319-AVG	15-MW007-20140319-D	15-MW007_20140922	15-MW007_20140922-AVG	15-MW007_20140922-D	15-MW007-20150316	15-MW007-20150316-AVG
SAMPLE DATE	20140319	20140319	20140319	20140922	20140922	20140922	20150316	20150316
SAMPLE CODE	ORIG	AVG	DUP	ORIG	AVG	DUP	ORIG	AVG
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	0.5 J	0.48	0.46 J	NA	NA	NA	NA	NA
METALS (µg/L)								
ARSENIC	4.1 J	4.05	4 J	3.3 J	3.8	4.3 J	10	10
DISSOLVED METALS (µg/L)								
ARSENIC	3.3 U	3.35 U	3.4 U	1.7	2.3	2.9	9.1	9.1
FIELD (MG/L)								
DISSOLVED OXYGEN	0.3	0.3	NA	NA	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	0	0	NA	NA	NA	NA	NA	NA
SALINITY (%)	0	0	NA	NA	NA	NA	NA	NA
TEMPERATURE (deg C)	15.12	15.12	NA	NA	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	0.094	0.094	NA	NA	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	-5	-5	NA	NA	NA	NA	NA	NA
TURBIDITY (ntu)	4.31	4.31	NA	NA	NA	NA	NA	NA
PH (s.u.)	5.12	5.12	NA	NA	NA	NA	NA	NA

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sampl

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	15-MW007							
SAMPLE ID	15-MW007-20150316-D	15-MW007-20150923	15-MW007-20150923-AVG	15-MW007-20150923-D	15-MW007-20160412	15-MW007-20160412-AVG	15-MW007-20160412-D	15-MW007-20160926
SAMPLE DATE	20150316	20150923	20150923	20150923	20160412	20160412	20160412	20160926
SAMPLE CODE	DUP	ORIG	AVG	DUP	ORIG	AVG	DUP	ORIG
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	NA	NA	NA	NA	NA	NA	NA	NA
METALS (µg/L)								
ARSENIC	10	5.4	5.75	6.1	3.4 U	4.05	6.4	3.4 J
DISSOLVED METALS (µg/L)								
ARSENIC	9.1	5 J	5.2	5.4	3.9 U	4.1 U	4.3 U	3.6 J
FIELD (MG/L)								
DISSOLVED OXYGEN	NA	NA	NA	NA	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	NA	NA	NA	NA	NA	NA
SALINITY (%)	NA	NA	NA	NA	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	NA	NA	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA	NA	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA	NA	NA	NA	NA	NA
TURBIDITY (ntu)	NA	NA	NA	NA	NA	NA	NA	NA
PH (s.u.)	NA	NA	NA	NA	NA	NA	NA	NA

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sampl

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	15-MW007					WOD-MW001		WOD-MW002D
SAMPLE ID	15-MW007-20160926-AVG	15-MW007-20160926-D	15-MW007-20171017	15-MW007-20171017-AVG	15-MW007-20171017-D	WOD-MW001-20130318	WOD-MW001-20130904	WOD-MW002D-20130318
SAMPLE DATE	20160926	20160926	20171017	20171017	20171017	20130318	20130904	20130318
SAMPLE CODE	AVG	DUP	ORIG	AVG	DUP	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)								
BENZENE	NA	NA	NA	NA	NA	0.11 U	0.25 U	4.5
METALS (µg/L)								
ARSENIC	3.2	3 J	6.4	6	5.6	0.29 U	5 J	**13**
DISSOLVED METALS (µg/L)								
ARSENIC	4.9	6.2	4.4 J	4.65	4.9 J	0.29 U	1.2 U	9
FIELD (MG/L)								
DISSOLVED OXYGEN	NA	NA	NA	NA	NA	3	NA	0.1
DISSOLVED OXYGEN - HORIBA	NA	NA	NA	NA	NA	8.19	NA	0.01
SALINITY (%)	NA	NA	NA	NA	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	NA	NA	NA	12.58	NA	11.66
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA	NA	NA	0.232	NA	0.237
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA	NA	NA	271	NA	-34
TURBIDITY (ntu)	NA	NA	NA	NA	NA	0.62	NA	17.3
PH (s.u.)	NA	NA	NA	NA	NA	5.82	NA	6.25

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sampl

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	WOD-MW002D						
SAMPLE ID	WOD-MW002D-20130903	WOD-MW002D-20140319	WOD-MW002D-20140922	WOD-MW002D-20150316	WOD-MW002D-20150923	WOD-MW002D-20160411	WOD-MW002D-20160926
SAMPLE DATE	20130903	20140319	20140922	20150316	20150923	20160411	20160926
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)							
BENZENE	2 J	1.2 J	NA	NA	NA	NA	NA
METALS (µg/L)							
ARSENIC	**16**	**11**	9 J	9.1	**11**	**16**	**14**
DISSOLVED METALS (µg/L)							
ARSENIC	15	8.8 J	8.7	9.5	11	15	14
FIELD (MG/L)							
DISSOLVED OXYGEN	1 <	0.6	NA	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	0.2	0	NA	NA	NA	NA	NA
SALINITY (%)	NA	0	NA	NA	NA	NA	NA
TEMPERATURE (deg C)	21.68	13.05	NA	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	0.115	0.159	NA	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	-83	-33	NA	NA	NA	NA	NA
TURBIDITY (ntu)	7.58	24.6	NA	NA	NA	NA	NA
PH (s.u.)	6.05	6.23	NA	NA	NA	NA	NA

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sampl

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	WOD-MW002D	WOD-MW002S					
SAMPLE ID	WOD-MW002D-20171017	WOD-MW002S-20130318	WOD-MW002S-20130903	WOD-MW002S-20140319	WOD-MW002S_20140922	WOD-MW002S-20150316	WOD-MW002S-20150923
SAMPLE DATE	20171017	20130318	20130903	20140319	20140922	20150316	20150923
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)							
BENZENE	NA	0.11 U	0.25 U	0.25 U	NA	NA	NA
METALS (µg/L)							
ARSENIC	**11**	0.29 U	5.4 J	1.7 J	2.8 J	3.8	7.3
DISSOLVED METALS (µg/L)							
ARSENIC	9.4	2	4.4 J	1.3 U	6.6	2.3	5.5
FIELD (MG/L)							
DISSOLVED OXYGEN	NA	1	2	3	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	3.15	1.91	2.44	NA	NA	NA
SALINITY (%)	NA	NA	NA	0	NA	NA	NA
TEMPERATURE (deg C)	NA	10.52	19.2	11.62	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	0.313	0.141	0.244	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	9	-26	28	NA	NA	NA
TURBIDITY (ntu)	NA	4.03	19.2	17.76	NA	NA	NA
PH (s.u.)	NA	6.73	6.35	6.45	NA	NA	NA

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sampl

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	WOD-MW002S			WOD-MW003R			
SAMPLE ID	WOD-MW002S-20160412	WOD-MW002S-20160926	WOD-MW002S-20171017	WOD-MW003R-20130318	WOD-MW003R-20130903	WOD-MW003R-20140319	WOD-MW003R_20140922
SAMPLE DATE	20160412	20160926	20171017	20130318	20130903	20140319	20140922
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)							
BENZENE	NA	NA	NA	0.11 U	0.25 U	0.25 U	NA
METALS (µg/L)							
ARSENIC	3.8 U	2.9 J	2.3 U	1.2	1.2 U	1.2 U	0.29 UJ
DISSOLVED METALS (µg/L)							
ARSENIC	2.3 U	2.3 U	2.3 U	0.75 J	1.2 U	1.2 U	0.29 U
FIELD (MG/L)							
DISSOLVED OXYGEN	NA	NA	NA	10	6	6	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	NA	7.74	5.61	5.99	NA
SALINITY (%)	NA	NA	NA	NA	NA	0	NA
TEMPERATURE (deg C)	NA	NA	NA	13.09	22.49	14.6	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA	0.119	0.056	0.061	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA	354	173	208	NA
TURBIDITY (ntu)	NA	NA	NA	0.6	7.14	0.17	NA
PH (s.u.)	NA	NA	NA	6.26	6.01	5.8	NA

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sampl

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	WOD-MW003R				WOD-MW008		
SAMPLE ID	WOD-MW003R-20150316	WOD-MW003R-20150923	WOD-MW003R-20160926	WOD-MW003R-20171017	WOD-MW008-20130318	WOD-MW008-20130903	WOD-MW008-20140319
SAMPLE DATE	20150316	20150923	20160926	20171017	20130318	20130903	20140319
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)							
BENZENE	NA	NA	NA	NA	0.11 U	0.25 U	0.25 U
METALS (µg/L)							
ARSENIC	0.29 U	2.3 U	2.3 U	2.3 U	0.29 U	1.2 U	1.2 U
DISSOLVED METALS (µg/L)							
ARSENIC	0.34 J	2.3 U	2.3 U	2.3 U	0.29 U	1.2 U	1.2 U
FIELD (MG/L)							
DISSOLVED OXYGEN	NA	NA	NA	NA	2	7	5
DISSOLVED OXYGEN - HORIBA	NA	NA	NA	NA	7.69	6.65	5.43
SALINITY (%)	NA	NA	NA	NA	NA	NA	0
TEMPERATURE (deg C)	NA	NA	NA	NA	10.98	22.71	13.22
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA	NA	0.097	0.06	0.098
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA	NA	231	366	222
TURBIDITY (ntu)	NA	NA	NA	NA	0.15	1.7	2.98
PH (s.u.)	NA	NA	NA	NA	5.34	4.91	5.44

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sampl

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-4
Data Summary Table LTM
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

LOCATION	WOD-MW008					
SAMPLE ID	WOD-MW008-20140922	WOD-MW008-20150316	WOD-MW008-20150923	WOD-MW008-20160411	WOD-MW008-20160926	WOD-MW008-20171017
SAMPLE DATE	20140922	20150316	20150923	20160411	20160926	20171017
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW
VOLATILES (µg/L)						
BENZENE	NA	NA	NA	NA	NA	NA
METALS (µg/L)						
ARSENIC	0.29 UJ	0.34 J	2.3 U	2.3 U	2.3 U	2.3 U
DISSOLVED METALS (µg/L)						
ARSENIC	1.7	0.29 U	2.3 U	2.3 U	2.3 U	2.3 U
FIELD (MG/L)						
DISSOLVED OXYGEN	NA	NA	NA	NA	NA	NA
DISSOLVED OXYGEN - HORIBA	NA	NA	NA	NA	NA	NA
SALINITY (%)	NA	NA	NA	NA	NA	NA
TEMPERATURE (deg C)	NA	NA	NA	NA	NA	NA
SPECIFIC CONDUCTANCE (ms/cm)	NA	NA	NA	NA	NA	NA
OXIDATION REDUCTION POTENTIAL (mv)	NA	NA	NA	NA	NA	NA
TURBIDITY (ntu)	NA	NA	NA	NA	NA	NA
PH (s.u.)	NA	NA	NA	NA	NA	NA

µg/L- micrograms per liter
mg/L- miligrams per liter
GW- groundwater
J- estimated value
NA- not applicable
U- analyte not detected in the sampl

Notes:
1. Cleanup levels are defined in the 2008 Record of Decision (ROD).
2. Shadded and **bolded** values indicate exceedance of appropriate ROD cleanup levels.

Table C-5
Frequency of Detection Table
Waste Oil Dump
Second Five Year Review
NASA Wallops Flight Facility, Wallops Island, Virginia

Chemicl of Concern (COC)	Cleanup Level (µg/L)	Frequency of Detection	Total Cleanup Level Exceedances	Range of Detections
Volatile Organics (µg/L)				
BENZENE	5	5/23	0	0.46 - 4.5
Metals, Total (µg/L)				
ARSENIC	10	44/64	16	0.34 - 21
Metals, Dissolved (µg/L)				
ARSENIC	NA	40/64	--	0.34 - 21

µg/L- micrograms per liter
NA- not applicable

1. Frequency of detection, total number of cleanup level exceedances, and range of detections were calculated for LTM sampling conducted from 2013 to 2017.

N

FFTA-MW105D
FFTA-MW057S
13.48
FFTA-MW102D
FFTA-MW058S
14.50
FFTA-MW106
14.79
FFTA-MW056D
FFTA-MW107
14.78
14.26
FFTA-MW061I
FFTA-MW103D
FFTA-MW103I
FFTA-MW103S
14.94
14-MW005
9.67
14-MW008
14-MW004
9.68
FFTA-MW059S
15.01
FFTA-MW055S
FFTA-MW055D
15.08
15.08
14-MW007
14-MW006
14-MW003
FFTA-MW108
15.25
FFTA-MW101S
15.18
FFTA-MW002S
15.12
FFTA-MW060I
14.74
FFTA-MW054S
FFTA-MW002D
FFTA-MW001
14-MW001
FFTA-MW053S*

MSL- mean sea level
*- Well damaged (PVC broken)

Legend

- Monitoring Well-NOT SAMPLED
- Monitoring Well-ABANDONED
- Monitoring Well
- Surface Water Line
- Groundwater Flow
- Groundwater Contour (Feet MSL)
- Groundwater Contour Inferred (Feet MSL)
- Topo NASA 2008 (Feet MSL)

0 50 100 200 Feet

G:\GIS_files\NASA WI\MXD\FFTA\ffta_plmap_031715.mxd

TETRA TECH

SHALLOW AND INTERMEDIATE GROUNDWATER POTENTIOMETRIC MAP MARCH 17, 2015 FORMER FIRE TRAINING AREA NASA WALLOPS FLIGHT FACILITY WALLOPS ISLAND, VIRGINIA

FILE 112G06802	SCALE AS NOTED
FIGURE NO. 2-1	REV DATE 4/26/15

Legend

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

N

FFTA-MW107

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	6
Naphthalene	**39**
Total Metals	µg/L
Arsenic	**28**
Manganese	**490**

FFTA-MW58S

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	0.23 U
Naphthalene	**17**
Total Metals	µg/L
Arsenic	8.3
Manganese	**1,100**

FFTA-MW102D

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	0.22 U
Naphthalene	0.024 U
Total Metals	µg/L
Arsenic	0.29 U
Manganese	3 J

FFTA-MW61I

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	0.22U
Naphthalene	0.22
Total Metals	µg/L
Arsenic	7.5
Manganese	**740**

FFTA-MW57S

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	0.21 U
Naphthalene	0.33
Total Metals	µg/L
Arsenic	0.48 J
Manganese	**320**

FFTA-MW106

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	0.22 U
Naphthalene	0.024 U
Total Metals	µg/L
Arsenic	0.29 U
Manganese	1.2 U

FFTA-MW105D

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	0.22 U
Naphthalene	0.03 J
Total Metals	µg/L
Arsenic	0.29 U
Manganese	1.2 U

FFTA-MW55S

	3/15	3/15 DUP
SVOCs	µg/L	µg/L
3- and 4-Methylphenol	24	19
Naphthalene	1.4 J	0.94 J
Total Metals	µg/L	µg/L
Arsenic	**26**	**27**
Manganese	**300**	**300**

FFTA-MW55D

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	0.21 U
Naphthalene	0.06 J
Total Metals	µg/L
Arsenic	0.47 J
Manganese	29

FFTA-MW108

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	0.21 U
Naphthalene	0.023 U
Total Metals	µg/L
Arsenic	0.29 U
Manganese	0.48 U

FFTA-MW101S

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	0.2 U
Naphthalene	0.2
Total Metals	µg/L
Arsenic	0.45 J
Manganese	0.77 U

FFTA-MW56D

	3/15
SVOCs	µg/L
3- and 4-Methylphenol	0.22 U
Naphthalene	0.1 J
Total Metals	µg/L
Arsenic	0.93 J
Manganese	**790**

FFTA-MW103I
FFTA-MW103D
FFTA-MW103S
FFTA-MW059S
FFTA-MW054S
FFTA-MW002S
FFTA-MW002D
FFTA-MW060I
FFTA-MW053S
14-MW008
14-MW005
14-MW004
14-MW007
14-MW003
14-MW006
14-MW002
14-MW001
MW029

Site Cleanup Goals

Benzene -	5	µg/L
3 and 4- Methylphenol -	27	µg/L
Naphthalene -	16	µg/L
Arsenic -	10	µg/L
Manganese -	124	µg/L

Notes:
Bolded Values Exceed Cleanup Goals
SVOC - semi-volatile organic compound
µg/L - micrograms per liter water
J - Estimated Value
U - Analyte was not detected in the sample at a level greater than the instrument detection

0 100 200 400 Feet

G:\GIS_Files\NASA WI\MXD\FFTA\FFTA_gwres_TAG_exceedance_mar2015.MXD

DRAWN BY	DATE
MMC	5/4/15
CHECKED BY	DATE
REVISED BY	DATE
SCALE	AS NOTED

TETRA TECH

March 2015 Cleanup Goal Exceedance
Former Fire Training Area
NASA Wallops Flight Facility
Wallops Island, Virginia

CONTRACT NUMBER	112G06802
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO.	REV
3-2	0

N

FFTA-MW105D
13.24 FFTA-MW057S
FFTA-MW056D
FFTA-MW102D
FFTA-MW058S
14.11
FFTA-MW106
14.37
FFTA-MW107
14.37
13.91
FFTA-MW061I
FFTA-MW103D
FFTA-MW103I
FFTA-MW103S
14.31
9.03
14-MW005
14-MW008
14-MW004
10.07
14-MW007
14-MW006
14-MW003
14-MW001
FFTA-MW059S
14.52
FFTA-MW055S
FFTA-MW055D 14.67
14.66
FFTA-MW108
14.85
FFTA-MW054S
FFTA-MW101S
14.78
FFTA-MW002S
14.73
FFTA-MW002D
FFTA-MW060I
14.37
FFTA-MW001
FFTA-MW053S

MSL- mean sea level

Legend

- Monitoring Well-NOT SAMPLED
- Monitoring Well-ABANDONED
- Monitoring Well
- Surface Water Line
- Groundwater Flow
- Groundwater Contour (Feet MSL)
- Groundwater Contour Inferred (Feet MSL)
- Topo NASA 2008 (Feet MSL)

0 50 100 200 Feet

NOR: G:\GIS_files\NASA\MXD\FFTA\ffta_pot_map_120215.mxd MMC

TETRA TECH

SHALLOW AND INTERMEDIATE GROUNDWATER POTENTIOMETRIC MAP DECEMBER 1, 2015 FORMER FIRE TRAINING AREA NASA WALLOPS FLIGHT FACILITY WALLOPS ISLAND, VIRGINIA

FILE 112G07578	SCALE AS NOTED
FIGURE NO. 2-1	REV DATE 1/26/2016

N

FFTA-MW105D
FFTA-MW057S
14.10
FFTA-MW102D
FFTA-MW058S
14.99
FFTA-MW056D
FFTA-MW106
15.22
FFTA-MW061I
14.76
FFTA-MW107
15.22
FFTA-MW103D
FFTA-MW103I
FFTA-MW103S
14.98
14-MW005
8.43
14-MW008
14-MW004
DRY
15.48
FFTA-MW055S
FFTA-MW055D
15.47
FFTA-MW059S
15.26
14-MW007
14-MW006
14-MW003
FFTA-MW108
15.64
FFTA-MW101S
15.57
15.52
FFTA-MW002S
FFTA-MW002D
15.15
FFTA-MW060I
FFTA-MW054S
FFTA-MW001
14-MW001
FFTA-MW053S

14.5
15
15.5
14
13
12
11
10
9
8.5

Legend

- Monitoring Well-NOT SAMPLED
- Monitoring Well-ABANDONED
- Monitoring Well
- Surface Water Line
- Groundwater Flow
- Groundwater Contour (Feet MSL)
- Groundwater Contour Inferred (Feet MSL)
- Topo NASA 2008 (Feet MSL)

MSL- mean sea level

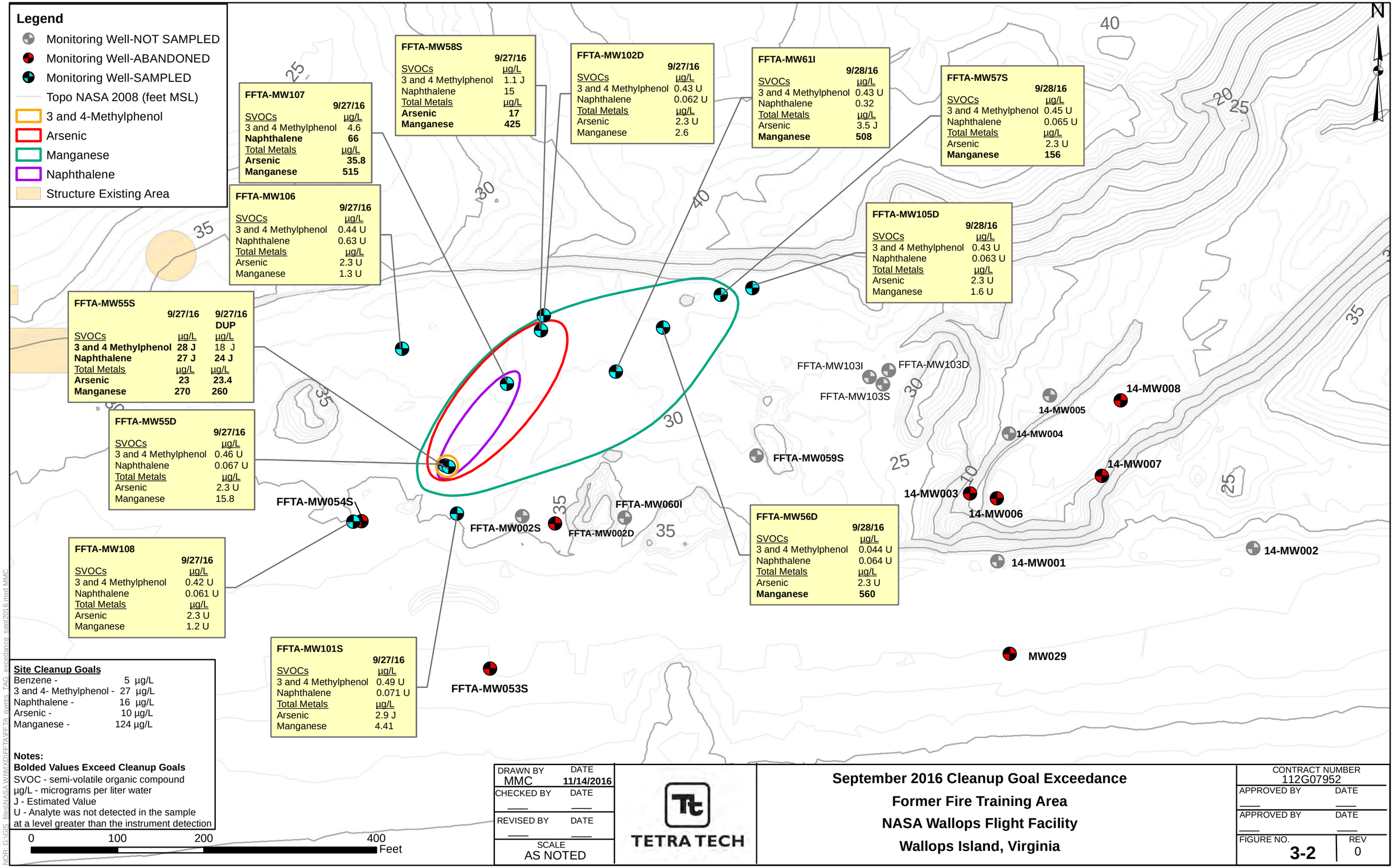
0 50 100 200 Feet

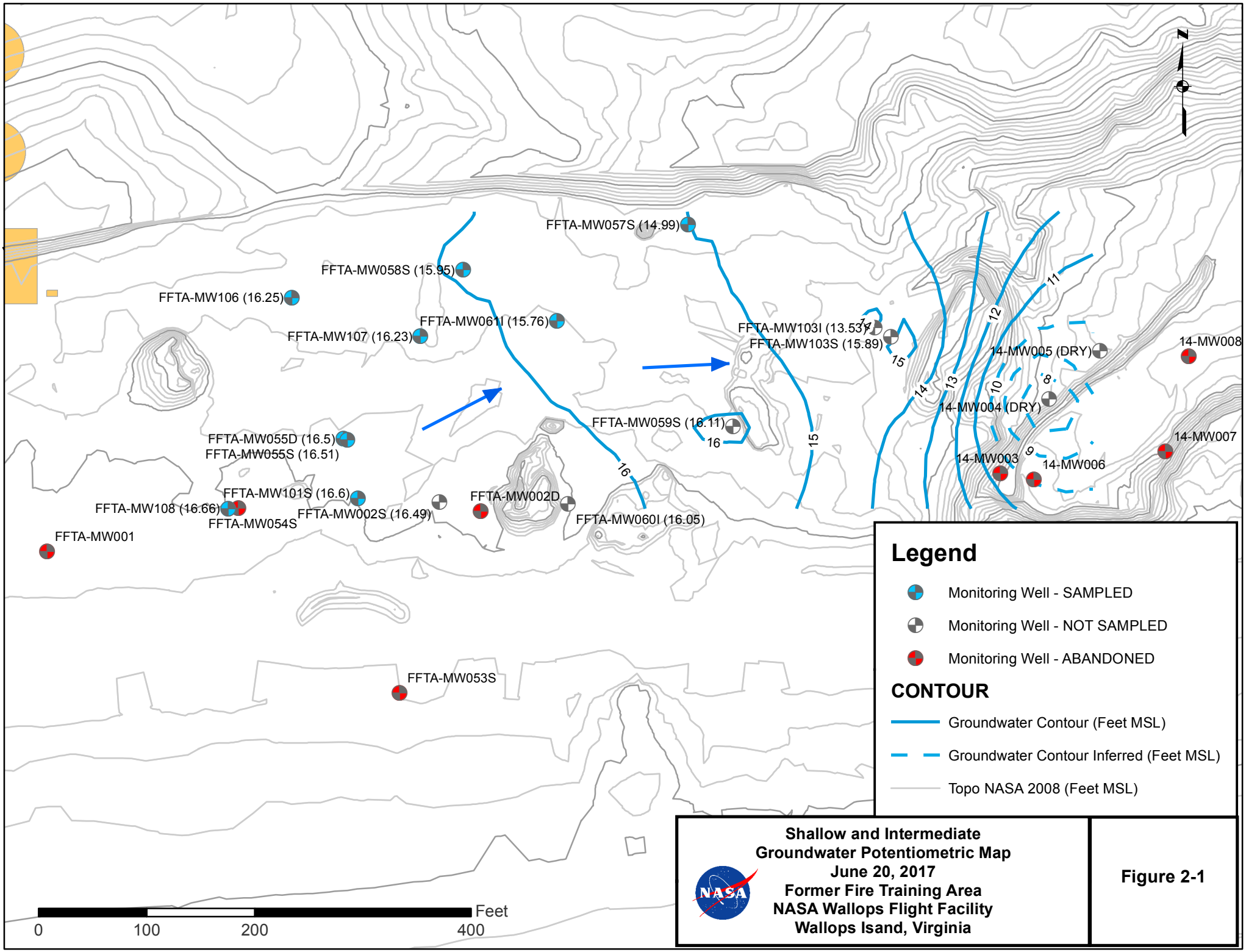
TETRA TECH

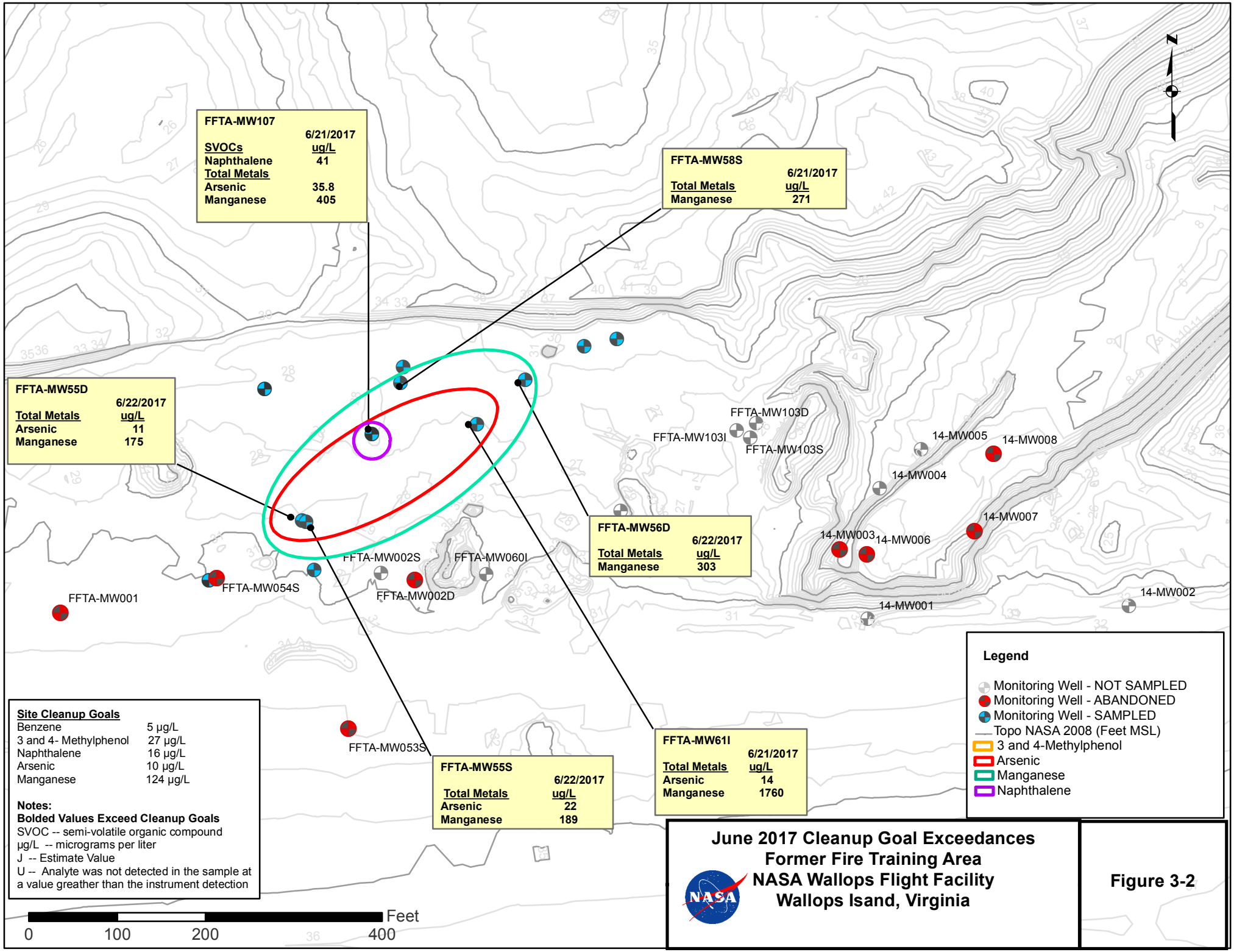
SHALLOW AND INTERMEDIATE GROUNDWATER POTENTIOMETRIC MAP SEPTEMBER 26, 2016 FORMER FIRE TRAINING AREA NASA WALLOPS FLIGHT FACILITY WALLOPS ISLAND, VIRGINIA

FILE	112G07578	SCALE	AS NOTED
FIGURE NO.	2-1	REV	DATE 11/22/2016

NOR: G:\GIS_files\NASA.WIMXD\FFTA\ffta_pot_map_092616.mxd MMC

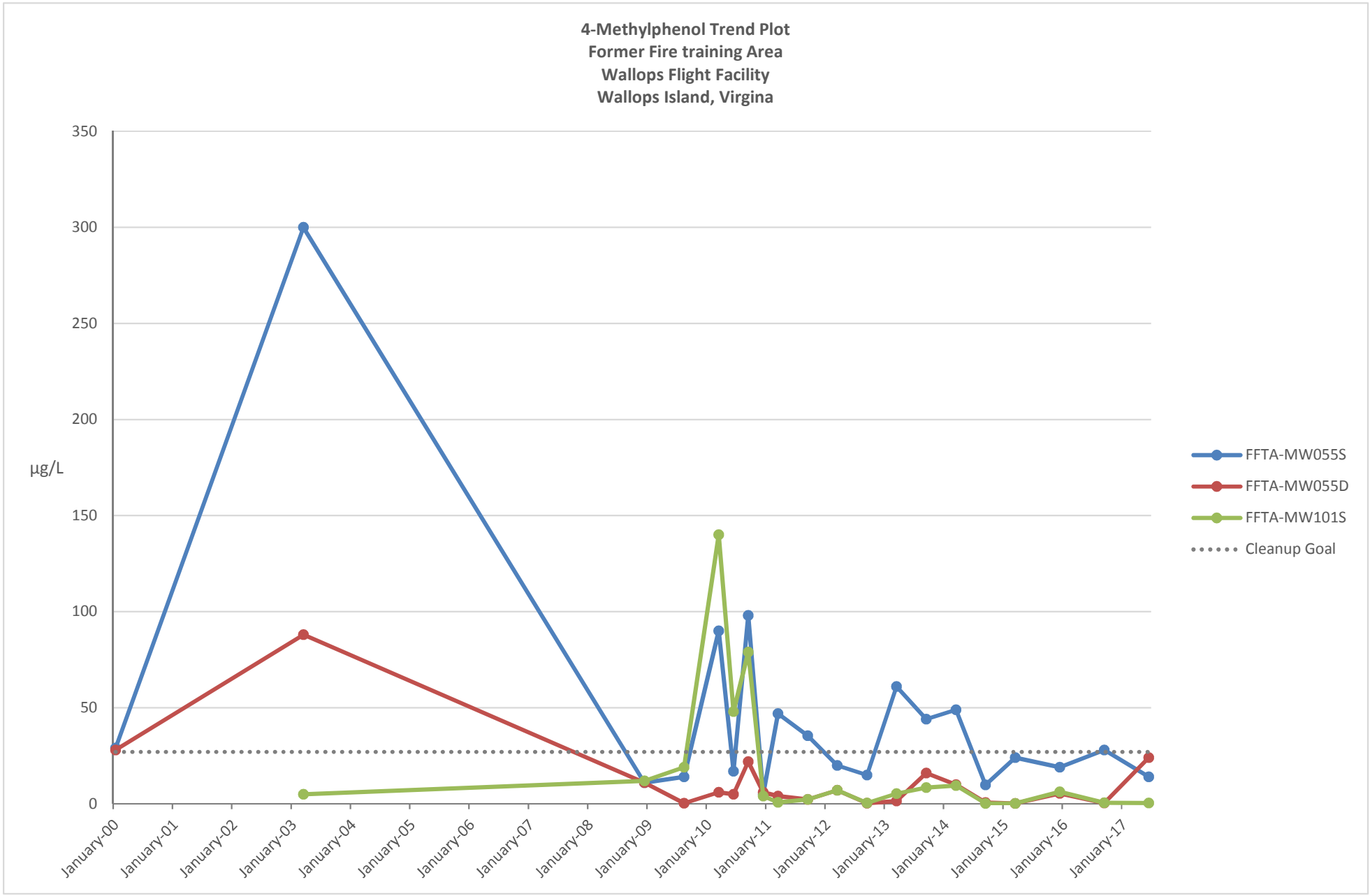

Legend
Monitoring Well-NOT SAMPLED
Monitoring Well-ABANDONED
Monitoring Well-SAMPLED
Topo NASA 2008 (feet MSL)
3 and 4-Methylphenol
Arsenic
Manganese
Naphthalene
Structure Existing Area
N
FFTA-MW107
9/27/16
SVOCs µg/L
3 and 4 Methylphenol 4.6
Naphthalene 66
Total Metals µg/L
Arsenic 35.8
Manganese 515
FFTA-MW58S
9/27/16
SVOCs µg/L
3 and 4 Methylphenol 1.1 J
Naphthalene 15
Total Metals µg/L
Arsenic 17
Manganese 425
FFTA-MW102D
9/27/16
SVOCs µg/L
3 and 4 Methylphenol 0.43 U
Naphthalene 0.062 U
Total Metals µg/L
Arsenic 2.3 U
Manganese 2.6
FFTA-MW61I
9/28/16
SVOCs µg/L
3 and 4 Methylphenol 0.43 U
Naphthalene 0.32
Total Metals µg/L
Arsenic 3.5 J
Manganese 508
FFTA-MW57S
9/28/16
SVOCs µg/L
3 and 4 Methylphenol 0.45 U
Naphthalene 0.065 U
Total Metals µg/L
Arsenic 2.3 U
Manganese 156
FFTA-MW106
9/27/16
SVOCs µg/L
3 and 4 Methylphenol 0.44 U
Naphthalene 0.63 U
Total Metals µg/L
Arsenic 2.3 U
Manganese 1.3 U
FFTA-MW105D
9/28/16
SVOCs µg/L
3 and 4 Methylphenol 0.43 U
Naphthalene 0.063 U
Total Metals µg/L
Arsenic 2.3 U
Manganese 1.6 U
FFTA-MW55S
9/27/16
9/27/16 DUP
SVOCs µg/L µg/L
3 and 4 Methylphenol 28 J 18 J
Naphthalene 27 J 24 J
Total Metals µg/L µg/L
Arsenic 23 23.4
Manganese 270 260
FFTA-MW55D
9/27/16
SVOCs µg/L
3 and 4 Methylphenol 0.46 U
Naphthalene 0.067 U
Total Metals µg/L
Arsenic 2.3 U
Manganese 15.8
FFTA-MW103I
FFTA-MW103D
FFTA-MW103S
FFTA-MW059S
14-MW008
14-MW005
14-MW004
14-MW007
14-MW003
14-MW006
14-MW001
14-MW002
FFTA-MW054S
FFTA-MW002S
FFTA-MW060I
FFTA-MW002D
FFTA-MW056D
9/28/16
SVOCs µg/L
3 and 4 Methylphenol 0.044 U
Naphthalene 0.064 U
Total Metals µg/L
Arsenic 2.3 U
Manganese 560
FFTA-MW108
9/27/16
SVOCs µg/L
3 and 4 Methylphenol 0.42 U
Naphthalene 0.061 U
Total Metals µg/L
Arsenic 2.3 U
Manganese 1.2 U
FFTA-MW101S
9/27/16
SVOCs µg/L
3 and 4 Methylphenol 0.49 U
Naphthalene 0.071 U
Total Metals µg/L
Arsenic 2.9 J
Manganese 4.41
FFTA-MW053S
MW029
Site Cleanup Goals
Benzene - 5 µg/L
3 and 4- Methylphenol - 27 µg/L
Naphthalene - 16 µg/L
Arsenic - 10 µg/L
Manganese - 124 µg/L
Notes:
Bolded Values Exceed Cleanup Goals
SVOC - semi-volatile organic compound
µg/L - micrograms per liter water
J - Estimated Value
U - Analyte was not detected in the sample at a level greater than the instrument detection
0 100 200 400 Feet
DRAWN BY MMC DATE 11/14/2016
CHECKED BY DATE
REVISED BY DATE
SCALE AS NOTED
TETRA TECH
September 2016 Cleanup Goal Exceedance
Former Fire Training Area
NASA Wallops Flight Facility
Wallops Island, Virginia
CONTRACT NUMBER 112G07952
APPROVED BY DATE
APPROVED BY DATE
FIGURE NO. 3-2
REV 0
NOR: G:\GIS_files\NASA.WIMXD\FFTA\FFTA_gwres_TAG_exceedance_sept2016.mxd MMC

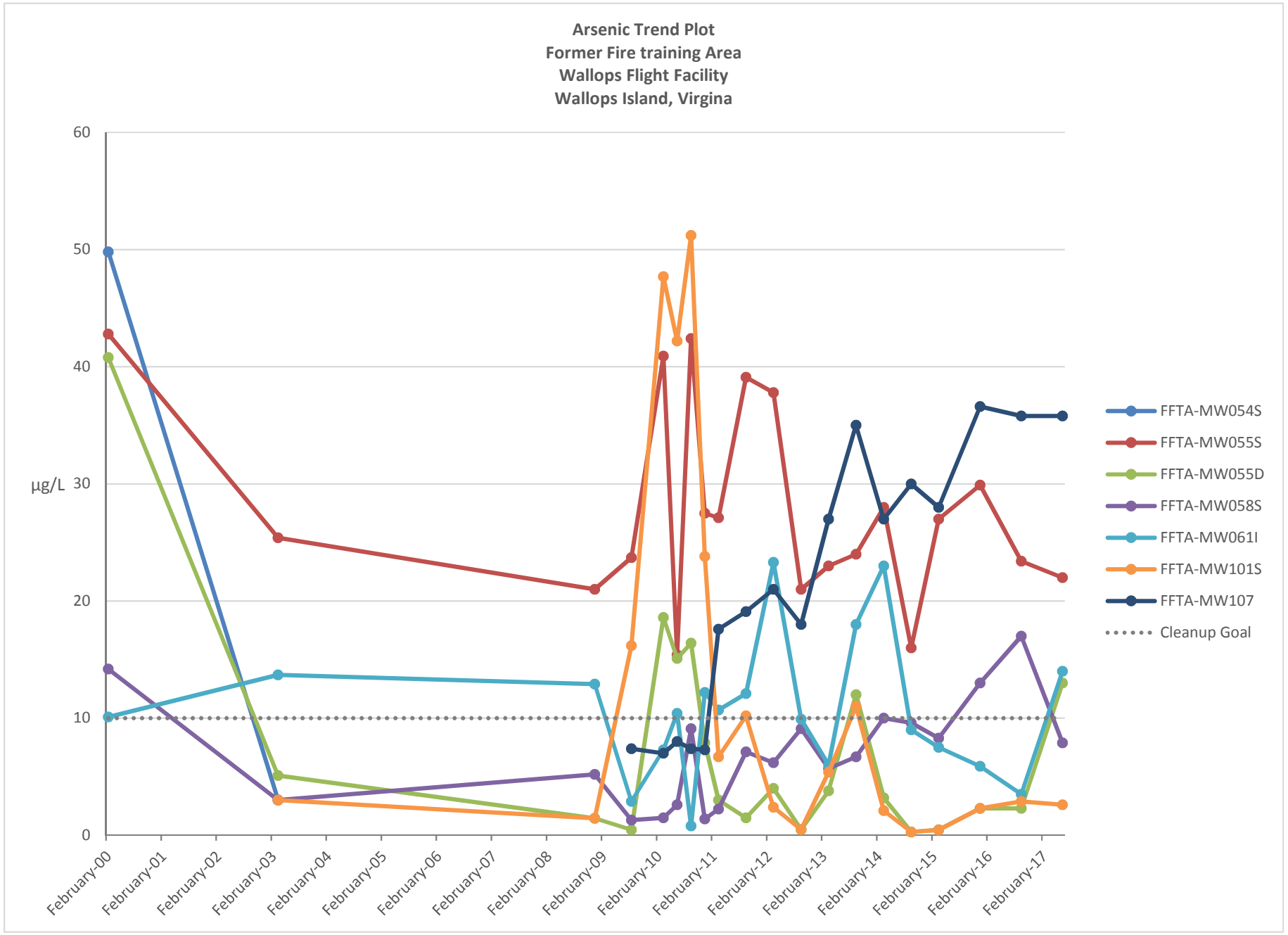

FFTA-MW057S (14.99)
FFTA-MW058S (15.95)
FFTA-MW106 (16.25)
FFTA-MW061I (15.76)
FFTA-MW107 (16.23)
FFTA-MW103I (13.53)
FFTA-MW103S (15.89)
14-MW005 (DRY)
14-MW008
14-MW004 (DRY)
FFTA-MW059S (16.11)
FFTA-MW055D (16.5)
FFTA-MW055S (16.51)
14-MW007
14-MW003
14-MW006
FFTA-MW101S (16.6)
FFTA-MW108 (16.66)
FFTA-MW054S
FFTA-MW002S (16.49)
FFTA-MW002D
FFTA-MW060I (16.05)
FFTA-MW001
FFTA-MW053S
16
15
14
13
12
11
10
9
8
17
N
0
100
200
400
Feet
Legend
Monitoring Well - SAMPLED
Monitoring Well - NOT SAMPLED
Monitoring Well - ABANDONED
CONTOUR
Groundwater Contour (Feet MSL)
Groundwater Contour Inferred (Feet MSL)
Topo NASA 2008 (Feet MSL)
Shallow and Intermediate
Groundwater Potentiometric Map
June 20, 2017
Former Fire Training Area
NASA Wallops Flight Facility
Wallops Isand, Virginia
Figure 2-1

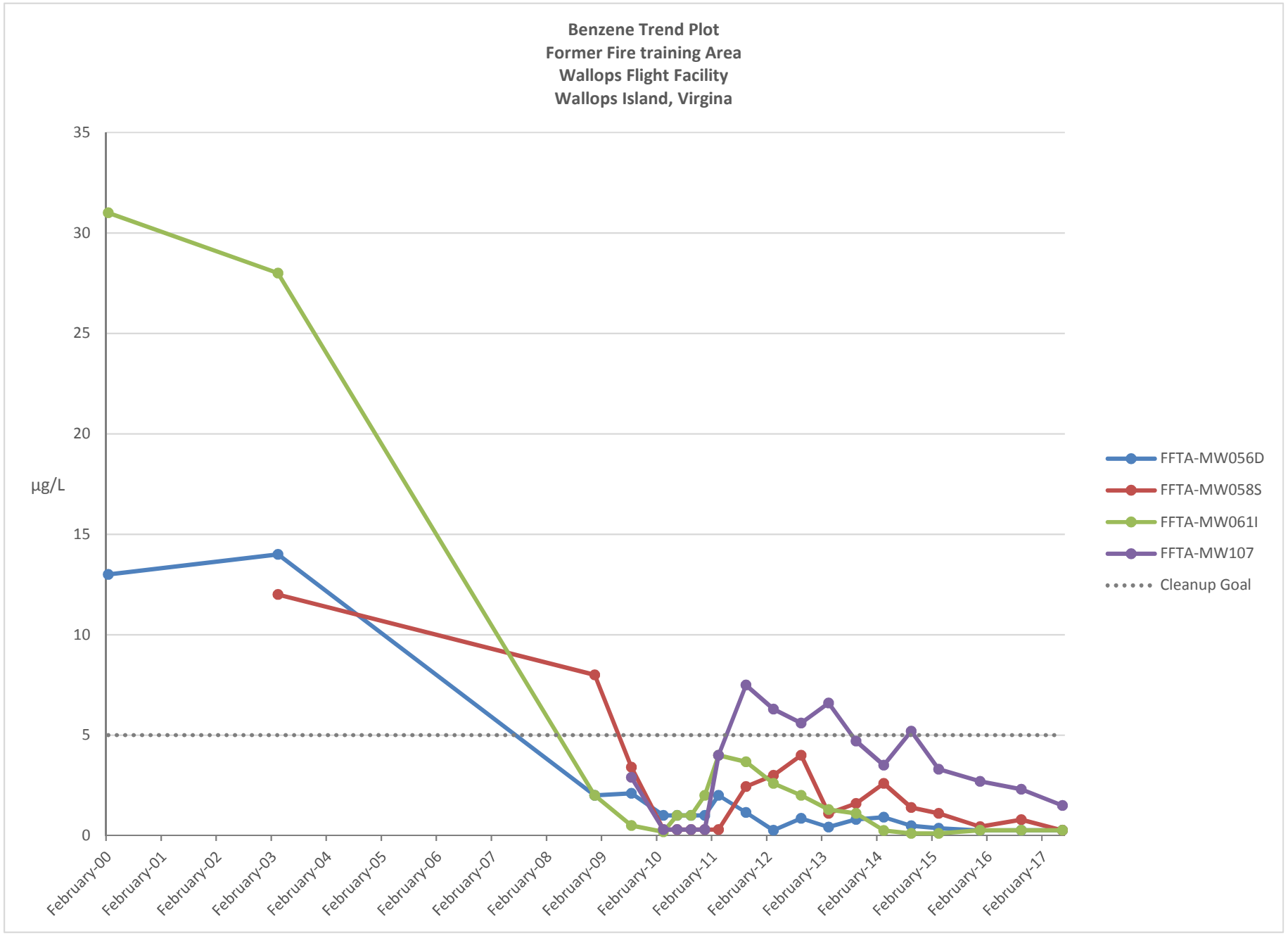

FFTA-MW107
6/21/2017
SVOCs ug/L
Naphthalene 41
Total Metals
Arsenic 35.8
Manganese 405
FFTA-MW58S
6/21/2017
Total Metals ug/L
Manganese 271
FFTA-MW55D
6/22/2017
Total Metals ug/L
Arsenic 11
Manganese 175
FFTA-MW56D
6/22/2017
Total Metals ug/L
Manganese 303
FFTA-MW55S
6/22/2017
Total Metals ug/L
Arsenic 22
Manganese 189
FFTA-MW61I
6/21/2017
Total Metals ug/L
Arsenic 14
Manganese 1760
FFTA-MW103D
FFTA-MW103I
FFTA-MW103S
14-MW005
14-MW008
14-MW004
14-MW007
14-MW003
14-MW006
14-MW001
14-MW002
FFTA-MW002S
FFTA-MW060I
FFTA-MW054S
FFTA-MW002D
FFTA-MW001
FFTA-MW053S
Site Cleanup Goals
Benzene 5 µg/L
3 and 4- Methylphenol 27 µg/L
Naphthalene 16 µg/L
Arsenic 10 µg/L
Manganese 124 µg/L
Notes:
Bolded Values Exceed Cleanup Goals
SVOC -- semi-volatile organic compound
µg/L -- micrograms per liter
J -- Estimate Value
U -- Analyte was not detected in the sample at a value greather than the instrument detection
Legend
Monitoring Well - NOT SAMPLED
Monitoring Well - ABANDONED
Monitoring Well - SAMPLED
Topo NASA 2008 (Feet MSL)
3 and 4-Methylphenol
Arsenic
Manganese
Naphthalene
0 100 200 400 Feet
June 2017 Cleanup Goal Exceedances
Former Fire Training Area
NASA Wallops Flight Facility
Wallops Isand, Virginia
Figure 3-2

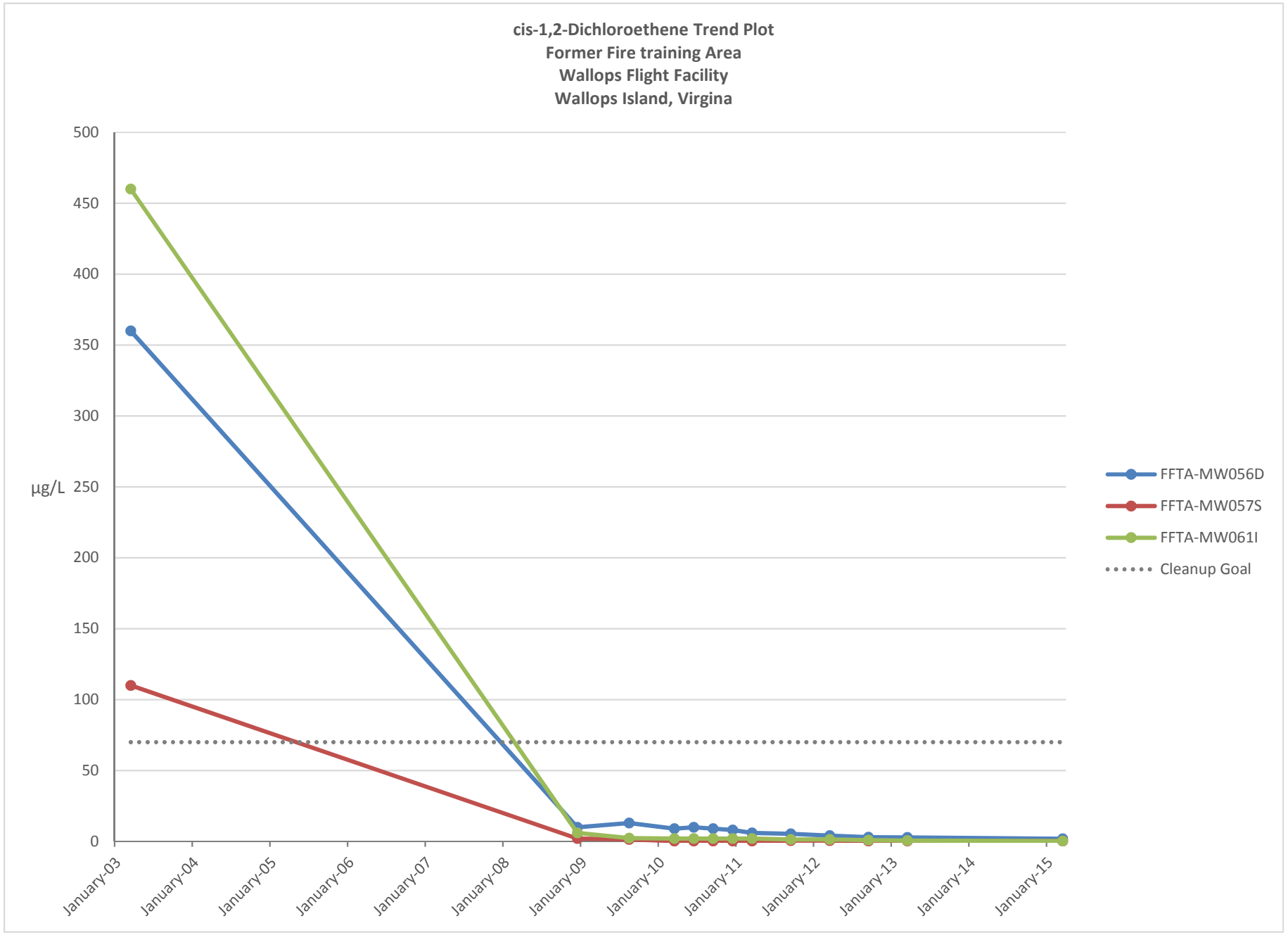
APPENDIX D

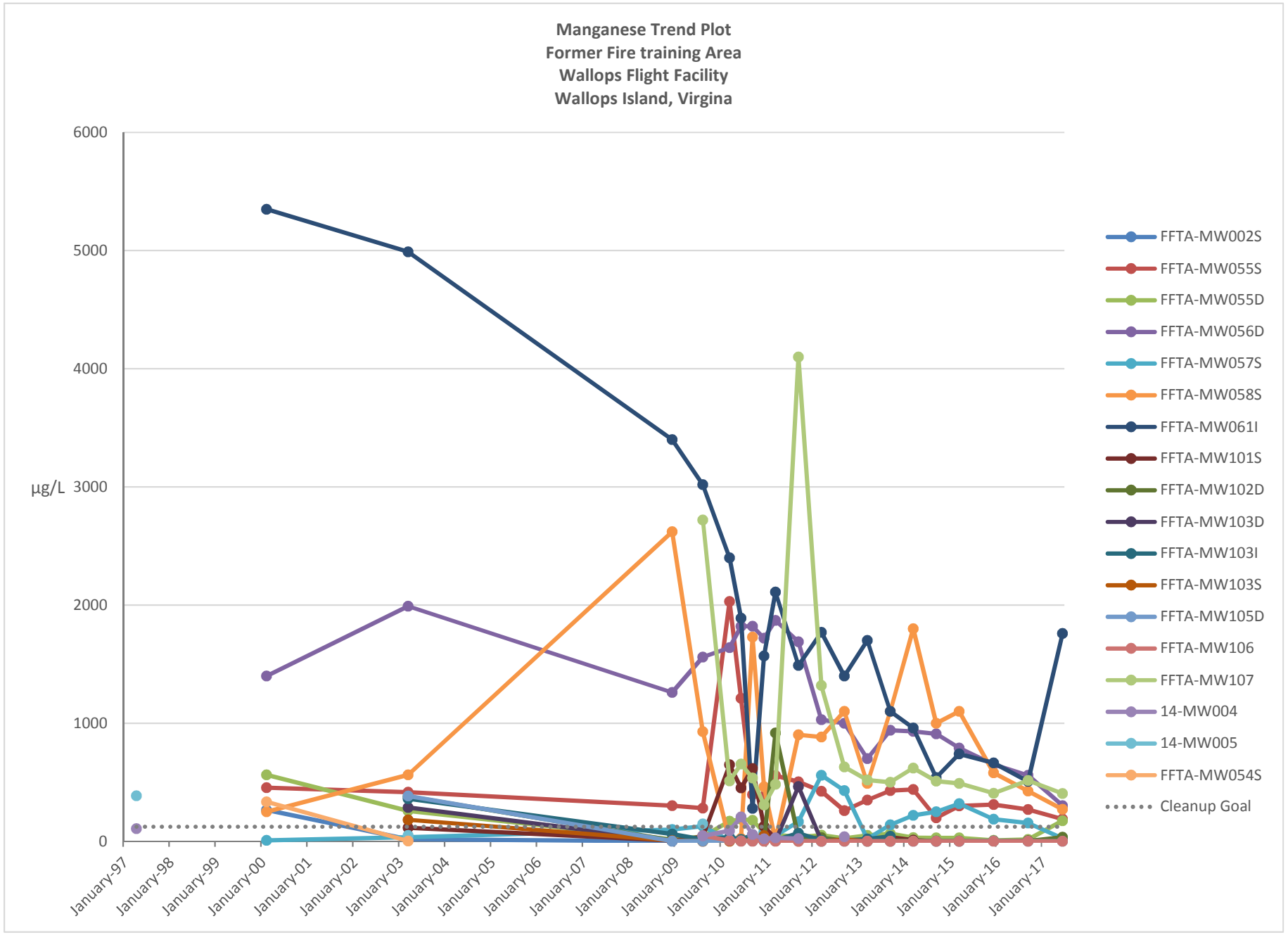
ANALYTICAL DATA GRAPHS

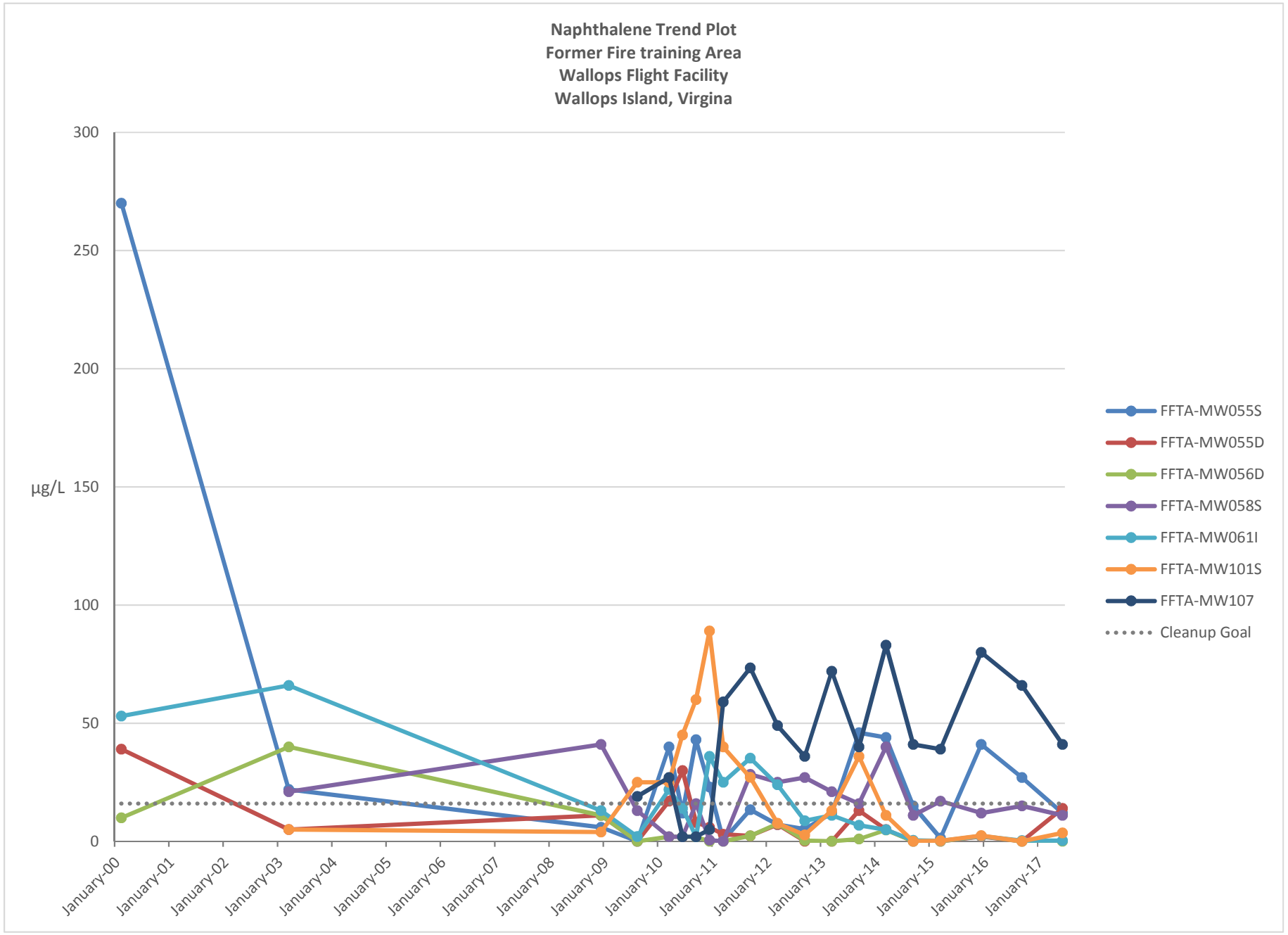

4-Methylphenol Trend Plot
Former Fire training Area
Wallops Flight Facility
Wallops Island, Virgina
µg/L
350
300
250
200
150
100
50
0
January-00
January-01
January-02
January-03
January-04
January-05
January-06
January-07
January-08
January-09
January-10
January-11
January-12
January-13
January-14
January-15
January-16
January-17
FFTA-MW055S
FFTA-MW055D
FFTA-MW101S
Cleanup Goal

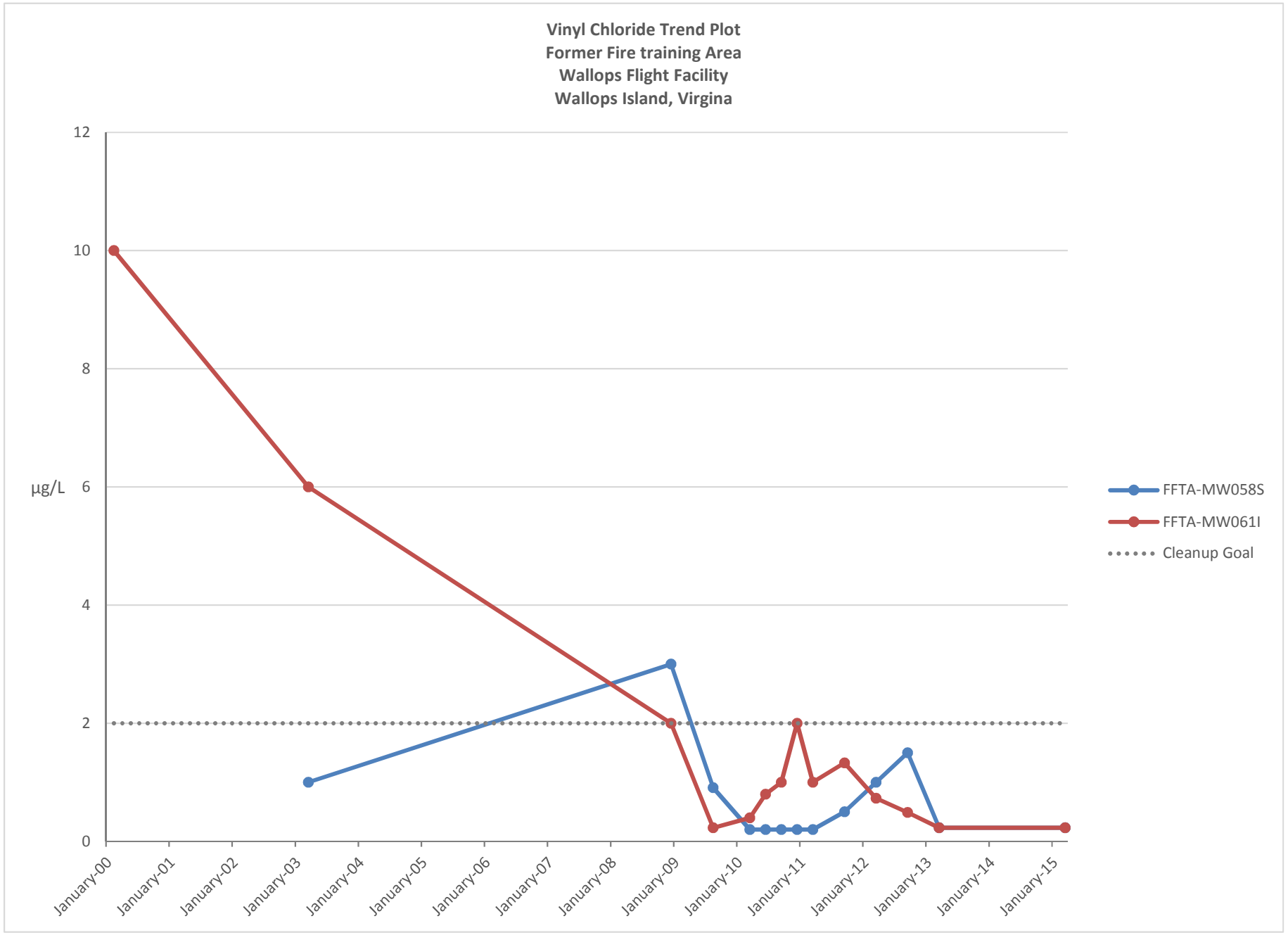

Arsenic Trend Plot
Former Fire training Area
Wallops Flight Facility
Wallops Island, Virgina
µg/L
60
50
40
30
20
10
0
February-00
February-01
February-02
February-03
February-04
February-05
February-06
February-07
February-08
February-09
February-10
February-11
February-12
February-13
February-14
February-15
February-16
February-17
FFTA-MW054S
FFTA-MW055S
FFTA-MW055D
FFTA-MW058S
FFTA-MW061I
FFTA-MW101S
FFTA-MW107
Cleanup Goal

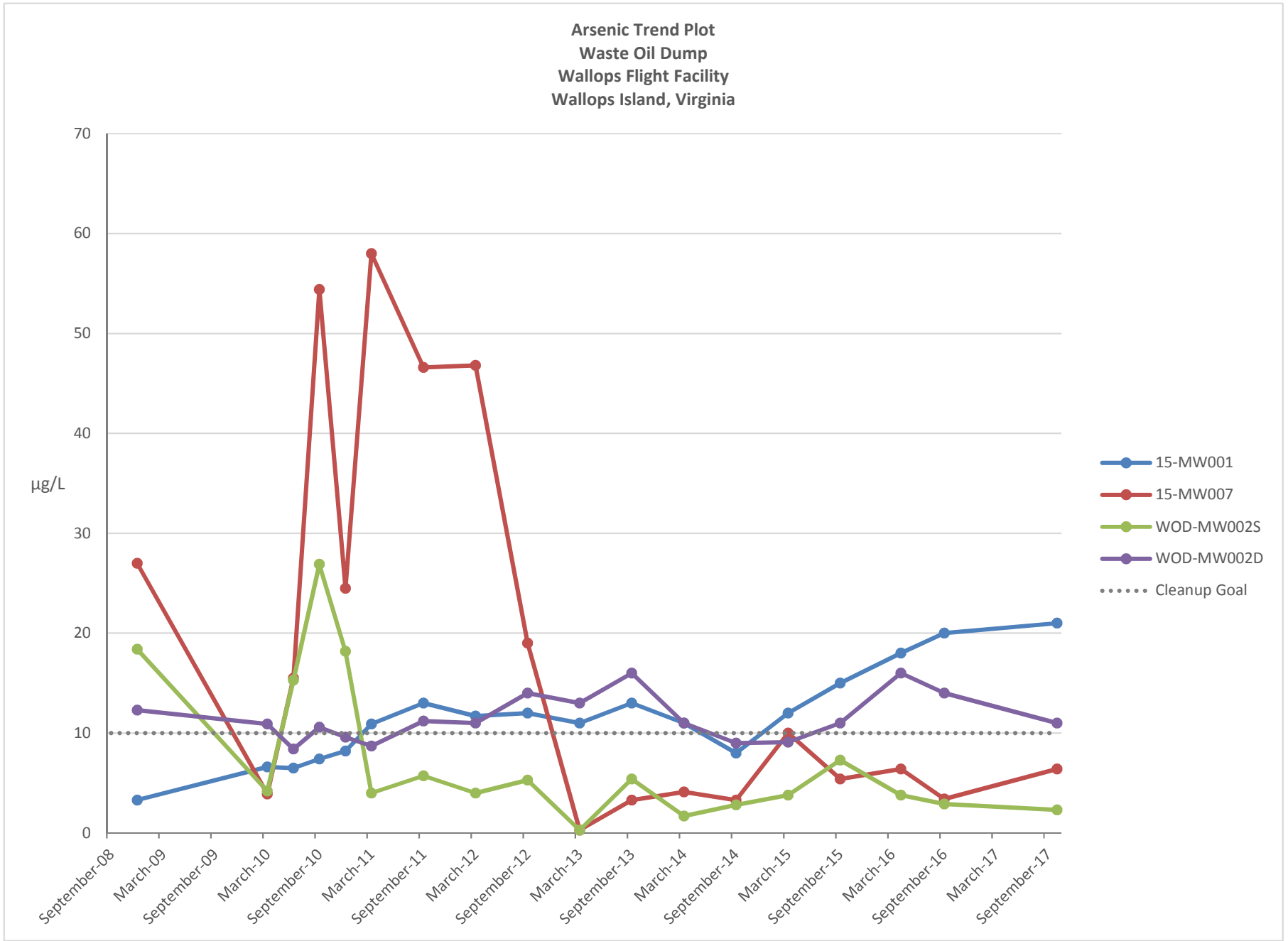

Benzene Trend Plot
Former Fire training Area
Wallops Flight Facility
Wallops Island, Virgina
µg/L
35
30
25
20
15
10
5
0
February-00
February-01
February-02
February-03
February-04
February-05
February-06
February-07
February-08
February-09
February-10
February-11
February-12
February-13
February-14
February-15
February-16
February-17
FFTA-MW056D
FFTA-MW058S
FFTA-MW061I
FFTA-MW107
Cleanup Goal

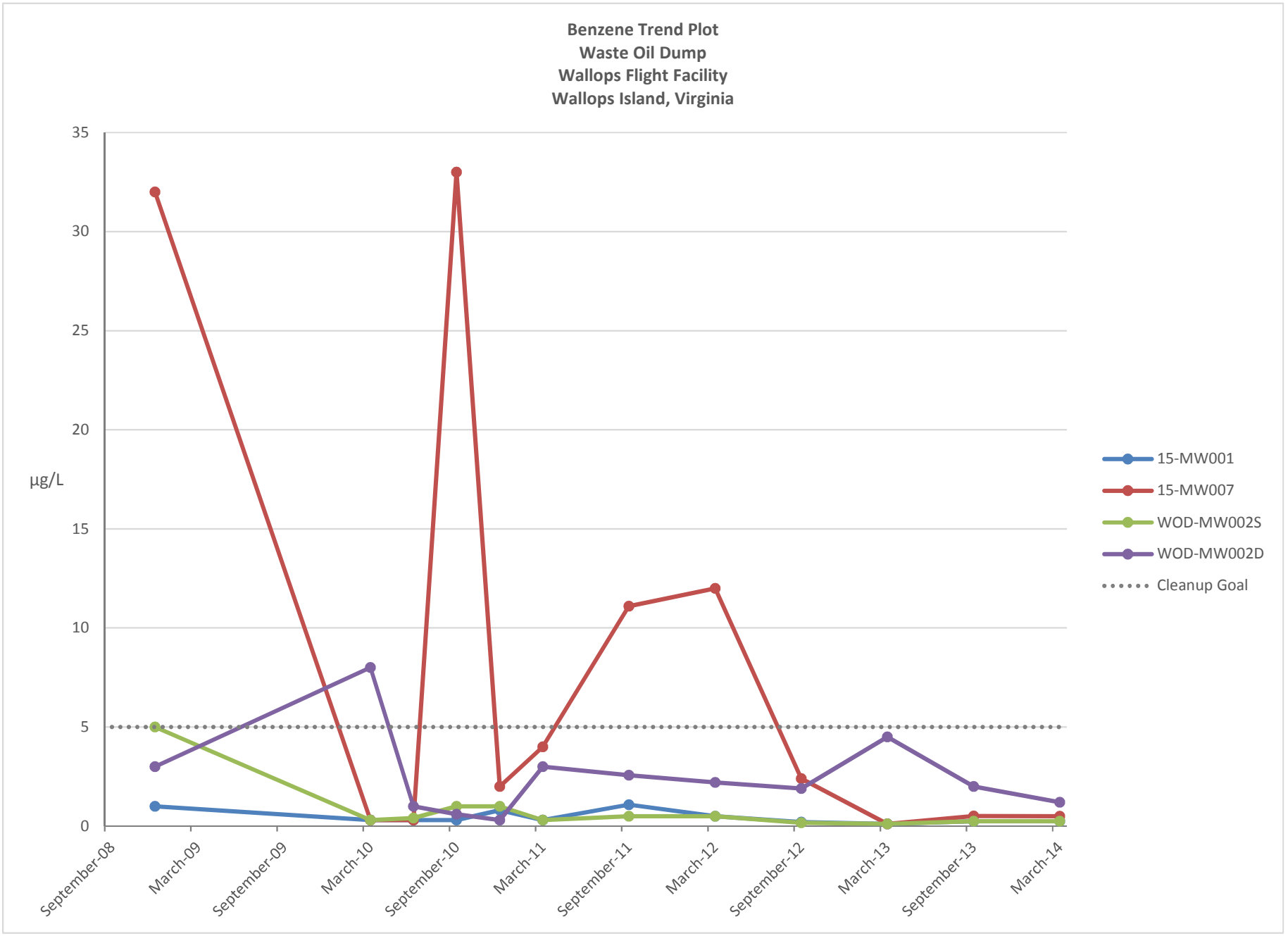

cis-1,2-Dichloroethene Trend Plot
Former Fire training Area
Wallops Flight Facility
Wallops Island, Virgina
µg/L
500
450
400
350
300
250
200
150
100
50
0
January-03
January-04
January-05
January-06
January-07
January-08
January-09
January-10
January-11
January-12
January-13
January-14
January-15
FFTA-MW056D
FFTA-MW057S
FFTA-MW061I
Cleanup Goal


Manganese Trend Plot
Former Fire training Area
Wallops Flight Facility
Wallops Island, Virgina
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
January-15
January-16
January-17
FFTA-MW002S
FFTA-MW055S
FFTA-MW055D
FFTA-MW056D
FFTA-MW057S
FFTA-MW058S
FFTA-MW061I
FFTA-MW101S
FFTA-MW102D
FFTA-MW103D
FFTA-MW103I
FFTA-MW103S
FFTA-MW105D
FFTA-MW106
FFTA-MW107
14-MW004
14-MW005
FFTA-MW054S
Cleanup Goal


Naphthalene Trend Plot
Former Fire training Area
Wallops Flight Facility
Wallops Island, Virgina
µg/L
300
250
200
150
100
50
0
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
January-15
January-16
January-17
FFTA-MW055S
FFTA-MW055D
FFTA-MW056D
FFTA-MW058S
FFTA-MW061I
FFTA-MW101S
FFTA-MW107
Cleanup Goal


Vinyl Chloride Trend Plot
Former Fire training Area
Wallops Flight Facility
Wallops Island, Virgina
µg/L
12
10
8
6
4
2
0
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
January-15
FFTA-MW058S
FFTA-MW061I
Cleanup Goal


Arsenic Trend Plot
Waste Oil Dump
Wallops Flight Facility
Wallops Island, Virginia
µg/L
70
60
50
40
30
20
10
0
September-08
March-09
September-09
March-10
September-10
March-11
September-11
March-12
September-12
March-13
September-13
March-14
September-14
March-15
September-15
March-16
September-16
March-17
September-17
15-MW001
15-MW007
WOD-MW002S
WOD-MW002D
Cleanup Goal


Benzene Trend Plot
Waste Oil Dump
Wallops Flight Facility
Wallops Island, Virginia
µg/L
35
30
25
20
15
10
5
0
September-08
March-09
September-09
March-10
September-10
March-11
September-11
March-12
September-12
March-13
September-13
March-14
15-MW001
15-MW007
WOD-MW002S
WOD-MW002D
Cleanup Goal

APPENDIX E

SITE INSPECTION CHECKLIST AND PHOTOGRAPHS

Site Inspection Checklist

I. SITE INFORMATION

Site name: NASA Wallops Flight Facility Former Fire Training Area (FFTA)	**Date of inspection:** July 10, 2018
Location and Region: Wallops Island, VA EPA Region 3	**EPA ID:** VA8800010763
Agency, office, or company leading the five-year review: NASA	**Weather/temperature:** Mid 80°F Mostly Sunny Winds SW at 5 to 10 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
- ☒ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Photo Log ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** David Liu (Name) NASA Project Coordinator (Title) 07/17/2018 (Date)
   Interviewed ☐ at site ☐ at office ☒ by phone/email Phone no. 757-824-2141
   Email david.liu-1@nasa.gov
   Problems, suggestions; ☐ Report attached none

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 U.S. Environmental Protection Agency
   Contact Lorie Baker (Name) Project Manager (Title) 7/30/2018 (Date) (215) 814-3355 (Phone no.)
   Email Baker.Lori@epa.gov
   Problems; suggestions; ☒ Report attached [see Five-Year Review Interview questionnaire]

   Agency Virginia Department of Environmental Quality
   Contact Michelle Payne (Name) Project Manager (Title) 7/20/2018 (Date) 804-698-4014 (Phone no.)
   Email Michelle.Payne@deq.virginia.gov
   Problems; suggestions; ☐ Report attached none

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

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 i.e., "Long-Term Monitoring Plan" for groundwater along with "LUC Remedial Design."

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

3. **O&M and OSHA Training Records** — ☐ Readily available — ☐ Up to date — ☒ N/A

   Remarks

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 Provided to regulators upon issue and maintained by NASA.

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

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☒ Federal Facility in-house ☒ Contractor for Federal Facility
☐ Other_____

2. **O&M Cost Records**

☐ Readily available ☐ Up to date ☒ N/A
☐ Funding mechanism/agreement in place
Original O&M cost estimate_____ ☐ 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**

Describe costs and reasons: _____
____None. Typical monitoring well maintenance and vegetation clearing for access to wells._____
_____
_____

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

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks: __No fencing specific to site. Facility boundary is fenced._____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A
Remarks: Site is located within the controlled federal property of NASA WFF; facility and site access are restricted and controlled.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Drive by / Site walk with self-reporting.

Annual inspections Inspected during each groundwater monitoring event

Responsible party/agency NASW WFF prime [onsite] contractor, LJT & Assoc.

Contact Susan Dunn (Name) Environmental Scientist (Title) July 10, 2018 (Date) 757-824-1832 (Phone no.)

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 located within the controlled federal property of NASA WFF; facility and site access are restricted. Groundwater at the site is not used or accessed, other than for environmental monitoring.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks

2. **Land use changes on site** ☐ N/A

Remarks Land use has not changed since the last FYR event on June 25, 2013

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 No roads present at FFTA. An abandoned taxiway is adjacent but is maintained by the facility

B. Other Site Conditions

Remarks The stairway down to 14-MW004 and 14-MW005 is in good condition. The vegetation on the path to the FFTA-MW103 well cluster had to be cleared a bit to access easily.

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 N/A

2. **Cracks** ☐ Location shown on site map ☐ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks N/A

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent_____ Depth_____
   Remarks N/A

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
   Areal extent_____ Depth_____
   Remarks N/A

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks N/A

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
   Remarks N/A

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident
   Areal extent_____ Height_____
   Remarks N/A

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 N/A

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
   Areal extent_____
   Remarks N/A

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 N/A

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
   Material type_____ Areal extent_____
   Remarks N/A

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
   Areal extent_____ Depth_____
   Remarks N/A

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
   Areal extent_____ Depth_____
   Remarks N/A

5. **Obstructions** Type_____ ☐ No obstructions
   ☐ Location shown on site map Areal extent_____
   Size_____
   Remarks N/A

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 N/A

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

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

4. **Leachate Extraction Wells**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
   Remarks

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☒ N/A
   Remarks

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

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition ☐ Needs Maintenance
   Remarks N/A

2. **Gas Collection Wells, Manifolds and Piping**
   ☐ Good condition ☐ Needs Maintenance
   Remarks N/A

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

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

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

2. **Erosion** Areal extent_____ Depth_____
   ☒ Erosion not evident
   Remarks_____
   _____

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 N/A

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
   Remarks N/A

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

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
   Areal extent_____ Depth_____
   Remarks N/A

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

3.	**Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent_____ Depth_____ Remarks N/A
4.	**Discharge Structure** ☐ Functioning ☒ N/A Remarks
	VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A
1.	**Settlement** ☐ Location shown on site map ☐ Settlement not evident Areal extent_____ Depth_____ Remarks N/A
2.	**Performance Monitoring** Type of monitoring_____ ☐ Performance not monitored Frequency_____ ☐ Evidence of breaching Head differential_____ Remarks N/A
	IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A	
1.	**Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☒ N/A Remarks
2.	**Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks N/A
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks N/A _____
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A	
1.	**Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks N/A
2.	**Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks N/A
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks N/A

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 N/A

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

D. Monitoring Data

1. Monitoring Data
   ☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring data suggests:
   ☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

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 in mostly good condition. FFTA-MW101S has a cap that has rusted through and should be replaced.

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 of the following Chemicals of Concern (COCs): benzene; cis-1,2-DCE; vinyl chloride; 4-methylphenol; naphthalene; arsenic; and manganese. The remedy is intended to contain and reduce the contaminant plume, and to prevent exposure until cleanup levels are met. The in situ biological treatment component was accomplished with a pilot study. 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. Groundwater monitoring and institutional controls will continue until cleanup levels are met.

Compared to the site conditions prior to the biostimulation injection in 2009, the maximum concentrations of benzene, 4-methyphenol, naphthalene, and manganese have decreased and the contaminant plume(s) has(have) decreased in size. Only arsenic, manganese, and naphthalene exceed cleanup goals. Arsenic and manganese seem to be stable both in concentration and areal extent. Long-term monitoring continues. The remedy is effective and functioning as intended.

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. LTM Program is evaluated and updated regularly by NASA and the regulators based on LTM data.

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.

No issues or observations suggest the remedy protectiveness will be compromised.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

As discussed in LTM evaluation reports and determined by NASA with regulator concurrence, 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.

FFTA—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	Northwest	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Standing near monitoring well FFTA-MW002S looking across the site. Several other monitoring wells are visible in the distance.

Date:	View:	Photographer:
7/10/2018	Southwest	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Standing adjacent to FFTA-MW061I looking across the site back towards the abandoned taxiway, where the dump trucks are parked. Wells are visible in the distance and are unlocked to inspect for this FYR.

FFTA—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	East	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Standing near FFTA-MW102D looking across the site. Several wells are visible in the distance. The access point to the FFTA-MW103 well cluster in to the right of the parked car.

Date:	View:	Photographer:
7/10/2018	Northeast	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of the path leading to the FFTA-MW103 well cluster. The path was overgrown, so some minor clearing was performed.

FFTA—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	Northwest	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Standing near FFTA-MW059S looking across site. Several wells are visible in the distance.

Date:	View:	Photographer:
7/10/2018	NA	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of FFTA-MW059S. The well is in good condition other than some rust.

FFTA—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	South	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Stairway to access to the two monitoring wells (14-MW004 and 14-MW005) by the creek on the east side of FFTA.

Date:	View:	Photographer:
7/10/201	East	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of creek on the east side of FFTA near well 14-MW005.

FFTA—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	NA	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of FFTA-MW109. Flush mount completion in grass on south side of abandoned taxiway.

Date:	View:	Photographer:
7/10/2018	NA	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of FFTA-MW055S and FFTA-MW055D. Other than some rust the well are in good condition.

FFTA—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	NA	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of FFTA-MW101S and its rusted, deteriorated protective casing cover.

Date:	View:	Photographer:
7/10/2018	NA	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of 14-MW005. There is no protective casing installed for this well due to the location.

Site Inspection Checklist

I. SITE INFORMATION

Site name: NASA Wallops Flight Facility Waste Oil Dump (WOD)	**Date of inspection:** July 10, 2018
Location and Region: Wallops Island, VA EPA Region 3	**EPA ID:** VA8800010763
Agency, office, or company leading the five-year review: NASA	**Weather/temperature:** Mid 80°F Mostly Sunny Winds SW at 5 to 10 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
- ☒ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Photo Log ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** David Liu (Name) NASA Project Coordinator (Title) 7/17/2018 (Date)
   Interviewed ☐ at site ☐ at office ☒ by phone/email Phone no. 757-824-2141
   Email david.liu-1@nasa.gov
   Problems, suggestions; ☐ Report attached none

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 U.S. Environmental Protection Agency
   Contact Lorie Baker (Name) Project Manager (Title) 7/30/2018 (Date) (215) 814-3355 (Phone no.)
   Email Baker.Lori@epa.gov
   Problems; suggestions; ☒ Report attached [see Five-Year Review Interview questionnaire]

   Agency Virginia Department of Environmental Quality
   Contact Michelle Payne (Name) Project Manager (Title) 7/20/2018 (Date) 804-698-4014 (Phone no.)
   Email Michelle.Payne@deq.virginia.gov
   Problems; suggestions; ☐ Report attached none

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

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 i.e., "Long-Term Monitoring Plan" for groundwater along with "LUC Remedial Design."

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

3. **O&M and OSHA Training Records** — ☐ Readily available — ☐ Up to date — ☒ N/A

   Remarks

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 Provided to regulators upon issue and maintained by NASA.

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

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☒ Federal Facility in-house ☒ Contractor for Federal Facility
☐ Other_____

2. **O&M Cost Records**

☐ Readily available ☐ Up to date ☒ N/A
☐ Funding mechanism/agreement in place
Original O&M cost estimate_____ ☐ 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**

Describe costs and reasons: _____
____None. Typical monitoring well maintenance and vegetation clearing for access to wells._____
_____
_____

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

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks: __No fencing specific to site. Facility boundary is fenced._____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A
Remarks:_Site is located within the controlled federal property of NASA WFF; facility and site access are restricted and controlled.
_____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Drive by / Site walk with self-reporting.

Annual inspections Inspected during each groundwater monitoring event

Responsible party/agency NASW WFF prime [onsite] contractor, LJT & Assoc.

Contact Susan Dunn (Name) Environmental Scientist (Title) July 10, 2018 (Date) 757-824-1832 (Phone no.)

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 located within the controlled federal property of NASA WFF; facility and site access are restricted. Groundwater at the site is not used or accessed, other than for environmental monitoring.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks

2. **Land use changes on site** ☐ N/A

Remarks Land use has not changed since the last FYR event on June 25, 2013

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 No paved roads present at WOD. Runway 17-35 is adjacent but is maintained by the facility. A dirt road is present at WOD that leads to a facility perimeter gate. This road is in good condition.

B. Other Site Conditions

Remarks Some vegetation was encroaching on certain wells, but this was trimmed back during the inspection.

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 N/A

2. **Cracks** ☐ Location shown on site map ☐ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks N/A

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent_____ Depth_____
   Remarks N/A

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
   Areal extent_____ Depth_____
   Remarks N/A

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks N/A

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
   Remarks N/A

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident
   Areal extent_____ Height_____
   Remarks N/A

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 N/A

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
   Areal extent_____
   Remarks N/A

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 N/A

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
   Material type_____ Areal extent_____
   Remarks N/A

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
   Areal extent_____ Depth_____
   Remarks N/A

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
   Areal extent_____ Depth_____
   Remarks N/A

5. **Obstructions** Type_____ ☐ No obstructions
   ☐ Location shown on site map Areal extent_____
   Size_____
   Remarks N/A

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 N/A

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

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

4. **Leachate Extraction Wells**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
   Remarks

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☒ N/A
   Remarks

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

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition ☐ Needs Maintenance
   Remarks N/A

2. **Gas Collection Wells, Manifolds and Piping**
   ☐ Good condition ☐ Needs Maintenance
   Remarks N/A

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

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

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

2. **Erosion** Areal extent_____ Depth_____
   ☒ Erosion not evident
   Remarks_____
   _____

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 N/A

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
   Remarks N/A

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

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
   Areal extent_____ Depth_____
   Remarks N/A

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

3.	**Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent_____ Depth_____ Remarks N/A
4.	**Discharge Structure** ☐ Functioning ☒ N/A Remarks
	VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A
1.	**Settlement** ☐ Location shown on site map ☐ Settlement not evident Areal extent_____ Depth_____ Remarks N/A
2.	**Performance Monitoring** Type of monitoring_____ ☐ Performance not monitored Frequency_____ ☐ Evidence of breaching Head differential_____ Remarks N/A
	IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A	
1.	**Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☒ N/A Remarks
2.	**Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks N/A
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks N/A _____
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A	
1.	**Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks N/A
2.	**Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks N/A
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks N/A

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 N/A

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

D. Monitoring Data

1. Monitoring Data
   ☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring data suggests:
   ☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

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 in mostly good condition. WOD-MW003R has a cap that has rusted through and should be replaced.

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 WOD includes in situ biological treatment (biostimulation), institutional controls, and monitoring of the following Chemicals of Concern (COCs): benzene and arsenic. The remedy is intended to contain and reduce the contaminant plume, and to prevent exposure until cleanup levels are met. The in situ biological treatment component was accomplished with a pilot study and full-scale injection. Groundwater monitoring and institutional controls will continue until cleanup levels are met.

Benzene was removed from the LTM program in 2014 after concentrations were below the cleanup level during four consecutive events. Only arsenic exceeds the cleanup goal; however, this is isolated to an area on the western boundary of the site. Long-term monitoring continues. The remedy is effective and functioning as intended.

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. LTM Program is evaluated and updated regularly by NASA and the regulators based on LTM data.

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.

No issues or observations suggest the remedy protectiveness will be compromised.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

As discussed in LTM evaluation reports and determined by NASA with regulator concurrence, 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.

Benzene has been removed from monitoring; only arsenic remains. Also, the LTM event frequency has been reduced to biannual.

WOD—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	Northeast	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Standing near WOD-MW003R looking across the site.

Date:	View:	Photographer:
7/10/2018	NA	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of WOD-MW003R. The protective casing's cap has rusted through and needs replaced.

WOD—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	West	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Standing near 15-MW007 looking at brushy fringe. The brush has encroached on 15-MW007 and had to be cut back. The brush will need to be cleared if it encroaches any further.

Date:	View:	Photographer:
7/10/2018	South	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Standing along dirt access back towards Runway 17-35. The asphalt/cement plan which used to be located on the north side of the runway has recently been removed.

WOD—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	North	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Standing along dirt access road that leads to perimeter gate.

Date:	View:	Photographer:
7/10/2018	East	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Standing along dirt access road looking at WOD-MW002S and WOD-MW002D and perimeter fence.

WOD—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	South	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of WOD-MW008. Other than some minor rust the well is in good condition.

Date:	View:	Photographer:
7/10/201	North	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of the dirt access road and facility perimeter gate.

WOD—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	South	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Standing near 15-MW002 looking at the drop off towards the creek. No unusual erosion was noted.

Date:	View:	Photographer:
7/10/2018	NA	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

View of 15-MW002. There is no protective casing due to the location of the well.

WOD—FIVE-YEAR REVIEW PHOTOGRAPHIC LOG

Date:	View:	Photographer:
7/10/2018	Northeast	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Looking down the facility perimeter fence from inside the facility.

Date:	View:	Photographer:
7/10/2018	Northeast	J. Birkett (Tetra Tech; contractor for NASA c/o LJT & Associates)

Looking down the facility perimeter fence from outside the facility.