National Aeronautics and Space Administration

Record of Decision

Operable Unit 6

Formerly Used Defense Site Project 13 – Old Wastewater Treatment Plant – Soil, Sludge, Sediment, and Surface Water

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia

June 2023

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Acronyms and Abbreviations

ADAFs	age-specific adjustment factors
ADD	average daily dose
ARAR	applicable or relevant and appropriate requirement
BAF	bioaccumulation factor
BCF	bioconcentration factor
bgs	below ground surface
BHHRA	baseline human health risk assessment
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNAAS	Chincoteague Naval Auxiliary Air Station
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSF	cancer slope factor
CSM	Conceptual Site Model
DDD	dichlorodiphenyltrichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DoD	Department of Defense
DPT	direct push technology
EC	exposure concentration
ECO SSL	Ecological Soil Screening Level
ERA	ecological risk assessment
ESD	Explanation of Significant Differences
ESS	Environmental Site Survey
FFS	Focused Feasibility Study
FUDS	Formerly Used Defense Site
GSFC	Goddard Space Flight Center
HI	hazard index
HQ	hazard quotient
ILCR	incremental lifetime cancer risk
IUR	inhalation unit risk
LADD	lifetime average daily intake (dose)
LOAEL	lowest observed adverse effect level
LSI	Limited Site Investigation
LTM	long-term monitoring
LUC	land use control

M&E	Metcalf and Eddy, Inc.
MEK	methyl ethyl ketone
mg/kg	milligram per kilogram
mg/kg/day	milligram per kilogram per day
mg/L	milligram per liter
mg/m3	milligram per cubic meter
MIBK	methyl isobutyl ketone
MOA	Memorandum of Agreement
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	no observed adverse effect level
NPW	net present worth
ORNL	Oak Ridge National Laboratory
OU	Operable Unit
O&M	operation and maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PFAS	per- and polyfluoroalkyl substances
PID	photoionization detector
PP	Proposed Plan
ppm	parts per million
PRG	preliminary remediation goal
RAO	remedial action objective
RBCs	risk-based concentrations
RCRA	Resource Conservation Recovery Act
RfC	reference concentration
RfD	reference dose
RI	Remedial Investigation
RSL	Regional Screening Levels
ROD	Record of Decision
SI	Site Inspection
SLERA	screening level ecological risk assessment
SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TRV	toxicity reference value
TCRA	Time Critical Removal Action
UCL	upper confidence limit
USACE	Unites States Army Corps of Engineers
USC	United States Code

USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit
UXO	unexploded ordnance
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound
VPA	Virginia Pollution Abatement
VPDES	Virginia Pollutant Discharge Elimination System
WFF	Wallops Flight Facility
WWTP	Wastewater Treatment Plant
µg/kg	microgram per kilogram
µg/L	microgram per liter
µg/mg	microgram per milligram
µg/m3	microgram per cubic meter
µg/kg	microgram per kilogram

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1.0 INTRODUCTION

1.1 SITE NAME AND LOCATION

Operable Unit (OU) 6
Formerly Used Defense Site (FUDS)
Project 13 – Old Wastewater Treatment Plant – Soil, Sludge, Sediment, and Surface Water
NASA Wallops Flight Facility
Wallops Island, Virginia

1.2 STATEMENT OF BASIS AND PURPOSE

This decision document presents the Record of Decision (ROD) for soil, sediment, surface water, and sludge at OU 6, the FUDS Old Wastewater Treatment Plant (WWTP). The Old WWTP is located at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) Wallops Flight Facility (WFF) in Accomack County, Virginia. The Selected Remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, 42 United States Code (USC) Section 9601 et seq., and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300. This decision is based on the Administrative Record file for WFF.

NASA has selected the remedy, and the Virginia Department of Environmental Quality (VDEQ) and United States Environmental Protection Agency (USEPA) concur with the Selected Remedy.

1.3 ASSESSMENT OF SITE

NASA has determined that Sludge Removal and Off-Site Disposal is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. No action for soil, surface water, and sediment is necessary to protect public health or welfare or the environment. Potential risks associated with groundwater contamination will be addressed in the FUDS Project 11 Main Base Remedial Investigation (RI) and the Main Base investigation for per- and polyfluoroalkyl substances (PFAS), currently in progress.

1.4 DESCRIPTION OF SELECTED REMEDY

The Old WWTP Site is one of the sites identified under the FUDS program at NASA WFF. The Department of Defense (DoD) and NASA have executed a Memorandum of Agreement (MOA) under which NASA is the lead agency for implementing CERCLA actions at NASA WFF for FUDS (NASA, 2015). This ROD only applies to the Old WWTP Site. Separate investigations and assessments are being conducted for the other FUDS in accordance with the Administrative Agreement on Consent (USEPA, 2021).

Previous investigations have identified the presence of metals, polycyclic aromatic hydrocarbon (PAHs), and pesticides in sludge that pose an unacceptable risk to human health and the environment. Based on the results of the baseline human health risk assessment (BHHRA), no action is necessary for soil, surface water, and sediment at the Old WWTP Site. The human health risks from exposure to residual sludge were not evaluated in the BHHRA for the hypothetical Future Adult and Child Resident due to the assumption that the sludge would be removed from the site during residential development. Based on the results of the screening level ecological risk assessment (SLERA), contaminated Old WWTP sludge containing chromium, mercury, 4,4'-dichlorodiphenyldichloroethane (DDD), and 4,4'-dichlorodiphenyldichloroethylene (DDE) present a moderate to high ingestion risk to ecological receptors (American robin and short-tailed shrew). Potential risks associated with groundwater will be addressed under FUDS Project 11 and ongoing investigations for PFAS.

The selected remedy is Alternative 4 - Sludge Removal and Off-Site Disposal. The selected remedy addresses source material (sludge) that constitutes low-level threat wastes. The major components associated with the selected remedy, Sludge Removal and Off-Site Disposal, are as follows:

- Sampling of sludge for off-site disposal requirements,
- Installation of erosion controls,
- Dust controls,
- Excavation of contaminated sludge,
- Off-site disposal of excavated sludge,
- Post-excavation confirmation sampling,
- Backfill of the excavated areas with clean fill material, and
- Ground cover restoration.

1.5 STATUTORY DETERMINATIONS

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and resource recovery technologies to the maximum extent practicable.

The remedy for the Old WWTP Site does not satisfy the statutory preference for treatment as a principal element of the remedy for the following reasons: (1) principal threat material is not present at the Site, and (2) contaminated materials/waste at the Site are contained, are non-mobile, and are of low to moderate toxicity.

Because this remedy will not result in site-related hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a five-year review will not be required for this remedial action.

1.6 ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD:

✓ Chemicals of concern (COCs) and their respective concentrations.

✓ Baseline risk represented by the COCs.

✓ Cleanup levels established for COCs and the basis for these levels.

✓ How source materials constituting principal threats are addressed.

✓ Current and reasonably anticipated future land use assumptions used in the baseline risk assessment and ROD (See Section 2.6 Current and Potential Future Land and Resource Uses).

✓ Potential land use that will be available at the site as a result of the Selected Remedy.

- ✓ Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- ✓ Key factor(s) that led to selecting the remedy.

Additional information can be found in the Administrative Record file for this Site.

1.7 AUTHORIZING SIGNATURES

DAVID RETH Digitally signed by DAVID RETH
Date: 2023.06.16 13:31:56 -04'00'

David A. Reth, Director
Management Operations
Wallops Flight Facility

Date

PAUL LEONARD Digitally signed by PAUL LEONARD
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Paul Leonard, Director
Superfund & Emergency Management Division
USEPA Region 3

Date

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2.0 DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION

WFF is located in northeastern Accomack County, Virginia. The facility is comprised of three separate areas: Main Base, Wallops Island, and Wallops Mainland (Figure 2-1). The Old WWTP Site is located on the Main Base (Figure 2-2). The Main Base is situated on the Atlantic Coast of the Delmarva Peninsula approximately 5 miles south of the Maryland/Virginia state boundary, and just to the west of Chincoteague Island. The Main Base is comprised of 2,230 acres and is bounded by Little Mosquito Creek to the north, northwest, and northeast, Route 175 to the south, Simoneaston Bay and the Chincoteague Wildlife Refuge to the east, and the Marine Science Consortium, farms and residences, and Wattsville Branch to the west. Wallops Island and Wallops Mainland are located approximately 7.5 miles southeast of the Main Base.

The Old WWTP Site, OU 6, is comprised mainly of dense vegetative cover including woodland underbrush and young trees (Figures 2-3 and 2-4). The Site is bounded to the north by undeveloped woodland, wetlands, and an unnamed intermittent tributary of Little Mosquito Creek, to the west by a storm water drainage culvert draining to Outfall 013, and to the east by a storm water drainage culvert. The culvert to the east drains to Outfall 005 and is separated by grassy land situated adjacent to (west of) Runway 17-35, to the south by the abandoned taxiway leading to Runway 17-35 and adjacent to Runway 10-28. The surficial aquifer groundwater flows in a northwesterly direction toward the wetlands and the unnamed tributary (Figure 2-5).

The Old WWTP Site was investigated under the United States Army Corps of Engineers (USACE) FUDS program. In 2015, NASA and the DoD, through the Department of the Army, negotiated and signed a MOA delegating CERCLA response action authority for the FUDS Program at NASA WFF to NASA (NASA, 2015). Under the agreement, the DoD will continue to fund the FUDS Program and NASA will be responsible for implementing the program. NASA is now the lead agency for site activities at the WFF. USEPA is the lead regulatory agency, and VDEQ is the support agency. Funding is provided through the USACE.

Old WWTP Site soil, sediment, surface water, and sludge are addressed by this ROD. There is a small quantity of wastewater in the settling tank that will be addressed with the sludge. Potential risks associated with groundwater contamination found in an upgradient well will be addressed under FUDS Project 11 and ongoing investigations for PFAS. The Old WWTP Site is located northwest of the intersection of Runway 17-35 and the abandoned taxiway that parallels Runway 10-28 in the north-central portion of the Main Base. The area surrounding the Old WWTP comprises approximately 0.8 acre, and includes mounded material identified in previous investigations as possible residual sludge piles located approximately 150 to 200 feet north of the Old WWTP structures. In addition, two sludge drying beds thought to contain residual sludge materials associated with Old WWTP activities are located in the eastern portion of the Old WWTP (Figure 2-3).

The Old WWTP Site consists of, and is surrounded by, dense vegetative cover including woodland underbrush and young trees. Prior to initiation of Time Critical Removal Action (TCRA) activities in 2006 (Weston, 2006), trees and underbrush were cleared to gain vehicle/heavy equipment access to the Site and establish a temporary gravel access road in the western portion of the Old WWTP area. The Site drains to an unnamed tributary to Little Mosquito Creek. The drainage way also receives runoff from the runway, taxiway, ramp area, and the surrounding vicinity. The Old WWTP is no longer active, and the structures are currently partially degraded and overgrown with vegetation. NASA abandoned the facility upon obtaining custody of the land and has not used the Old WWTP Site for any purpose since the transfer of the facility ownership in 1959.

2.2 SITE HISTORY AND ENFORCEMENT ACTIONS

2.2.1 Site History

The Department of the Navy began purchasing land for the Chincoteague Naval Auxiliary Air Station (CNAAS) in 1942 through condemnation in order to establish the CNAAS as a training facility for World War II naval aviators. Prior to being developed for the CNAAS, the land principally consisted of farmland and marshes. Historical aerial photographs show that various buildings and three runways had been constructed by 1943.

On January 26, 1946, the Naval Aviation Ordnance Test Station was established on the Wallops Island portion of CNAAS. The former CNAAS was transferred to NASA on June 30, 1959. NASA identified this Station as Wallops Station from 1959 to 1974. In 1975, Wallops Station was renamed Wallops Flight Center. In October 1981, Wallops Flight Center was consolidated with the Goddard Space Flight Center in Maryland, and the name was officially changed to WFF. Since then, WFF has become NASA's primary facility for suborbital programs and is home to the Mid-Atlantic Regional Spaceport.

2.2.2 Previous Investigations, Removal Actions, and Enforcement Actions

In 1990, an Environmental Site Survey (ESS) Report identified the Old WWTP Site for investigation, based on a lack of historical data and potential environmental significance (Ebasco, 1990a).

In 1993, a magnetometer survey was conducted at the Old WWTP Site as Phase I of the Site Inspection (SI) (Ebasco, 1990b). During the unexploded ordnance (UXO)/magnetometer survey, three areas (A - area surrounding the Old WWTP structures, B - sludge disposal area, and C - drainage swale) were investigated to determine the presence of buried tanks, process piping, and UXO. Multiple subsurface objects were detected but not investigated during the survey. Based on the results of the UXO/magnetometer survey, the recommendation was made to record Area C (drainage swale) as a possible ordnance disposal area on the Facilities Master Plan. The survey also concluded that additional subsurface UXO investigations should be conducted prior to any intrusive activity at this site.

In 1993, a soil gas survey was completed at the Old WWTP Site as Phase II of the SI. Six soil gas samples were collected in the vicinity of the Old WWTP Site. Soil gas sampling was not performed in areas of suspected UXO due to the potential safety hazard (M&E, 1996). Field investigation screening procedures using a photoionization detector (PID) indicated that volatile organic compound (VOC) concentrations of 7 and 200 parts per million (ppm) were present in the subsurface soil. The report indicated that additional evaluation of the Old WWTP Site would be conducted by USACE.

From 1993 to 1995, evaluations were completed at the Old WWTP Site as Phases III through V of the multi-phase base-wide SI. The Old WWTP Site was included in the SI evaluation based on a 1988 NASA memorandum to USACE that indicated that a drainage swale located near the Old WWTP Site potentially had been used as an ordnance disposal site (Ebasco, 1988). The SI Report reiterated the findings of the 1993 preliminary reports that no evidence of ordnance was noted during the initial phases of the investigation. However, NASA discontinued field investigation of the Old WWTP Site in 1993 after completion of the UXO/magnetometer and soil gas surveys because the Site was associated with former

Navy activities (prior to 1959) and, therefore, fell under the jurisdiction of USACE FUDS Program (SAIC, 2003).

In 2000, a site assessment that included personnel interviews, direct push technology (DPT) soil sample collection (one boring), and laboratory analysis, was conducted at the Old WWTP Site (Earth Tech, Inc., 2000). A relative risk evaluation was performed using existing data and found the relative risk to be high.

In 2003, on behalf of the USACE, SAIC, Inc. completed a Limited Site Investigation (LSI) of several FUDS program sites located at WFF, including the Old WWTP Site. Soil samples were collected from three soil borings advanced in the suspected residual sludge mounds and in the sludge drying beds. Arsenic, iron, and silver were detected in surface and shallow subsurface samples that exceeded the human health and/or migration to groundwater screening criteria (USEPA Region III risk-based concentrations [RBCs] for residential and industrial soils, and USEPA Region III RBCs for protection of groundwater). SAIC, Inc. reported that data suggested that arsenic concentrations detected were the result of natural conditions or minor releases of arsenic at the sludge drying beds (SAIC, 2003). In addition, the iron and silver detected at concentrations that exceeded screening criteria in soil samples were collected from the sludge drying beds only, suggesting that former wastewater treatment activities had released metals to the sludge drying beds, as would be expected. Although mercury was not detected at concentrations exceeding screening criteria, the distribution of mercury detected in the soil samples indicated that the trickling filter may have been the source of the mercury (SAIC, 2003).

Organic compounds detected at concentrations above screening criteria at the Old WWTP Site consisted of five semivolatile organic compounds (SVOCs) (four PAHs and one non-PAH SVOC). No VOCs were detected at concentrations greater than screening criteria. The PAHs exceeding screening criteria were limited to the sludge drying beds and the maximum concentrations of these compounds were detected in the surface soil of the sludge beds and were attenuating with depth. This information indicated that the Old WWTP process was the source of the PAHs and that the elevated concentrations of PAHs should be limited to locations containing residual sludge.

It was recommended to collect additional soil samples adjacent to or beneath the sludge drying beds to confirm that concentrations exceeding screening criteria do not exist in the subsurface and to collect groundwater samples based upon the potential for contaminants detected in the soil to migrate to the groundwater.

On March 3, 2004, USACE representatives and Reactives Management Corporation performed a site visit to investigate the drainage swale leading from a storm water outfall identified under the Phase 1 SI as a possible ordnance disposal area. A low sensitivity Schonstedt magnetometer was utilized to survey the swale from the lowest identifiable point up hill to where rip-rap had been placed to control erosion. The survey identified a vertical stabilizer from an old aircraft (model not positively identified), several pieces of polycarbonate, evidently from aircraft windows or canopies, and various pieces of ferrous slag. No ordnance or aircraft explosive devices were located. Based on this survey, it was concluded that there is no indication of ordnance or explosive material in the swale at the Old WWTP Site (Tetra Tech, 2004).

In 2005, USACE representatives conducted site reconnaissance of the Old WWTP Site. During the visit, beads of elemental mercury were discovered several inches below the surface immediately adjacent to the pedestal of the rotary arm trickling filter. During an inspection of the trickling filter, a clogged and uncapped pipe was noted in the location where the seal drain should have been. Just below the surface of the stone filter media, beads of elemental mercury were observed several inches from the pedestal.

In 2006, a TCRA was conducted involving the demolition and removal of the trickling filter structure, including recovery of elemental mercury through vacuuming (approximately 7 to 8 pounds), from the Old WWTP (Weston, 2006). Soil samples collected below the trickling filter did not indicate an impact from the mercury release.

In 2007, an SI for the Old WWTP Site was completed, which included monitoring well installation and groundwater, soil, surface water, sediment, and sludge sampling. The SI also included a human health screening level risk assessment and an ecological screening (Weston, 2007). The SI Report concluded that the preliminary screening suggests that soil, sediment, and surface water do not pose a potential risk, whereas sludge and groundwater may pose a potential risk to human health and/or ecological receptors.

In 2012, as part of the RI, a sampling event was conducted in the area around the Pump House and transformer pad to further assess the extent of lead contamination in soil. In addition, paint chip samples were collected from the Pump House exterior to determine whether elevated detections of lead in soil around the transformer pad were attributed to lead-based paint flaking off the Pump House. The investigation determined that the lead-based paint flaking off the exterior of the Pump House was the source for lead contamination in soil around the transformer pad (Weston, 2013). Additional information regarding the RI is presented in Sections 2.5 through 2.7.

No other enforcement activities, removal actions, or remediation activities have been initiated at the Old WWTP Site.

2.3 COMMUNITY PARTICIPATION

The Proposed Plan (PP) for the Old WWTP Site was made available to the public on August 21, 2022. A copy of the PP was also sent to eight Federally Recognized Tribes. The PP and other documents, such as the RI report and Focused Feasibility Study (FFS) (Weston, 2015), can be found in the Administrative Record file and the Information Repositories maintained at the Eastern Shore Public Library (23610 Front Street, Accomack, Virginia 23301) and Island Library (4077 Main Street, Chincoteague, Virginia 23336). The notice of availability of the PP was placed in the Eastern Shore News on August 19 and on their website from August 19 through August 31, 2022. A public comment period was held from August 22 through September 21, 2022. A public information session was held on August 24, 2022 at the NASA Wallops Flight Facility Visitor Center. No comments were received during the comment period as noted in the Responsiveness Summary section of this ROD.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

The FUDS and other sites at NASA WFF have been divided into Operable Units (OUs) by the USEPA to further address future investigations and remediation, and the Old WWTP is designated as OU 6. This ROD deals only with the WFF FUDS Old WWTP Site and does not include or affect any other site or OU. The Old WWTP Site is one of multiple sites at WFF being addressed under CERCLA. The Old WWTP Site is adjacent to Site 9, Site 14, and Site 15 (Figure 2-2). This ROD applies only to the sludge, soil, surface water, and sediment at the Old WWTP Site. Separate investigations and assessments are being conducted for the other sites in accordance with CERCLA. Separate RODs, and remedial actions as appropriate, have been or will be prepared for the other sites.

The Selected Remedy is the final remedial action for the sludge, soil, surface water, and sediment at the Old WWTP Site under CERCLA.

The scope and role of the response action for the Old WWTP Site is to reduce risks to human health and the environment associated with exposure to contamination in sludge at the Old WWTP Site, which is a low-level threat waste. NASA has determined that Sludge Removal and Off-Site Disposal is necessary for the protection of ecological and human receptors. Through excavation and off-site disposal of sludge, this remedy will address all known and potential ecological and human health risks associated with sludge, soil, surface water, and sediment at the Old WWTP Site.

Groundwater is being addressed under the Project 11 Main Base RI and the ongoing PFAS investigation. Additional CERCLA actions unrelated to this ROD may be taken to address groundwater contamination.

2.5 SITE CHARACTERISTICS

2.5.1 Physical Setting

The Old WWTP Site is situated at the base of a moderate hill that consists of approximately 30 feet of topographic relief. The area surrounding the Old WWTP Site comprises approximately 0.8 acres, and includes mounded material identified in previous investigations as possible residual sludge piles located approximately 150 to 200 feet north of the Old WWTP structures (Figure 2-3). Elevation at the site ranges from approximately 16 to 20 feet above mean sea level. Topography of the Old WWTP Site slopes generally to the northwest. No perennially flowing surface water bodies are located on or adjacent to the Old WWTP Site. Stormwater runoff from the site flows overland in a northwesterly direction and discharges into one of two intermittent streams/stormwater drainage ditches located in the northern portion of the site. The intermittent streams originate at the discharge points of two permitted outfalls for the WFF stormwater collection network: Virginia Pollution Discharge Elimination System (VPDES) Permit No. VA0024457 Outfall 013 and Outfall 005 (Figure 2-3). These outfalls drain airfield runways and taxiways and grassy areas and are also fed by groundwater seeps. The intermittent streams converge in the northern area of the Old WWTP Site, after which surface water is conveyed in a northerly direction for approximately 0.4 miles before discharging into Little Mosquito Creek. This unnamed tributary to Little Mosquito Creek also receives runoff from other nearby sites. It should be noted that from the confluence of the intermittent streams in the northern area of the Old WWTP Site, the stream exhibits more perennial flowing characteristics with increased distance from the Old WWTP Site.

The geology underlying the Old WWTP Site is characterized by layers of unconsolidated sediments (sand, silt, gravel) over deeply buried bedrock. Shallow unconsolidated sediments consist of the Pleistocene and Holocene Columbia Group which occurs to a depth of approximately 60 feet in the WFF area. The underlying Yorktown Formation is the uppermost unit in the Chesapeake Group and occurs at depths of 60 to 140 feet in Accomack County. Lithologic logs from monitoring well installation indicate the lithology is consistent with the Columbia Group formation consisting of light brown to tan silty sand and sand, and minor amounts of gravel. The depths of the on-site monitoring wells from the top of casing range between approximately 12 and 26 feet below ground surface (bgs). The Columbia Group is separated from the underlying Yorktown Formation by a 20- to 40-foot-thick clay and silt layer. Groundwater within the shallower Columbia Group is unconfined and flow follows the local topography. Groundwater in the deeper Yorktown Formation is separated from the overlying Columbia water table aquifer by the clay and silt confining layer (aquitard). The Yorktown Formation aquifer is a confined aquifer and generally flows to the east northeast.

2.5.2 Human Health Conceptual Site Model

Figure 2-6 presents the Conceptual Site Model (CSM) for human receptors at the Old WWTP Site. Figure 2-7 and Figure 2-8 present the CSMs for the terrestrial and aquatic ecosystem. The CSM graphically integrates information regarding the physical characteristics of the Site, exposed populations, sources of contamination, and contaminant mobility (fate and transport) to identify potential exposure routes and receptors evaluated in the risk assessment. A well-defined CSM allows for a better understanding of the risks at a site and aids in the identification of the potential need for remediation.

2.5.3 Sampling Strategy

The Old WWTP Site RI field investigation activities were conducted in 2007 and 2012 to evaluate the nature and extent of contamination after the completion of the 2006 TCRA (Weston, 2006). The 2007 investigation included the installation of monitoring wells and sampling of soil, groundwater, surface water, sediment, sludge, and wastewater. The 2012 investigation included surface soil samples collected to further define the nature and extent of lead contamination around the transformer pad and Pump House structure (Weston, 2013). Sampling locations are presented on Figure 2-4.

During the 2007 monitoring well installation, eighteen soil samples (6 samples at 0 to 0.5 feet bgs, 6 samples at 0.5 to 2.0 feet bgs, and 6 samples ranging from 2 to 21 feet bgs) were collected from the monitoring well locations to evaluate surface and subsurface soils in monitoring well areas and to assess potential leaching of contaminants from soil. In addition, eight soil samples were collected in areas around the Old WWTP Site (WFF1-SS1 through WFF1-SS10). Soil samples WFF1-SS6 and WFF1-SS7 are duplicate samples for WFF1-SS1 and WFF1-SS5, respectively. All soil samples were analyzed for TCL (Target Compound List) VOCs, TCL SVOCs, TCL pesticides/polychlorinated biphenyls (PCBs), Target Analyte List (TAL) metals, and cyanide.

Two sediment samples were collected at 0 to 3 inches bgs from the intermittent stream in the northern portion of the site (WFF1-SD1 and WFF1-SD2). Sediment samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, and cyanide.

One surface water sample (WFF1-SW1), co-located with the sediment sample collected at WFF1-SD1, was collected from the confluence of the intermittent streams downstream of the outfall. The surface water sample was analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, and cyanide.

Three composite sludge samples (WFF1-SL01, WFF1-SL02, and WFF1-SL03) and one wastewater sample (WFF1-WW01- collected from the primary settling tank), were collected at the Old WWTP Site. The sludge samples and the wastewater sample were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, and cyanide.

In 2012, nine soil samples (WWTP-01 through WWTP-09) were collected around the transformer pad and Pump House structure to assess the additional nature and extent of lead contamination associated with lead detected at location WFF1-SS1 collected during the 2007 sampling event. All soil samples were analyzed for total lead. In addition, two paint chip samples were collected from the outside of the Old WWTP Pump House structure at locations WWTP-01 and WWTP-02. Paint chip sample WWTP-01 was collected from the white paint that is present on the bulk of the outside of the structure while sample WWTP-02 was collected from the black trim paint. Paint chip samples were analyzed for total lead.

2.5.4 Nature and Extent of Contamination

Analytical results were compared to the USEPA Residential and Industrial Soil regional screening levels (RSLs), which are risk-based concentrations for residential and industrial/commercial receptor populations. The non-carcinogenic RSLs were adjusted by a factor of 0.1 to account for additive effects (USEPA, 2009).

During RI preparation, analytical results were also compared to the 95 percent upper tolerance limit (UTL) presented in the Background Soil and Groundwater Investigation Report for the Main Base (Tetra Tech, 2004). For analysis in this ROD, background threshold values calculated in the 2021 background document (NASA, 2021) were used. The data sets used in both documents was comprised from surface and subsurface soil samples collected in areas at WFF that were removed from and/or upgradient of suspected sites. Sampling locations were selected to achieve adequate spatial coverage and representativeness across varied topographical features as well as minimization of impacts from past human activities. The soils data were separated into four data sets: Bojac surface, Bojac subsurface, Molena surface, and Molena subsurface. Soil in the vicinity of the Old WWTP has been classified as Molena loamy sand. Therefore, results for soil collected at the Old WWTP Site were compared to the background threshold values for Molena surface and subsurface soil.

2.5.4.1 Soil

During the February 2007 field investigation, 18 soil boring samples and 8 soil samples were collected to characterize the nature and extent of contamination on-site and analyzed for TCL VOCs, TCL SVOCs, TCL pesticides, TCL PCBs, TAL metals, and cyanide. In 2012, nine surface soil samples were collected around the transformer pad/Pump House area where the level of lead previously detected exceeded the residential direct contact screening level (400 milligrams per kilogram [mg/kg]). In addition, two paint chip samples were collected outside of the Pump House. The 2012 samples were only analyzed for lead and their locations are presented in Figure 2-4.

This section describes the nature and extent of contamination and compares the soil data to USEPA human health screening criteria and background 95 percent UTLs. Results were compared to ecological soil benchmarks as part of the risk characterization of the SLERA and are presented in Section 2.7.2.

The following analytes were detected in Old WWTP Site soils:

- Six VOCs (acetone, methyl ethyl ketone [MEK], methyl isobutyl ketone [MIBK], tetrachloroethene [PCE], toluene, and total xylenes) were detected in Old WWTP Site soils, but no VOCs were detected at concentrations above soil screening criteria. Acetone and MEK are common laboratory contaminants.

- Six SVOCs (benzo(a)pyrene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, dibenz(a,h)anthracene, di-n-butyl phthalate, and indeno(1,2,3-cd)pyrene) were detected in Old WWTP Site soils. Two of the six SVOCs detected in Old WWTP Site soils benzo(a)pyrene (30 to 34 micrograms per kilogram [µg/kg]) and dibenz(a,h)anthracene (33 to 50 µg/kg) exceeded the residential direct contact screening level of 15 µg/kg at WFF1-MW2 (MW2) and MW6, respectively. No SVOC results exceeded the industrial direct contact screening levels.

- Four pesticides and one PCB were detected in soil. No pesticides were detected at concentrations above screening criteria. Aroclor-1260 was detected in exceedance of the residential direct contact screening level of 220 µg/kg in one soil sample (WFF1-SS1 [SS1]) and in its field and blind duplicate samples (SS1-D) at concentrations ranging from 190 µg/kg to 290 µg/kg. No results exceeded the industrial direct contact screening level.

- More than 21 metals and cyanide were detected in the Old WWTP Site soil. However, only seven metals (aluminum, antimony, arsenic, cobalt, iron, lead, and manganese) were detected at concentrations in exceedance of residential direct contact screening levels. Arsenic was also detected at concentrations exceeding the industrial direct contact screening level of 1.6 mg/kg.

- Due to the lead exceedance in 2007, nine additional surface soil samples were collected in 2012 in the area around SS1 and the Pump House to further assess the extent of lead contamination. Results indicated lead concentrations in this area ranged from 13.5 to 2,450 mg/kg with the highest concentrations present in the samples collected adjacent to the Pump House. Based on the locations of the highest lead contamination, two paint chip samples were collected from the outside of the Pump House to assess whether the flaking paint was the source of the lead in surface soils. Lead results for the white paint indicated it contains approximately 9 percent (91,591 mg/kg) lead while the black trim paint had a lower lead content at approximately 0.4 percent (4,240 mg/kg). The lead content of the white paint indicates that the flaking paint found on the exterior of the Pump House was the probable source of the lead detected in soils in this area. This area was the only area on the site where lead concentrations exceeded the residential screening level of 400 mg/kg.

2.5.4.2 Sediment

Two sediment samples (WFF1-SD1 [SD1] and SD2) were collected from intermittent streams in the northern portion of the Site during the February 2007 Site Investigation. Sediment samples were collected from locations presented in Figure 2-4 and analyzed for TCL VOCs, TCL SVOCs, TCL pesticides, TCL PCBs, TAL metals, and cyanide. Analytical results from sediment samples were compared to residential direct contact and Biological Technical Assistance Group (BTAG) freshwater sediment ecological screening levels to determine the nature and extent of chemical contamination in sediment. The nature and extent of sediment contamination, based on a comparison of the analytical data to their respective screening levels, is discussed below.

- A total of 18 metals were detected in the sediment samples, with all but one of the maximum concentrations detected in WFF1-SD2. Of these 18 metals, only arsenic was detected at concentrations exceeding residential direct contact screening levels. No metals were detected in sediment samples at concentrations exceeding ecological-based screening levels. Arsenic was detected in both sediment samples at concentrations ranging from 1.4 mg/kg to 2.7 mg/kg, exceeding the residential direct contact soil screening level of 0.39 mg/kg, but below the soil background threshold value of 5.3 mg/kg. The presence of arsenic in sediment adjacent to the Old WWTP Site is likely a result of transport via stormwater runoff.

- A total of three pesticides (4,4'-DDD, 4,4'-DDE, and 4,4'- dichlorodiphenyltrichloroethane [DDT]) were detected in the sediment samples. These pesticides were not detected at concentrations exceeding human health or ecological-based screening levels.

- No PCBs or SVOCs were detected in the sediment samples.

- Two VOCs were detected in the sediment samples-acetone and MEK. Acetone and MEK are common laboratory contaminants. Analytical results reveal that none of these VOCs exceeded screening levels.

2.5.4.3 Surface Water

One surface water sample was collected at the Site during the February 2007 Site Investigation. The surface water sample (WFF1-SW1), co-located with sediment sample WFF1-SD1, was collected from the confluence of the intermittent streams downstream of the suspected Old WWTP effluent outfall. The surface water sample location is presented in Figure 2-4 and was analyzed for TCL VOCs, TCL SVOCs, TCL pesticides, TCL PCBs, TAL metals, and cyanide. Analytical results from the surface water sample were compared to 2006 BTAG Freshwater Screening Benchmarks. The nature and extent of surface water contamination, based on a comparison of the analytical data to their respective screening levels, is discussed below.

- A total of 10 metals were detected in the surface water sample. Of the 10 detected metals, only aluminum, barium, iron, and manganese were detected at concentrations exceeding screening levels. Aluminum was detected in surface water at a concentration of 2.5 milligrams per liter (mg/L), exceeding the screening level of 0.087 mg/L. Barium was detected in surface water at a concentration of 0.031 mg/L, exceeding the screening level of 0.004 mg/L. Iron was detected in surface water at a concentration of 7.2 mg/L, exceeding the screening level of 0.3 mg/L. Manganese was detected in surface water at a concentration of 0.46 mg/L, exceeding the screening level of 0.12 mg/L.

- No pesticides, PCBs, or SVOCs were detected in surface water.

- One VOC, chloromethane, was detected in the surface water at an estimated concentration of 0.53 micrograms per liter (µg/L). A surface water screening level is not available for chloromethane.

2.5.4.4 Sludge

Three composite sludge samples (WFF1-SL01 [SL01], SL02, and SL03) were collected at the Site during the February 2007 SI. One sludge sample (SL01) was collected from the primary settling tank. Very little sludge and very little wastewater was observed at the settling tank location. It should be noted that the settling tank is not covered and is open to the outside elements. As a result, the tank continues to receive rainwater and material from outside the clarifier tank. Five-point composite samples were collected from each of the two sludge drying beds (SL02 and SL03). Sampling locations are presented in Figure 2-4. Samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides, TCL PCBs, TAL metals, and cyanide. Analytical results were compared to residential and industrial direct contact screening levels to determine the nature and extent of chemical contamination in sludge. This section describes the nature and extent of sludge contamination, based on a comparison of the analytical data to their respective human health USEPA screening levels. Results were compared to ecological soil benchmarks as part of the risk characterization of the SLERA and are presented in Section 2.7.2.

The following analytes were detected in Old WWTP Site sludges:

- Seven VOCs (1,1,2,2-tetrachloroethane, 2-hexanone, acetone, MEK, MIBK, PCE, and toluene), were detected in the sludge samples. In general, the maximum number of VOC analytes detected and the highest concentrations were observed in the sludge sample collected from the primary settling tank (SL01). Analytical results indicated that none of the detected VOCs exceeded the residential direct contact screening levels. Acetone and MEK are common laboratory contaminants and were detected in the sludge samples at low concentrations that may be attributable to laboratory contamination. PCE was detected in only one of the three sludge samples at SL02 at a concentration of 5.1 µg/kg, below the residential direct contact screening level of 38,000 µg/kg. PCE in soil is limited to the soil and sludge within the sludge drying bed. Toluene was detected in two of the sludge samples at concentrations of 6.2 µg/kg at SL02 and 1,200 µg/kg at SL01. These concentrations did not exceed the residential direct contact soil screening level of 500,000 µg/kg.

- Seventeen SVOCs were detected in the sludge samples. The maximum SVOC concentrations were detected in the sludge sample collected from the primary settling tank (SL01). Of the 17 detected SVOCs, 6 PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were detected at concentrations exceeding their respective residential direct contact screening levels. The extent of PAH contamination is limited to the sludge within the sludge drying beds and primary settling tank. The sludge drying bed samples were composite samples collected from 0 to 2 feet bgs. The depth of the sludge was observed to be approximately 6 inches and was underlain by approximately 18 inches of gravel and rock that, in turn, overlie what appears to be native soil (Weston, 2013). The presence of PAHs in the walled settling tank and sludge drying beds is thought to be attributable to the treatment of industrial water received via sanitary sewers at the Old WWTP and not a result of background conditions.

- Four pesticides (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and dieldrin) were detected in the sludge samples. Three of the pesticides (4,4'-DDD, 4,4'-DDE, and 4,4'-DDT) were detected in all of the sludge samples, with the maximum concentrations detected in the two sludge drying bed samples. Dieldrin was detected in the two sludge drying bed samples only. 4,4'-DDD was detected at concentrations ranging from 110 to 1,200 µg /kg; 4,4'-DDE was detected at concentrations ranging from 67 to 1,400 µg/kg; 4,4'-DDT was detected at concentrations ranging from 110 to 1,100 µg/kg; and dieldrin was detected at concentrations ranging from 5.6 to 9.9 µg/kg. No pesticides were detected in the sludge samples at concentrations exceeding residential direct contact screening levels.

- No PCBs were detected in the sludge samples.

- Numerous metals were detected in the three sludge samples collected from the sludge drying beds and settling tank at the Old WWTP Site. Eight metals, including antimony, arsenic, cobalt, iron, lead, manganese, mercury, and silver, were detected at concentrations exceeding residential direct contact screening levels. Arsenic and mercury were also detected at concentrations exceeding industrial direct contact screening levels. In general, the maximum concentrations of metals were detected in the sludge samples collected from the sludge drying beds, SL02 and SL03. The concentration ranges of metals, along with a comparison to the background 95 percent UTL, are described as follows:

  - Arsenic was detected in the two samples collected from the sludge drying beds at concentrations ranging from 2.6 to 3.2 mg/kg. Results from both samples exceeded the residential direct contact screening level of 0.39 mg/kg and the industrial direct contact screening level of 1.6 mg/kg. However, arsenic concentrations were below the background threshold value of 5.3 mg/kg.

- Cobalt was detected in the two samples collected from the sludge drying beds at concentrations ranging from 2.0 to 2.6 mg/kg. Results from one of the samples exceeded the residential direct contact screening level of 2.3 mg/kg. The background threshold value for cobalt is 8.8 mg/kg in soils. Cobalt in sludge is below the background threshold value.

- Iron was detected in all sludge samples at concentrations ranging from 12,000 to 15,000 mg/kg. Concentrations of iron exceeded the residential direct contact screening level of 5,500 mg/kg in all sludge samples. The background threshold value for iron is 24,200 mg/kg in soils. Iron detected in the sludge samples are below the background threshold value.

- Lead was detected in all sludge samples at concentrations ranging from 130 to 530 mg/kg. Results from one of the samples collected from the sludge drying beds exceeded the residential direct contact screening level of 400 mg/kg.

- Manganese was detected in all sludge samples at concentrations ranging from 160 to 270 mg/kg. Results from two of the samples exceeded the residential direct contact screening level of 180 mg/kg. The background threshold value for manganese is 213 mg/kg in soils. Manganese detected in the sludge samples is similar to the background threshold value.

- Mercury was detected in all sludge samples at concentrations ranging from 0.17 to 28 mg/kg. The two sludge samples collected from the sludge drying beds contained mercury concentrations exceeding the residential direct contact screening level of 0.67 mg/kg and the industrial direct contact screening level of 2.8 mg/kg. The background threshold value for mercury is 0.048 mg/kg in soils. Mercury concentrations in sludge exceeded the background threshold value for soil.

- Silver was detected in the two samples collected from the sludge drying beds at concentrations ranging from 110 to 130 mg/kg. Results from both samples exceeded the residential direct contact screening level of 39 mg/kg.

- Concentrations of arsenic, cobalt, iron, and manganese in Old WWTP Site sludge are attributable to background concentrations in soil at the Old WWTP Site. Background threshold values are not available for lead and silver. Concentrations of mercury in sludge exceeded the background threshold value and residential screening level. The source of mercury is likely a result of residual contamination associated with the trickling filter. Sludge contaminants, including lead, mercury, and silver, are confined to areas of the Old WWTP Site where sludge is located.

2.5.4.5 Wastewater

One wastewater sample (WFF1-WW01) was collected at the Site from the primary settling tank during the February 2007 Site Investigation. The wastewater sampling location is presented in Figure 2-4 and was analyzed for the TCL VOCs, TCL SVOCs, TCL pesticides, TCL PCBs, TAL metals, and cyanide. Analytical results from the wastewater sample were screened against 2006 BTAG Freshwater Screening Benchmarks.

The following analytes were detected in Old WWTP Site wastewater:

- Two common laboratory contaminants, acetone and MEK, were detected in the wastewater sample collected from the primary settling tank. Analytical results indicated that neither VOC was detected at concentrations that exceeded screening levels used for wastewater. The presence of acetone and MEK in the samples may be attributable to laboratory contamination.

- Three PAH constituents (fluoranthene, phenanthrene, and pyrene) were detected in the wastewater sample collected from the primary settling tank. All of the SVOCs were detected at concentrations exceeding their respective screening levels. Very little wastewater was observed at the settling tank location. The settling tank is not covered and is open to the outside. As a result, the tank continues to receive rainwater and material from outside the settling tank.

- No pesticides or PCBs were detected in the wastewater samples.

- Twelve metals were detected in the wastewater sample collected from the settling tank at the Old WWTP Site. Aluminum, barium, iron, lead, and manganese were detected at concentrations exceeding surface water screening levels. The presence of metals in the water collected from the settling tank is likely a result of suspended particles present in the sample. Aluminum, barium, iron, lead, and manganese were also detected in the sludge sample collected from the settling tank.

2.5.5 Fate and Transport

Sampling at the Old WWTP was designed to evaluate the impact of Old WWTP processes and the mounded material identified in previous investigations as possible residual sludge piles. Potential sources of contamination include the two sludge drying beds thought to contain residual sludge materials associated with Old WWTP activities, residual sludge piles, and the trickling filter. Some contaminants at the Site are likely the result of the historical use of pesticides (e.g., DDT) and flaking lead-based paint at the Pump House. The use of DDT as a pesticide was widespread for nearly 40 years until it was banned in 1972. Because of the low chemical reactivity, resistance to oxidation, and resistance to other degenerative processes, residues of these compounds have been shown to be persistent in the environment. Further, these compounds generally are not soluble in water but can accumulate in the tissues of organisms that live in the water. PAHs may be derived from a number of sources that have entered the Site through the wastewater treatment system, including fuel residue and the combustion of organic materials. PAHs, like DDT, have a strong tendency to bind to sediment particles rather than dissolve in water; therefore, when PAH residues enter a body of water (e.g., wastewater), they tend to accumulate in sediments (Lindsey et al., 1998) or in this case, the sludges.

Limited contamination in surface and subsurface soils has been confirmed by historical investigations at the Old WWTP Site. The contaminants that are present in site soils include pesticides (4,4'-DDD, 4,4'- DDE, 4,4'-DDT;, and dieldrin), Aroclor-1260, SVOCs (benzo[a]pyrene, benzo[g,h,i]perylene, bis[2- ethylhexyl]phthalate, dibenz[a,h]anthracene, di-n-butyl phthalate, and indeno[1,2,3-cd]pyrene), VOCs (acetone, MEK, MIBK, PCE, toluene, and total xylenes), and metals. Chemicals of potential concern (COPCs) (constituents detected at concentrations exceeding the screening levels) for soils include metals (aluminum, antimony, arsenic, cobalt, iron, lead, and manganese), Aroclor-1260, and PAHs (benzo[a]pyrene and dibenz[a,h]anthracene).

Residual sludge is present in the settling tank and the sludge drying beds. The contaminants that are present in site sludge include pesticides (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and dieldrin), SVOCs, VOCs, and metals. COPCs for sludge include metals (antimony, arsenic, cobalt, iron, lead, manganese, mercury, and silver) and PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene). These contaminants are subjected to physical, biological, and chemical reactions that directly influence their persistence and potential migration.

The constituents that were detected at levels greater than the screening levels in soils, sludge, and sediment at and adjacent to the Old WWTP Site have high adsorption coefficients, low water solubilities, and low vapor pressures, indicating the constituents are relatively immobile, somewhat persistent, and have low volatility.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

<u>Land Use</u>

Currently, WFF is used as a launch facility and airfield. Site personnel indicate that there are currently no plans to change the land use from industrial use or to close the facility. Further, closure of the facility is unlikely based on reasons related to orbital trajectory and economies that can be achieved from launches at the WFF latitude, but not at other latitudes.

The Old WWTP Site is northwest of the intersection of Runway 17-35 and the abandoned taxiway that parallels Runway 10-28 in the north-central portion of the Main Base. Access is strictly controlled by personnel in the Air Traffic Control Tower who monitor activities in the vicinity of the airfield. Only facility employees involved with mission related activities such as maintenance and groundskeeping are expected to enter the Old WWTP Site. In addition, security personnel routinely patrol the area.

It is likely that the future uses will include the current uses identified above. The Old WWTP Site is located near active runways and well within both noise hazard and airfield crash pattern areas. However, given its zoning, it is possible that the area can be commercially developed in the future. Although it is possible the Old WWTP Site could be developed at some point in the future for residential purposes, it is considered highly unlikely given the location of the Site (adjacent to active runways), the current uses of the Site, its surroundings, and the likelihood that the use of the area will not change.

2.7 SUMMARY OF SITE RISKS

2.7.1 Summary of Human Health Risk Assessment

The results and conclusions summarized in this section are from the BHHRA presented the RI (Weston, 2013), with updates provided in Section 2.7.1.4 of this ROD. These updates did not change the overall conclusion of the BHHRA. The BHHRA evaluated potential risks from contaminants in soil, sediment and surface water to the current/future older child trespasser, future commercial/industrial workers, future construction workers, hypothetical future child and adult residents, and age-adjusted resident. The BHHRA also evaluated the potential risks from contaminants in sludge and wastewater to the older child trespasser, future commercial/industrial workers, and future construction worker. The human health risks from exposure to residual sludge in the drying beds and residual sludge and wastewater in the settling tank were not evaluated for the hypothetical residential scenario due to the small amount of sludge/wastewater present and the construction activities associated with the hypothetical scenario. In the scenario where the Old WWTP Site is redeveloped for residential use, it was assumed that the existing Old WWTP structures, including residual sludge/wastewater, would be removed from the site during development. The risk summary is presented in Table 2-1. The risk estimates for the hypothetical future adult and age-adjusted residents, current/future older child trespasser, future commercial/industrial worker, and future construction worker were all within or below the USEPA risk management range of 1 x 10^{-6} to 1 x 10^{-4}. The future adult and child resident scenario had a hazard index (HI) less than the noncancer HI management level of 1, and HIs for the current/future older child trespasser, future commercial/industrial worker, and future construction worker were less than or equal to 1. The future residential scenarios were included in the evaluation to conservatively estimate cancer risks and HIs for the Old WWTP Site.

2.7.1.1 Identification of Chemicals of Potential Concern

Table 2-2 presents the COPCs, the frequency of detection, screening values, maximum concentration detected, and exposure point concentrations for each of the COPCs detected in soil, surface water, sediment, sludge and how the exposure point concentration was derived. Contaminants were selected as a COPC if the maximum detection exceeded the appropriate RBC. The exposure point concentration is the concentration that was used to estimate the exposure and risk from each COPC.

2.7.1.2 Exposure Assessment

This section presents a summary of the exposure assessment detailed in the RI Report (Weston, 2013). The exposure assessment defines and evaluates the type and magnitude of human exposure to the chemicals present at or migrating from a site. The exposure assessment is designed to depict the physical setting of the site, to identify potentially exposed populations, and to estimate chemical intakes under the identified exposure scenarios. Actual or potential exposures are based on the most likely pathways of contaminant release and transport, as well as human activity patterns. A complete exposure pathway has the following three components: a source of chemicals that can be released into the environment, a route of contaminant transport through an environmental medium, and an exposure or contact point for a human receptor.

The compilation of contaminant sources, likely exposure pathways, and receptors at the Old WWTP Site are depicted in the CSM (Figure 2-6). Potential receptors include current/future older child trespasser, future commercial/industrial workers, future construction workers, and hypothetical future child and adult residents. It was conservatively assumed that the site could be developed for residential purposes in the future, thus a hypothetical future residential scenario was evaluated.

Major assumptions about exposure frequency (days per year), exposure duration (years), and other exposure factors (e.g., body surface area for dermal exposure, ingestion rates) that were included in the exposure assessment can be found in the RI Report (Weston, 2013).

2.7.1.3 Toxicity Assessment

Tables 2-3 and 2-4 provide carcinogenic risk information which is relevant to the COPCs in soil, surface water, sediment, sludge, and wastewater. The oral reference doses (RfD) and inhalation reference concentrations (RfC) used for each compound, and the source of the data, are provided in the attached tables. As indicated in Tables 2-3 and 2-4, some compounds are not considered carcinogenic or lack sufficient toxicity information to support the development of specific oral or inhalation toxicity criteria (noted as NA in the tables). At this time, slope factors are not available for the dermal route of exposure. Thus, the dermal slope factors used in the assessment have been extrapolated from oral values. An adjustment factor is sometimes applied and is dependent upon how well the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50 percent absorption via the ingestion route. Adjustment factors applied for the chemicals evaluated at this site are provided in Table 2-3. For those compounds where an adjustment is not necessary, the factor is noted as 1.0 in Table 2-3 and the oral slope factor was used as the dermal carcinogenic slope factors.

Tables 2-5 and 2-6 provide noncarcinogenic risk information which is relevant to the COPCs in soil, surface water, sediment, sludge, and wastewater. Nine COPCs have toxicity data indicating their potential for adverse non-carcinogenic health effects on humans by oral and/or dermal absorption (Table 2-5). The oral RFDs applied to the Old WWTP Site contaminants, and the source of the toxicity data, are provided in Table 2-5. As was the case for the carcinogenic data, dermal RfDs can be extrapolated from the oral RfDs applying an adjustment factor as appropriate. Adjustment factors applied to the COPCs identified at the Old WWTP Site are shown in Table 2-5. The primary target organ affected by each COPC, if available for chronic and sub chronic animal studies, is provided in Table 2-5.

Four of the Old WWTP Site COPCs have toxicity data indicating a potential for adverse noncarcinogenic health effects on humans by the inhalation pathway. The inhalation RfC, and source of the toxicity data, for each applicable compound is shown in Table 2-6. This table also identifies the primary target organs affected by each COPC as applicable.

2.7.1.4 Human Health Risk Characterization

Cancer risks are calculated for carcinogens through applicable exposure routes (i.e., oral or dermal). Potential cancer risks are calculated by multiplying the estimated lifetime average daily intake (LADD) that is calculated for a COPC through an exposure route by the exposure route-specific cancer slope factor (CSF), as follows:

$$\text{Cancer Risk} = \text{LADD} \times \text{CSF}$$

Where:

LADD = Lifetime average daily intake (dose) of the carcinogen averaged over a 70-year lifetime (mg/kg per day [mg/kg/day]).
CSF = COPC- and route-specific cancer slope factor $(\text{mg/kg/day})^{-1}$.

The excess cancer risk for a receptor exposed via the inhalation pathway can be estimated with the following equation:

$$\text{Cancer Risk} = \text{EC} \times \text{IUR}$$

Where:

EC = Exposure concentration (micrograms per cubic meter [μg/m3]).
inhalation unit risk (IUR) = COPC-specific inhalation unit risk $(\mu g/m3)^{-1}$.

The total lifetime excess cancer risk for the scenarios and receptors is estimated by summing the cancer risks calculated for COPCs through applicable exposure routes.

The potential for noncarcinogenic health effects as a result of exposure to a single COPC through a single exposure pathway is referred to as the hazard quotient (HQ). HQs for the ingestion and dermal pathways are calculated using the following equation:

$$HQ = ADD/RfD$$

Where:

HQ = Hazard quotient.
ADD = Average daily dose for the COPC averaged over the exposure duration (mg/kg/day).
Reference Dose (RfD) = COPC- and route-specific reference dose (mg/kg/day).

The HQ for the inhalation pathway can be calculated with the following general equation:

HQ = EC/Toxicity value x 1,000 microgram per milligram (μg/mg).

Where:

HQ = Hazard quotient.
EC = Exposure concentration (μg/m3).
Toxicity value = Reference Concentration (RfC) = COPC-specific inhalation reference concentration (milligrams per cubic meter [mg/m3]).

HQs are summed to calculate a total HI for pathways and receptors. If the HI is less than or equal to one, it is believed that there will not be significant potential for noncarcinogenic health effects to that receptor. If the HI exceeds 1, there may be a risk of noncarcinogenic health effects. In that case, the HQs calculated for the COPCs, which reflect different chemical-specific toxic effects, may not be additive. Therefore, HIs are segregated according to target organ.

Chemicals of Concern

A chemical was retained as a COC if the total incremental lifetime cancer risk (ILCR) for a medium exceeded $1x10^{-4}$ and the chemical specific ILCR exceeded $1x10^{-6}$ or if the total HI on a target organ basis exceeded 1 and the chemical specific HI exceeded 0.1. The carcinogenic trigger represents the summed risks to a receptor considering all pathways, media, and routes per land use scenario. The HI represents the total of the HQs of all COPCs in all pathways, media, and routes to which the receptor is exposed. Chemicals are not considered COCs if their individual carcinogenic risk contribution is less than $1x10^{-6}$ and their noncarcinogenic HQ is less than 0.1. No COCs were identified for the hypothetical age-adjusted resident (Table 2-7), future adult resident (Table 2-8), and the hypothetical future child resident (Table 2- 9), as there were no primary risk drivers for soil, sediment, and surface water.

Future Age-Adjusted Resident

The carcinogenic risk calculated in the 2013 RI for the future age-adjusted resident is presented in Table 2-7A. The total carcinogenic risk for this receptor was estimated to be $2x10^{-5}$. Therefore, no primary risk drivers were identified.

Risks were recalculated to account for mutagenic carcinogens because age-specific adjustment factors (ADAFs) were not applied in the 2013 RI. In addition, updated toxicity criteria and exposure assumptions were used in these calculations. The recalculated carcinogenic risks for the future age-adjusted resident are presented in Table 2-7B. The total carcinogenic risk is estimated at $1x10^{-5}$ and is comparable to the total risk calculated in the 2013 RI ($2x10^{-5}$).

Hypothetical Future Adult Resident

The carcinogenic and noncarcinogenic risk calculated in the 2013 RI for the hypothetical future adult resident is presented in Table 2-8A. The total noncarcinogenic risk was estimated to be 0.1. Therefore, no primary risk drivers were identified.

Risks were recalculated to account for mutagenic carcinogens because ADAFs were not applied in the 2013 RI. In addition, updated toxicity criteria and exposure assumptions were used in these calculations. The recalculated carcinogenic risks for the hypothetical future adult resident are presented in Table 2-8B. The total carcinogenic risk for this receptor is estimated to be $2x10^{-6}$ and is comparable to the total risk calculated in the 2013 RI ($5x10^{-6}$). The total noncarcinogenic risk is estimated to be 0.1 and is equal to that presented in the 2013 RI (0.1).

Hypothetical Future Child Resident

The noncarcinogenic risk calculated in the 2013 RI for the hypothetical future child resident is presented in Table 2-9A. The total noncarcinogenic risk was estimated to be 1.

Risks were recalculated to account for updated toxicity criteria and updated exposure assumptions. The recalculated carcinogenic risks for the hypothetical future child resident are presented in Table 2-9B. The total noncarcinogenic risk is estimated to be 1, which is equal to the HI calculated in the 2013 RI.

Uncertainty Analysis

The BHHRA assumed that the sludge would be removed if the site was ever redeveloped for residential use, so the risk for residential exposure to the sludge was not calculated.

No site-related COCs with vapor intrusion potential were identified in the media. Therefore, vapor intrusion is an incomplete exposure pathway, and further evaluation was not necessary in the risk assessment.

There were no significant sources of uncertainty in the risk assessment. The inherent uncertainties in this risk assessment from using the USEPA methods would likely overestimate actual risk.

2.7.2 Summary of Ecological Risk Assessment

The SLERA was performed to evaluate the potential ecological effects from exposure to the contaminants at the Old WWTP Site. This multi-pathway analysis was based on reasonable, protective assumptions about the potential for ecological receptors to be exposed and/or adversely affected by the exposure to chemicals of potential ecological concern (COPECs). Figure 2-2 shows the close proximity between Sites 9, 14, 15, and the Old WWTP Site. As a result, their habitats and ecological receptors are similar, and some of the data collected and used to characterize risks from these other sites have been incorporated into the assessment for the Old WWTP Site. Details may be found in the RI Report (Weston, 2013). The SLERA for the Old WWTP Site included the following steps of the SLERA process:

- Step 1 - Screening-level problem formulation and ecological effects evaluation.
- Step 2 - Screening-level exposure estimate and risk calculation.
- Step 3 - Baseline risk assessment problem formulation.
- Step 4 - Study design and data quality objective process.
- Step 5 - Field verification of sampling design.
- Step 6 - Site investigation and analysis phase.
- Step 7 - Risk characterization.

- Step 8 - Risk management.

2.7.2.1 Identification of Chemicals of Concern

To establish the list of COPECs, the USEPA Region III BTAG Screening Benchmarks and other available sources were used to screen soil, sludge, sediment, and surface water for ecological risks. If the BTAG tables did not provide a value for a detected compound, benchmarks were obtained from various sources (Ecological Soil Screening Levels [ECO SSL], Oak Ridge National Laboratory (ORNL), Interim sediment quality guideline, probably effect level, and VDEQ Water Quality for Freshwater Acute and Chronic Aquatic Life Standards). The final list of COPECs for which food chain modeling was conducted consisted of constituents meeting the following criteria:

- Constituents whose maximum concentration exceeded the ecological benchmark.
- Constituents for which ecological benchmarks were not available.
- Bioaccumulative compounds.

Food chain modeling was also conducted for COPECs. To determine whether fish potentially entering the upper portion of the unnamed tributary adjacent to the Site could be impacted by contaminated surface water or sediment, potential concentrations of COPECs in fish tissue were modeled for comparison with literature-based data on toxicological effects. The projected fish tissue concentration was modeled based on derivation of bioaccumulation factors (BAFs) using data previously collected on fish and sediment in Little Mosquito Creek during the ecological risk assessment of Sites 14 and 15. Specific results of the SLERA evaluation are presented in the RI (Weston, 2013) and FFS (Weston, 2015).

There is a potential for adverse effects to ecological receptors from COPECs concentrations in the terrestrial and aquatic systems. Because of the biomagnification potential associated with some of the COPECs, it was determined that representative, upper and intermediate trophic level receptors needed to be evaluated. For terrestrial evaluation, the American robin, short-tailed shrew, red fox, and red-tailed hawk were selected as target receptors. For aquatic, the mink, raccoon, and great-blue heron were selected as target receptors. The food chain HQ was calculated for each of these receptors.

Two different risk scenarios were addressed by modeling. The first was highly conservative, and evaluated risks using a no observed adverse effect level (NOAEL) as a toxicity reference value (TRV), or measure of toxicological effect. The second scenario was more realistic as the lowest observable adverse effect level (LOAEL) was used as a measure of toxicological effect for comparison with the dose under this scenario. Soil and sludge data were used to evaluate the ecological risk to terrestrial receptors. Sediment and surface water data were used to evaluate the ecological risk to aquatic receptors.

<u>Terrestrial Ecosystems</u>

COPECs in soil were evaluated and found to have a low degree of risk over a limited geographic area. Population impacts to the species evaluated were found to be unlikely.

COPECs in sludge samples collected from the drying beds contained metals, pesticides and PAHs at concentrations in excess of ecological screening levels. The RI concluded that the sludge drying beds were small and contained and not viewed to be adequate for ecological receptor habitat. The FFS considered the likelihood of release that could occur in the future which could result in ecological risk. Further evaluation and food chain modelling presented in the FFS indicated that chromium, mercury, DDD, and DDE concentrations in the sludge present a moderate to high ingestion risk to ecological receptors (American robin and short-tailed shrew).

Table 2-10 presents the Old WWTP Site occurrence, distribution, and selection of COPECs and Table 2-11 presents the preliminary remediation goals (PRGs) and HQs for terrestrial receptors. Results indicate the potential for ecological risks to American robins and short-tailed shrews from ingestion of earthworms contaminated with site sludge. HQs greater than 1.0 calculated using the LOAEL as a toxicological reference were noted for the American robin from ingestion of earthworms contaminated with DDD (HQ = 3.5), DDE (HQ = 9.8), chromium (HQ = 1.1), and mercury (HQ = 52). HQs greater than 1.0 calculated using the LOAEL as a toxicological reference were noted for the short-tailed shrew from mercury (HQ = 1.5).

Aquatic Ecosystems

No HQs greater than 1.0 were noted for the aquatic receptors evaluated. Detailed tables can be found in the RI (Weston, 2013).

2.7.2.2 Exposure Assessment

This section presents a summary of exposure assessment detailed in the Old WWTP Site RI Report (Weston, 2013). The habitat, contaminants present, migration pathways, and the routes by which receptors may be exposed to chemicals were defined and evaluated as part of the SLERA. The Old WWTP Site consists of a disturbed area that is regenerating early successional old field vegetation, dominated by common species such as switchgrass, broomsedge, bush clover (*Lespedeza* sp.), ragweed (*Ambrosia artemesifolia*), goldenrods (*Solidago* spp.) and others. It is adjacent to a forested area to the north dominated by an overstory of sweet gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), black cherry (*Prunus serotina*) and loblolly pine, and understories of greenbrier (*Smilax rotundifolia*), wax myrtle (*Morella cerfera*), and ostrich fern (*Matteuccia struthiopteris*). This type of habitat is common in the forested floodplains of coastal northern Virginia.

The largest parcel of natural terrestrial habitat at WFF, a mixed deciduous/pine forest that borders Little Mosquito Creek, is adjacent to and west of the Old WWTP. This forest consists of a dense canopied stand of loblolly and Virginia pine (*P. taeda* and *Pinus virginiana*), willow and black oak (*Quercus phellos* and *Qurecus velutina*), sweetgum, and red maple. Shrub and herb layers are sparse throughout the forest, except in the occasional open areas. In the shrubby areas, spicebush (*Lindera benzoin*), Tartarian honeysuckle (*Lonicera tatarica*), and principal canopy trees are found. Bracken (*Pteridium aquilinum*) and partridgeberry (*Mitchella repens*), as well as unidentified grasses, are found in the forest.

The portion of the unnamed tributary adjacent to the Site is surrounded by freshwater (palustrine) forested wetlands dominated by sweetgum, red maple and occasional loblolly pine. The soil and sediment samples collected during the RI were collected largely within this area.

The unnamed tributary itself receives runoff from the runway, taxiways and ramp areas, and the surrounding vicinity. It is clear on the basis of available information that the upper end of this tributary at the Site is fed primarily by stormwater flow. Site personnel indicated that the flow is intermittent or non-flowing during periods without precipitation. The tributary is fed by two existing stormwater outfalls (013 and 005) (Figure 2-3). In addition, it is likely that the Old WWTP itself provided a significant source of discharge water to the unnamed tributary because it discharged to the tributary when the Old WWTP was still operational. The overflow pipe's outfall could not be located during the TCRA. However, during the Site Investigation field activities, the pipe was located approximately 2 feet below grade and completely buried. The location of the suspected effluent outfall is shown in Figure 2-3. The intermittent streams converge north-northwest of the Old WWTP Site, after which stormwater runoff is conveyed in a northerly direction for approximately 0.3 mile before discharging into Little Mosquito Creek.

The wetlands associated with the unnamed tributary are tidally-influenced and primarily herbaceous. Principal species include Spartina grasses (*Spartina alterniflora, S. patens*, and *S. cynosuroides*) and threesquare (*Scirpus pungent*). In the delta where the drainage ditch flows into Little Mosquito Creek, there is an area of tidally-influenced wetland scrub/shrub habitat. This habitat is dominated by wax myrtle, buttonbush (*Cephalanthus occidentalis*), and groundsel bush (*Baccharia halimifolia*). Some small trees are also found scattered in this area, primarily black willow (*Salix nigra*) and red maple. Cinnamon fern (*Osmunda cinnamomea*) and royal fern (*Osmunda regalis*) are the primary herbs found in the scrub/shrub habitat.

A very narrow margin of deciduous forested wetland exists along most of the length of the drainage ditch of the scrub/shrub area. These wetlands are not tidally-influenced and are dominated by small trees (6- to 10-inch-diameter at breast height) with a 60-foot tall canopy. The primary species found there are red maple, black willow, and sweetgum. Spicebush is the most commonly found shrub, with sensitive fern (*Onoclea sensibilis*), royal fern, and cinnamon fern being the most common herbs.

The USEPA recommends that receptor species be selected to represent a specific trophic level or feeding guild for assessing local food chain effects. This selection process was used to develop and refine a conceptual food chain model which incorporates a variety of ecological receptors deemed representative of plant and animal communities associated with the Old WWTP Site. Figures 2-6 and 2-7 presents the Ecological CSM for the terrestrial and aquatic ecosystem.

The Old WWTP Site is located within the Little Mosquito Creek Conservation Site. Of the special status species lists resulting from searches, only the bald eagle is known to have been observed and the species has nested at one location on Little Mosquito Creek.

Table 2-12 presents the ecological exposure pathways of concern as well as assessment and measurement endpoints of concern. The assessment endpoints have been selected to address both the potential direct and indirect impacts resulting from exposure to COPECs. The receptors evaluated for the Old WWTP Site terrestrial ecosystem are vegetation, soil fauna, insectivorous birds and mammals, and carnivorous mammals. The receptors evaluated for the aquatic ecosystem are surface water and sediment benthic invertebrates, fish, and piscivorous mammals and birds.

2.7.2.3 Ecological Effects Assessment

The assessment methods used in the SLERA considered only comparisons of media concentrations, comparisons of tissue residues, or modeled doses with benchmark values and reference toxicity values. The selection of receptors for actual modeling considered available site-specific information already collected at nearby Sites 14 and 15 (Figure 2-2). Because fish live their entire life in the water column and would be exposed to contaminants for a longer duration, they are conservative receptors for evaluating the unnamed tributary since the upper portion of it adjacent to the Old WWTP Site is apparently dry for part of the year. While the CSM indicated that frogs are receptors that potentially could be at risk, a separate analysis was not undertaken for frogs due to lack of tissue data, and the fact that the analysis using fish data should be adequately protective of frogs as well. Uptake to killifish was modeled with the site-specific data from Sites 14 and 15.

The food chain ingestion models employed to assess potential risks to piscivorous birds and mammals used killifish as the exclusive food item. The concentration in the fish tissue was modeled using site-specific data collected previously during the Sites 14 and 15 RI (Weston, 2013). Maximum concentrations of analytes detected in killifish collected in Little Mosquito Creek were divided by maximum sediment concentrations of the same analytes to determine the fraction of contaminants potentially accumulating into fish tissue, or BAF. The fish tissue BAF was then multiplied by the maximum concentration of analytes detected in sediment in the three samples collected adjacent to Site 9. The analysis limited those analytes that were COPECs, that is, that were considered bioaccumulative in sediment above screening benchmarks. The resultant BAFs by analyte that were used to estimate tissue concentrations of killifish potentially entering the upper portion of the unnamed tributary can be found in the Site 9 RI (Weston, 2013).

2.7.2.3.1 Assessment Endpoints

<u>Terrestrial Ecosystem</u>

Maximum concentrations of metals in soil (aluminum, antimony, cadmium, iron, lead, manganese, mercury, vanadium, and zinc) as well as 4,4,-DDT, dieldrin, and aroclor-1260 exceeded soil ecological benchmarks at the Old WWTP Site. Of these, zinc exceeded its WFF background threshold value. Background threshold value are not available for antimony, lead, and dieldrin. Lead concentrations are related to flaking lead-based paint on the exterior of the Pump House. All chemicals that do not have or exceed a background threshold value, chemicals for which no benchmarks were available (cyanide, bis[2-ethylhexyl]phthalate, acetone, MEK, and MIBK), and bioaccumulative chemicals (mercury and DDT compounds) were all retained for analysis of potential food chain impacts using modeling. PCBs were not analyzed as part of the background evaluation, thus Aroclor-1260 was also retained for further assessment.

Food chain HQ modeling of COPECs in soil indicated that the American robin and short-tailed shrew will be at risk from ingestion of soil invertebrates. Modeling using the NOAEL as a toxicological reference indicated risks from robins ingesting soil invertebrates contaminated with DDD, DDE, DDT, Aroclor-1260, aluminum, lead, mercury, vanadium, and zinc. Modeling using the LOAEL as a toxicological reference indicated risks from robins ingesting soil invertebrates contaminated with DDT, aluminum, lead, mercury, and zinc. Modeling using the NOAEL indicated risks to shrews from Aroclor-1260, antimony, lead, and vanadium. Modeling using the LOAEL indicated risks to shrews from lead and vanadium. Concentrations of aluminum, vanadium. DDD, and DDT in soils at the Old WWTP Site are below their respective threshold values. Background threshold values are not available for DDE, aroclor-1260, and antimony. Concentrations of zinc in Old WWTP Site soil exceeded the background threshold value. Lead in soils is associated with flaking lead-based paint from the exterior of the Pump House. Mercury in sludge is most likely from the trickling filter.

The detected concentrations of several chemicals (i.e., Aroclor-1260, lead, and zinc) were elevated at one soil sample location, WFF1-SS1. As noted in Sections 5.2.1 and 8.4.3.1 of the RI report (Weston, 2013), because sample location WFF1-SS1 is adjacent to the Pump House, it was determined that the lead in WFF1-SS1 is associated with lead-based paint flaking from the exterior of the Pump House. As a result, any contamination due solely to lead-based paint flaking from the building or from normal weathering of building materials is not addressed. The detection of Aroclor-1260 is considered an outlier because its detection in WFF1-SS1 is the only detection of this constituent in the 26 soil samples collected at the Old WWTP Site. Additional surface soil samples were collected from around the transformer pad and adjacent building as part of a paint chip investigation for analysis of lead. Lead concentrations were similar in all three samples located immediately adjacent to the transformer pad (425 mg/kg to 497 mg/kg), and were elevated (143 mg/kg and 2,450 mg/kg) in two samples located immediately adjacent to the building. However, lead concentrations decreased significantly (<60 mg/kg) in samples collected within 5 to 20 feet of the pad/building. Therefore, elevated lead levels are confined to a small area along the buildings. Aroclor-1260 was not detected in soil samples WFF1-01, -03, and -04. These sample locations were in the immediate vicinity of WFF1-SS1, indicating that Aroclor-1260 has not migrated to other areas of the site.

Both lead and Aroclor-1260 are relatively insoluble in water and will be bound to the soil particles, so their migration is limited by the movement of the soil particles. Therefore, because elevated lead levels are confined to a small area along the buildings, the extent of elevated Aroclor-1260 levels will also be limited to immediately around the transformed pad. Aroclor-1260 was not detected in any sediment or surface water sample collected from the Old WWTP Site. A single elevated zinc concentration was detected at sample location WFF1-SS1 and is considered an outlier.

As noted in Section 8.4.3.1 of the RI report (Weston, 2013), after excluding data from location WFF1-SS1, the 95 percent upper confidence levels (UCLs) were re-calculated for chemicals with an HQ greater than one for either the robin or short-tailed shrew (DDT compounds, aluminum, antimony, lead, mercury, vanadium, and zinc). The re-calculation showed that removing soil contamination at location WFF1-SS1 will reduce the HQ for shrews to <1 (using the LOAEL) for all contaminants except aluminum and vanadium, which fall below the background threshold value. Removing soil contamination at WFF1-SS1 will reduce the HQ for robins to <1 (using the LOAEL) for all contaminants except aluminum, lead, mercury, and zinc. Aluminum concentrations fall below the background threshold value. The remaining lead concentrations will result in an HQ of 2.1 reduced from an HQ of 99. The remaining zinc concentrations will result in an HQ of 1.5 to robins reduced from 3.9. Given the low degree of risk over a limited geographic area, population impacts to these species are unlikely. The remaining receptors (i.e. red fox and red-tailed hawk) modeled did not show evidence of potential ecological risks from soil.

Three sludge samples collected from the Old WWTP Site (one sample from each of the sludge drying beds and one from a settling tank) contained within the former concrete infrastructure, but open to the air, exhibited maximum concentrations of the metals aluminum, antimony, cadmium, chromium, copper, iron, lead, manganese, mercury, silver, vanadium, and zinc; dieldrin; DDT compounds; PAHs; and toluene that exceeded ecological benchmarks. Concentrations of two metals (mercury at 28 mg/kg, and zinc at 680 mg/kg) exceeded their respective background threshold values. As previously stated, the maximum concentrations of metals detected were in the sludge samples collected from the sludge drying beds, WFF1-SL02 and -SL03. No further ecological evaluation was conducted in the RI because the areas are small and contained. However, if the sludge beds were used as primary habitat for ecological receptors or if a release occurred in the future, it could result in ecological risk. The settling tank is not considered a potential primary habitat due to a combination of a small opening and large depth-to-water. Therefore, to address ecological risk, possible remedial alternatives for the two sludge drying beds are evaluated as part of the Old WWTP Site FFS.

2.7.2.3.2 Aquatic Ecosystem

Concentrations of aluminum, barium, iron, and manganese in the one surface water sample collected from the unnamed tributary of Little Mosquito Creek exceeded the respective Region 3 BTAG freshwater ecological benchmarks and thus represent a potential contamination source to Little Mosquito Creek. However, as noted in Sections 8.4.1.2 and 8.6.2 of the RI report (Weston, 2013), prior downstream surface water data collected as part of the Sites 14 and 15 RI did not indicate exceedances of these metals in Little Mosquito Creek (Weston, 2013); therefore, there is little likelihood of impact within the estuarine ecosystem of the creek due to the Old WWTP Site.

No analytes were detected in sediment within the unnamed tributary to Little Mosquito Creek at concentrations that exceeded ecological screening benchmarks.

Modeling undertaken to evaluate whether fish potentially entering the upper portion of the unnamed tributary to Little Mosquito Creek could be at risk indicated that modeled tissue concentrations will not exceed toxicological effects levels reported in Jarvinen and Ankley (1999). Food chain HQ modeling indicated that no HQs greater than 1.0 were noted for any of the receptors evaluated.

2.7.2.4 Ecological Risk Characterization

Food chain modeling indicated that the American robin and short-tailed shrew have the potential to be at risk from the ingestion of invertebrates due to the concentrations of chromium, mercury, DDD, and DDE present in Old WWTP Site sludge in the two drying beds and thus were a primary focus of the FFS (Table 2-10). The sludge within the two drying beds is partially contained within concrete walls that are open to the atmosphere. The sludge within the settling tanks is minimal and enclosed by the concrete walls of the Old WWTP Site. The metals and pesticides are unlikely to migrate from the containment areas unless the integrity of the structures is compromised.

2.7.2.5 Refinement of Ecological Risk Assessment Results

The direct toxicity to invertebrates and plants are evaluated by comparing the results to ecological screening levels. The maximum concentrations of aluminum, antimony, cadmium, iron, lead, manganese, mercury, vanadium, zinc, 4,4,-DDT, dieldrin, and Aroclor-1260 exceeded soil ecological benchmarks (lowest of plant, invertebrate, avian, or mammalian values) at the Old WWTP site (Table 2-10). The FFS indicated that of these, only concentrations of antimony and zinc also exceeded their respective background threshold values; background threshold values were not available for lead, dieldrin, and Aroclor-1260. The maximum concentration of antimony (3.2 mg/kg), and average concentrations of lead (60.1 mg/kg) and zinc (57.1 mg/kg) in soil are much lower than their respective screening levels for plants or invertebrates (5 mg/kg for antimony and 120 mg/kg for lead and zinc). Also, lead (460 mg/kg) only exceeded the screening level at 1 of 19 site locations, and zinc (160 mg/kg and 250 mg/kg) only exceeded the screening level at 2 of 19 site locations. Therefore, potential impacts are isolated and significant impacts to plants and invertebrates across the site are not expected.

Dieldrin was only detected at 1 of 19 site locations, at a concentration of 5.7 µg/kg. Although no specific plant or invertebrate screening levels were presented in the RI Report, Region 4 recently updated their soil screening levels in August 2015 and have plant and invertebrate screening levels for dieldrin of 10,000 µg/kg and 100 µg/kg, respectively. The dieldrin detection at the site is much lower than these values so risks to plants and invertebrates are not expected. Aroclor-1260 also was only detected at 1 of 19 site locations, at a concentration of 290 µg/kg. The ORNL screening level for plants presented in the RI Report was 40,000 µg/kg. The Canadian Soil Quality Guideline for direct soil contact for plants and invertebrates is 33,000 µg/kg. The Aroclor-1260 detection at the site is much lower than these values so risks to plants and invertebrates are not expected.

2.7.3 Risk Assessment Conclusion

The results of the BHHRA, SLERA, and the supplemental food chain modeling are used to determine the COCs and the specific media (soil, sediment, surface water, wastewater, and sludge).

Supplemental food chain modeling was conducted for the American robin and the short-tailed shrew using site-specific concentrations of detected chemicals in sludge (maximum detected concentrations) and bioconcentration factors (BCFs) or BAFs to model earthworm tissue concentrations. The supplemental food chain modeling indicated that the American robin and short-tailed shrew have the potential to be at risk from the ingestion of invertebrates due to the concentrations of chromium, mercury, DDD, and DDE present in Old WWTP Site sludge.

The BHHRA evaluated the potential risks from contaminants in sludge to the older child trespasser, future commercial/industrial workers, and future construction worker. Human health risks were not fully quantified because residential exposure to sludge was not evaluated in the BHHRA. No COCs were identified as part of the BHHRA. Based on the results of the limited-BHHRA and supplemental food chain modeling, the evaluation of remedial alternatives for Old WWTP Site sludge is included in this ROD. Ecological-based cleanup levels were developed for chromium, mercury, DDD, and DDE, and are listed below in section 2.8.

The response action selected in this Record of Decision is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants from this Site into the environment.

2.8 REMEDIAL ACTION OBJECTIVES

Based on the ecological COPECs and the exposure pathways and receptors present at the Old WWTP Site, the below remedial action objective (RAO) was developed for the Old WWTP Site:

- Prevent exposure of site insectivorous birds and mammals via ingestion of invertebrates to concentrations of chromium, mercury, DDD, and DDE in Old WWTP Site sludge that could result in adverse effects.

The Old WWTP Site COCs and associated cleanup levels for the RAO are presented below. In developing the cleanup levels, the same methodology used to calculate the ecological risks were used to calculate the concentrations that would result in no adverse effects to the ecological receptors. The calculated concentration was compared to the available background threshold value and the higher of the two was selected as the cleanup level. Based on the background threshold values calculated and approved in 2021, all cleanup levels are based on risk-based levels. The cleanup levels for the Old WWTP Site are based on protection of the ecological receptors American robin and short-tailed shrew.

COPEC	Cleanup Level (mg/kg)
Chromium	61.1
Mercury	0.538
DDD	0.342
DDE	0.143

Contaminant specific cleanup levels for the protection of human health were not calculated because there are no identified unacceptable risks to human health receptors; however, the potential risk to future residents exposed to Old WWTP Site sludge was reviewed.

2.9 DESCRIPTION OF ALTERNATIVES

Remedial alternatives evaluated for the Old WWTP Site sludge are presented below. More detailed descriptions of the alternatives can be found in the FFS Report (Weston, 2015).

2.9.1 Description of Remedy Components

This section provides a list of the major components of each alternative as they occur in the remediation process. Each list includes treatment components and the materials they will address, institutional controls, operation and maintenance (O&M) activities to maintain the integrity of the remedy, and monitoring requirements. In addition, the applicable or relevant and appropriate requirements (ARARs) are listed and summarized in Table 2-13 of this ROD.

The four remedial alternatives for the Old WWTP Site are described in the following subsections:

- Alternative No. 1 - No Action
- Alternative No. 2 - Land Use Controls
- Alternative No. 3 - Low-Permeability Cap Installation
- Alternative No. 4 - Sludge Removal and off-Site Disposal

2.9.1.1 Alternative 1 - No Action

CERCLA requires evaluation of a No Action alternative. Under Alternative 1, no further efforts or resources will be expended at the Old WWTP Site. No action will be implemented to address the existing contamination in the Old WWTP Site sludge. Alternative 1 serves as the baseline for comparing the other alternatives. This alternative is required under the NCP.

2.9.1.2 Alternative 2 - Land Use Controls

This alternative will manage risks through Land Use Controls (LUCs) (access restrictions). A remedial design and LUC plan will be prepared to specify actions and restrictions to be implemented and maintained for the Old WWTP Site, thus ensuring long-term effectiveness and permanence. Access restrictions in the form of fine mesh fencing and avian netting will be implemented to prevent ecological receptors from contacting the sludge and potentially being exposed to COCs above cleanup levels. Institutional controls will be established to prevent residential exposure to the Old WWTP Site sludge.

In general, LUCs and access restrictions recommended for the Old WWTP Site include the following:

- Signs,

- Master Plan revisions to document access restrictions and maintenance of LUCs and to restrict intrusive activities in the sludge drying bed areas, and

- Installation of fine mesh fencing and avian netting.

Long-term monitoring (LTM) of the Old WWTP Site will be warranted to ensure land use and engineered controls remain effective and protective of the environment and to assess whether the access restrictions need to remain in place. The LTM program will include sampling and analysis of sludge in the current areas where concentrations of COCs (chromium, mercury, DDD, and DDE) exceed the cleanup levels. Residential use restrictions will remain in place as long as the sludge remains or until an updated risk assessment documents that no unacceptable risks exist. Preparation of the five-year review report will also be required for Alternative 2.

2.9.1.3 Alternative 3 - Low-Permeability Cap Installation

Alternative 3 includes the following steps:

- Installation of a low-permeability cap, consisting of a clay cover and a geotextile liner, for the contaminated sludge area,

- Dust controls,

- Installation of erosion controls,
- Ground cover restoration in the form of a vegetative cover, and
- LUCs.

In Alternative 3, the sludge from the areas containing contamination above cleanup levels will be covered with a clay cap consisting of a geotextile liner (to prevent erosion and burrowing) and approximately 2 feet of clean clay. LUCs (listed below) will also be implemented to control or manage any intrusive activities that will penetrate the soil cap, including demolition of the structure containing the sludge and wastewater. Depending upon the Old WWTP Site conditions at the time of the remedial action, dust controls might be necessary during cap construction to reduce potential exposure to workers through inhalation of contaminated particulates. Erosion controls (i.e., silt fence) will be installed as a vertical barrier around the work area to prevent the potential migration of contaminated sludge off-site via runoff. A vegetative ground cover and geotextile liner will be established on top of the soil cover for erosion control purposes. Five-year reviews will be required to demonstrate that the remedy remains protective of human health and the environment.

Sludge COCs will remain on-site. Therefore, the following LUCs will be implemented as part of Alternative 3:

- Master Plan to restrict intrusive activities in the sludge drying bed areas,
- Signs,
- Access restrictions to control access to the sludge settling tanks until they are removed, and
- Maintenance of cap integrity

Preparation of the five-year review report would be required for Alternative 3 to evaluate the effectiveness of the cap and LUCs at achieving the RAO.

2.9.1.4 Alternative 4 - Sludge Removal and Off-Site Disposal

Alternative 4 includes the following steps:

- Sampling of sludge and wastewater for off-site disposal requirements,
- Installation of erosion controls,
- Dust controls,
- Excavation of contaminated sludge and removal of wastewater,
- Off-site disposal of excavated sludge,
- Post-excavation confirmation sludge sampling,
- Backfill of the excavated areas with clean fill material, and
- Ground cover restoration.

In Alternative 4, the contaminated sludge in the drying beds and the residual sludge in the settling tanks will be excavated to meet the cleanup levels, removed from the Old WWTP Site, and disposed off-site.

The volume of sludge requiring remediation is estimated to be 82.5 cubic yards. Prior to excavation activities, the sludge and wastewater will be sampled and analyzed to ensure proper characterization prior to disposal at an off-site facility. It is anticipated that sludge and wastewater from the settling tanks will be removed using a vacuum truck and removed from the site or placed in the contained sludge drying bed. It is anticipated that excavated sludge and soils from the drying beds will be loaded directly into the dump truck with no need of on-site management. The sludge characterization analytical data will be submitted to the appropriate disposal facilities for ultimate approval prior to implementation of any alternative that includes off-site disposal. It is anticipated that sludge from the Old WWTP Site will be transported to a Resource Conservation and Recovery Act (RCRA) Subtitle D landfill for disposal as non-hazardous waste. Depending upon Old WWTP Site conditions at the time of the remedial action, dust controls may be necessary during excavation activities to reduce the potential exposure through inhalation of particulates. Prior to excavation activities, erosion controls (i.e., silt fence) will be installed around the excavation area to prevent the contaminated sludge from migrating beyond construction areas via surface erosion and runoff. Prior to Old WWTP Site restoration activities, post-excavation confirmation sludge sampling for COCs (chromium, mercury, DDD, and DDE) will be conducted in the excavated areas to document compliance with the sludge cleanup levels.

Because the RAO will be achieved and no waste will remain on site, no five-year review will be required.

2.9.2 Common Elements and Distinguishing Features of Each Alternative

No response actions would be implemented under Alternative 1, the no-action alternative.

Alternative 2 includes only LUCs, while Alternative 3 would require LUCs in addition to a low-permeability cap to reduce the ecological risk. Because contaminants would remain on-site, Alternatives 2 and 3 would require five-year reviews to assess the adequacy of the remedial activities, and to determine whether further action is necessary. Alternative 4 will not result in hazardous substances, pollutants, or contaminants remaining on site above cleanup levels and will allow for unlimited use and unrestricted exposure.

Alternatives 2, 3, and 4 would be implemented within one year. Alternative 2 would be implemented faster than the other two alternatives because only LUCs would be needed and no active remediation would be required.

Alternative 4 includes the removal of residual sludge from the settling tank and the contaminated sludge from the drying beds above the cleanup levels from the Old WWTP Site to meet ecological cleanup levels.

The present worth costs of Alternatives 2, 3, and 4 are assessed based on capital costs (initial cost to implement) and annual O&M costs. Capital costs and annual O&M costs are on Table 2-14. Original costs from April 2015 have been updated to January 2023 values using the historical cost indices from Mechanical Costs with RS Means Data, 2023, 46th Annual Edition (The Guardian Group , 2022). The estimated present worth costs are as follows:

- Alternative 1: $0
- Alternative 2: $564,000
- Alternative 3: $870,000
- Alternative 4: $487,000

2.9.3 Expected Outcome of Each Alternative

For Alternative 1, no actions would be implemented, thereby resulting in unacceptable risks to the environment from exposure to contaminated sludge. For Alternatives 2 and 3, risk to human health would be minimal and potential risk to ecological receptors would be controlled. LUCs would be in place to restrict sludge exposure to potential future residents. Site activities would be controlled through restrictions documented in the Facility Master Plan. The LUCs would be required for an extended period of time. Under Alternative 4, the Site would allow for unrestricted future use and risks to ecological receptors would be addressed.

2.10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The objective of the comparative analysis of alternatives is to evaluate the relative performance of the alternatives with respect to the nine evaluation criteria established in the NCP so that the advantages and disadvantages of each are clearly understood. The first two evaluation criteria, Overall Protection of Human Health and the Environment and Compliance with ARARs, are threshold criteria that must be satisfied by a remedial alternative chosen for a site. Table 2-14 contains a summary of the comparative analysis of alternatives.

2.10.1 Overall Protection of Human Health and the Environment

Alternative 1 will not protect human health or the environment because no reduction in sludge COPEC contaminant concentrations and no reduction in ecological or human receptor exposures will occur. Alternatives 2, 3, and 4 are more protective of human health and the environment because they will provide some level of protection to ecological and human receptors from short-term and long-term risks associated with the Old WWTP Site contaminated sludge. Alternative 2 will be protective by controlling environmental receptors from accessing and restricting human exposure to the Old WWTP Site contaminated sludge. COPECs will remain on-site. Alternative 2 will not reduce vertical contaminant migration via infiltration processes and, therefore, will be less protective of the environment than Alternatives 3 and 4. Alternative 3 will reduce the potential for ecological receptors to access the sludge, provided the integrity of the cap is maintained, and will restrict human exposure to Old WWTP Site sludge. COPECs will remain on-site. Migration of COPECs will be controlled by the installation of the cap and geotextile liner. Under Alternative 4 sludge in the settling tank and contaminated sludge above the PRGs in the drying beds will be removed, thus eliminating the potential risks.

2.10.2 Compliance with ARARs

No chemical-specific or location-specific ARARs were identified for the Old WWTP Site. Alternative 4 will remove sludge above the PRGs. Ecological receptors will not be in contact with sludge having COPEC concentrations greater than the PRGs because the sludge will be removed from the Old WWTP Site. Alternative 1 would not comply with any ARARs because there are no remedial actions associated with this alternative. Alternatives 2, 3, and 4 will comply with action-specific ARARs. However, the substantive provisions of the Virginia Pollution Abatement (VPA) Permit Regulation would apply to the extent that allowing the contaminated sludge to remain on-site is viewed as a form of on-site sewage sludge disposal. If so, Alternative 2 would not comply with this ARAR. Under Alternatives 1, 2, and 3, COPECs will remain on-site above PRGs. Alternative 4 will attain PRGs because the sludge above PRGs will be removed.

2.10.3 Long-Term Effectiveness and Permanence

Alternative 4 will provide the greatest long-term effectiveness because potential risks to ecological and human receptors will be eliminated by the removal of sludge and COPECs above cleanup levels. Alternative 3 is less effective than Alternative 4 because COPECs above PRGs will remain on-site, and the effectiveness of Alternative 3 is a function of maintaining the integrity of the low-permeability cap and institutional controls. Alternative 2 will be less effective than Alternatives 3 and 4 because the installation of avian netting and fine mesh fencing may only minimize direct contact of ecological receptors with COPECs above cleanup levels. As with Alternative 3, the effectiveness of Alternative 2 is a function of maintaining the integrity of the engineered and institutional controls. Alternative 1 has the lowest long-term effectiveness and permanence because no action is taken. Only Alternative 4 will provide unrestricted land use because the contaminated sludge above the cleanup levels will be removed from the Old WWTP Site.

2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

None of the alternatives provide treatment. Therefore, none of the alternatives satisfy the preference for treatment as a principal element.

2.10.5 Short-Term Effectiveness

Alternative 1 is most effective in the short term because there will be no invasive activities that would expose the community or workers to site contaminants. Alternative 2 has fewer short-term impacts than all alternatives except Alternative 1 because of fewer invasive activities. Alternatives 3 and 4 will have minor short-term impacts on-site during implementation. These impacts, however, will be addressed by using standard work practices, safety measures, and dust control measures. Alternative 3 will involve more truck traffic and its associated physical hazards than Alternative 4 because the volume of clay needed for the low-permeability cap is greater than the volume of contaminated soil to be transported off-site under Alternative 4. These hazards will be mitigated by using standard work practices and safety measures. The increased truck traffic under both Alternatives 3 and 4 will not be concentrated in a manner that will significantly impact local traffic patterns. Although Alternative 3 involves more truck traffic than Alternative 4, only non-contaminated materials will be transported under Alternative 3.

2.10.6 Implementability

Alternatives 3 and 4 are less easily implemented than Alternatives 1 and 2 because they require more difficult and complex construction-related activities and operations. Alternative 1 is the easiest to implement because it requires no action. Alternative 2 is the most implementable of the alternatives that include an action because it involves only LUCs and fine mesh fencing, avian netting, and sign installation. Revisions to NASA's Master Plan are easily implemented as the property owner is knowledgeable of current documents and conditions at the Old WWTP Site. The low-permeability cap in Alternative 3 is a proven technology that has been implemented at other sites and is often used on landfills. Contaminant removal in Alternative 4 is a common practice and is used often for small sites such as the Old WWTP Site. No technical difficulties are associated with either Alternative 3 or 4. There is little difference in the implementability of Alternatives 3 and 4, although implementation of Alternative 3 requires the transport of more materials and potentially a larger construction area.

2.10.7 Cost

Alternative 1 involves no action; therefore, no cost is associated with this alternative. Alternative 3 is the costliest with a net present worth (NPW) of approximately $870,000. Alternative 2 has a NPW of $564,000 and is less costly than Alternative 3 but more costly than Alternative 4. The NPW of Alternative 4 is estimated at $487,000.

2.10.8 State Acceptance

The Commonwealth of Virginia has expressed its support of Alternative 4 and agrees with the Selected Remedy described in Section 2.12 below.

2.10.9 Community Acceptance

Because no comments were expressed at the public information session, and no written comments were received during the public comment period, it appears that the community generally agrees with the Selected Remedy. Specific details regarding the public comment period can be found in the Responsiveness Summary section of this ROD.

2.11 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable [40 CFR 300.430(a)(1)(iii)(A)]. Based on the results of the investigations, studies, and sampling conducted, the contaminated sludge at the Old WWTP Site does not constitute a principal threat waste as defined by the NCP. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. The contaminated Old WWTP sludge is considered to be of low toxicity and concentrations; therefore, would not be categorized as a principal threat waste.

2.12 SELECTED REMEDY

2.12.1 Summary of Rationale for the Selected Remedy

Alternative 1 does not meet the threshold criteria. Alternative 2 provides adequate protection of human and ecological receptors but only through the institutional controls and access controls of fine mesh fencing and avian netting. COPECs above cleanup levels will remain on-site under Alternatives 1 and 2. Alternative 3 is more protective of ecological receptors than Alternative 2, but COPECs above cleanup levels will also remain on-site under Alternative 3. Alternative 4 is the most protective of ecological and human receptors because contaminated sludge with COPECs above cleanup levels and residual sludge from the settling tanks will be removed. Therefore, Alternative 4 will provide a permanent solution that will remain effective over time. Both Alternatives 2 and 3 require ongoing maintenance of engineered and institutional controls to remain effective. Alternative 3 will require more extensive maintenance. Alternative 3 involves the greatest degree of short-term physical hazards to on-site workers and the community due to the amount of truck traffic associated with transporting capping materials to the Old WWTP Site. A lesser degree of short-term physical hazards to on-site workers and the community would be posed by Alternative 4 due to the lesser volume of materials requiring transport. Of the two alternatives (Alternatives 3 and 4) that reduce potential human health and ecological risks to acceptable levels upon implementation, Alternative 4 is the most cost-effective because it is less than Alternative 3 while providing a greater level of protection to potential ecological receptors and providing for unrestricted land use and unlimited exposure.

2.12.2 Description of Selected Remedy

The selected remedy is Alternative 4 - Sludge Removal and Off-Site Disposal. The Selected Remedy was formulated and analyzed to evaluate a remedial action that removes all known and potential risks to ecological and human receptors under the future hypothetical residential scenario. This alternative would include the removal of sludge from the settling tanks and approximately 82.5 cubic yards of contaminated sludge from the sludge drying beds over an area of approximately 1,780 square feet to a depth of 2 feet. The excavation limits would be defined by soil with COC concentrations that exceed cleanup levels. The alternative would also include the collection of verification samples to confirm the removal of soil contamination causing unacceptable ecological and human health risk. In addition, all construction/excavation-derived material and investigation-derived waste would be characterized prior to disposal. It is anticipated that excavated sludge from the Old WWTP Site will be transported to a RCRA Subtitle D landfill for disposal as non-hazardous waste.

Prior to Old WWTP Site restoration activities, post-excavation confirmation sampling for COCs (chromium, mercury, DDD, and DDE) will be conducted in the excavated areas to document compliance with the cleanup levels and to document unlimited land use and unrestricted exposure.

2.12.3 Summary of Estimated Remedy Costs

Cost estimate summaries for the Selected Remedy are provided in Table 2-15 (capital cost). The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. The estimated present worth of the selected remedy is $487,000. Changes in the cost elements may occur because of new information or data collected during the engineering design of the selected remedy. Major changes may be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Differences (ESD), or a ROD amendment depending on the scope of the change. This is an order-of-magnitude engineering cost estimate that is expected to be within plus 50 to minus 30 percent of the actual project cost. These estimates are refined as the remedy is designed and implemented.

2.12.4 Expected Outcomes of the Selected Remedy

After the Selected Remedy has been implemented, COCs exceeding cleanup levels in sludge would be removed from the site. There would be unrestricted use for site soil and no land use controls. The estimated time to achieve the RAO is one month of onsite work.

2.12.5 Performance Standards

The final cleanup levels based on protection of ecological receptors are as follows:

- Chromium - 61.1 mg/kg
- Mercury - 0.675 mg/kg
- DDD - 0.342 mg/kg
- DDE - 0.143 mg/kg

A Remedial Design and Remedial Action Work Plan and Reports will be prepared for USEPA and VDEQ review and USEPA approval. These documents will detail the excavation, sampling and analysis, data assessment, backfill, regrading, revegetation, and site restoration requirements to be implemented as part of the Selected Remedy.

2.13 STATUTORY DETERMINATIONS

Under CERCLA Section 121, as required by NCP 40 CFR § 300.430(f)(5)(ii), the lead agency must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the toxicity, mobility, or volume of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

2.13.1 Protection of Human Health and the Environment

The Selected Remedy, Alternative 4, will protect human health and the environment by removing sludge containing COCs above cleanup levels and properly disposing of the sludge off-site.

There are no short-term threats associated with the Selected Remedy that cannot be readily controlled. In addition, proper controls such as dust controls or silt fencing will be used to control cross-media impacts during implementation of the Selected Remedy.

2.13.2 Compliance with ARARs

Chemical-specific ARARs

Although no chemical-specific ARAR was identified for the contaminated sludge, Alternative 4 will comply with the cleanup levels for the sludge COCs because sludge with concentrations greater than the cleanup levels will be removed from the Old WWTP Site.

Location-specific ARARs

No location-specific ARARs were identified for the Old WWTP Site.

Action-specific ARARs

Action-specific ARARs applicable to Alternative 4 include possible impacts to air quality during any grading and removal operations. During the construction, reasonable precautions will be employed to prevent particulate matter from becoming airborne. Fugitive dust will be controlled by water sprays during any grading or removal operations. Application of water will be limited to avoid creating runoff. Stormwater runoff will be controlled through best management practices implemented through an erosion and sediment control plan. Compliance with RCRA and Virginia Solid Waste Management Regulations during off-site transport and disposal of contaminated sludge will be ensured through the use of a United States Department of Transportation licensed transporter for hauling of materials and off-site disposal at a VDEQ-approved facility for disposal of RCRA Subtitle D waste (non-hazardous solid waste).

2.13.3 Cost-Effectiveness

The Selected Remedy is cost effective. In making this determination, the following definition was used [40 CFR 300.430(f)(1)(ii)(D)]: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." NASA first evaluated the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and in compliance with ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, or volume through treatment; and short-term effectiveness). The overall effectiveness of all the alternatives was considered and then compared to each of their costs.

The estimated NPW of the Selected Remedy (Alternative 4) is $487,000. The NPW of Alternative 2 is approximately $77,000 more than for the Selected Remedy and would not attain cleanup levels. In addition, Alternative 2 requires long-term LUCs and O&M, and could interfere with future uses of the area. NPW for Alternative 3 is approximately $383,000 more than for the Selected Remedy, and is generally equally effective at attaining the clean-up levels in the same time frame; however, it would result in the contamination remaining on site under a low permeability cap, requires long-term LUCs and O&M, and could interfere with future uses of the area.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

NASA and USEPA, with VDEQ concurrence, have determined that the Selected Remedy Alternative 4:

Sludge Removal and Off-Site Disposal exceeding cleanup levels represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, NASA has determined that the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria. NASA also considered the statutory preference for treatment as a principal element and state and community acceptance.

The Selected Remedy would remove all the contaminated sludge from the Site. The contaminated sludge that presents a potential risk to human health and environment would be removed and disposed of in an off-site landfill. The Selected Remedy could be completed within one month. At the time of completion RAOs would be achieved with no risk remaining to human health or the environment. The Selected Remedy does not present short-term risks different than the other alternatives. There are no special implementability issues that set the Selected Remedy apart from any of the other alternatives evaluated.

2.13.5 Treatment as a Principal Element

Treatment is not a principal element of the selected remedy. Because of the small quantities of contaminated media and low concentrations of COCs, treatment processes would not be cost-effective and were not carried through the feasibility study. Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a five-year review will not be required for this remedial action.

2.13.6 Five-Year Review Requirement

Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a five-year review pursuant to CERCLA § 121(c) and NCP 40 CFR § 300.430(f)(5)(iii)(C) will not be required for this remedial action.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for the Old WWTP Site at NASA WFF, Wallops Island, Virginia was released for public comment on August 24, 2022. The Proposed Plan identified Alternative 4, Sludge Removal and off-Site Disposal, as the preferred alternative. No written or verbal comments were submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

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3.0 RESPONSIVENESS SUMMARY

In accordance with Sections 113 and 117 of CERCLA, NASA provided a public comment period from August 22 through September 21, 2022, for the proposed remedial action as described in the Proposed Plan for the Site. A public information session was held on August 24, 2022, at the NASA Wallops Flight Facility Visitor Center. Public input is a key element in the decision-making process.

The Proposed Plan remains available to the public in the Administrative Record. The RI is also available in the Administrative Record. The Information Repositories for the Administrative Record are maintained by the Eastern Shore Public Library (23610 Front Street, Accomack, Virginia 23301) and the Island Library (4077 Main Street, Chincoteague, Virginia 23336).

Public notices announcing the comment period and availability of documents were placed in the Eastern Shore News on August 19 and on their website from August 19 through August 31, 2022.

No comments were received by NASA, USEPA, or VDEQ during the public comment period.

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4.0 REFERENCES

Earth Tech (Earth Tech, Inc.), 2000. Letter Report Wallops Flight Facility, Wallops Island, Virginia. January, 2000.

Ebasco, 1988. Preliminary Assessment, Wallops Flight Facility. April, 1988.

Ebasco, 1990a. Environmental Sites Survey, Wallops Flight Facility. November, 1990.

Ebasco, 1990b. Site Inspection, Wallops Flight Facility. January, 1990.

Gilbert, R.O., 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand and Reinhold, New York, NY. July, 1987.

Jarvinen, A.W. and G.T. Ankley, 1999. Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals. Society for Environmental Toxicology and Chemistry (SETAC), Pensacola, FL. 364 pp.

Lindsey, B.D., Breen, K.J., Bilger, M.D., and Brightbill, R.A, 1998. Water Quality in the Lower Susquehanna River Basin, Pennsylvania, and Maryland. 1992-1995. USGS Circular 1168.

M&E, 1996. Site Inspection for Miscellaneous Sites at Wallops Flight Facility. Volume I. Site Inspection Report. March 27, 1996.

NASA, 2015, National Aeronautics and Space Administration & Department of the Army. Memorandum of Agreement Wallops Flight Facility, VA. February, 2015.

NASA, 2021. Updated Background Threshold Values Report for Soil and Groundwater, Wallops Flight Facility, Virginia. September, 2021.

NASA, 2022. Operable Unit 6, Wallops Flight Facility Formerly Used Defense Site, Project 13 – Old Wastewater Treatment Plant – Soil, Sludge, Sediment, and Surface Water. August, 2022.

SAIC (SAIC, Inc.), 2003. Limited Site Investigation. Wallops Flight Facility, Wallops Island, Virginia. May, 2003.

Tetra Tech, 2004. Background Soil and Groundwater Investigation Report for the Main Base. NASA Wallops Island Flight Facility. PHIL-17051. May, 2004.

The Guardian Group, 2022. Mechanical Costs with RS Means Data, 2023, 46th Annual Edition.

USEPA (U.S. Environmental Protection Agency), 1999. A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents. EPA 540/R-98/031, OSWER 9200.1-23P. July, 1999.

USEPA, 2009. USEPA's Provisional Peer Review Toxicity Values (PPRTVs).

USEPA, 2021. USEPA Docket Number: RCRA-03-2021-0022TH. Administrative Agreement on Consent, United States Environmental Protection Agency Region III in the Matter of National Aeronautics and Space Administration, Wallops FUDS Program, NASA Wallops Flight Facility. January, 2021.

Weston (Weston Solutions, Inc.), 2006. After Action Report for Time Critical Removal Action Former Wastewater Treatment Plant. Wallops Flight Facility, Wallops Island, Virginia. November, 2006.

Weston, 2007. Site Investigation Report for Former Wastewater Treatment Plant. Wallops Flight Facility, Wallops Island, Virginia. September, 2007.

Weston, 2013. Final Remedial Investigation Report, Former Wastewater Treatment Plant, Wallops Flight Facility, Virginia. August, 2013.

Weston, 2015. Focused Feasibility Study Report Project 15 – Active Remediation Projects Former Wastewater Treatment Plant, Wallops Flight Facility Formerly Used Defense Sites, Wallops Island, Virginia. May, 2015.

Tables

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TABLE 2-1
RISK SUMMARY
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Exposure Scenario by Exposure Subunit	Medium	Site Health Effects			
		ILCR	Percent of Total Site Risk[a]	HI	Percent of Total Site Risk[a]
Current/Future Older Child Trespasser (See Appendix D Tables D-28 & D-34)[b]					
Ingestion	SS	4E-08	4 (22)	0.002	12 (28)
Dermal Contact	SS	1E-07	15 (78)	0.005	31 (71)
Inhalation	SS	5E-14	0.00001 (0.00003)	0.00006	0.4 (1)
Soil Subtotal		***2E-07***		***0.007***	
Ingestion	SL	7E-08	8 (10)	0.01	38 (9)
Dermal Contact	SL	6E-07	72 (90)	0.06	369 (91)
Sludge Subtotal		***7E-07***		***0.06***	
Dermal Contact	WW	---	--- ---	0.002	10 (100)
Waste Water Subtotal		***---***		***0.06***	
Ingestion	SD	NC	--- ---	NC	--- ---
Dermal Contact	SD	NC	--- ---	NC	--- ---
Sediment Subtotal		***---***		***---***	
Ingestion	SW	---	--- ---	0.006	38 (68)
Dermal Contact	SW	---	--- ---	0.003	18 (32)
Surface Water Subtotal		***---***		***0.008***	
Site Total	SS+SL+WW+SD+SW	**9E-07**		**0.02**	
Future Commercial/Industrial Worker (See Appendix D Tables D-29 & D-35)[b]					
Ingestion	SS/SB	2E-06	21 (77)	0.03	8 (80)
Dermal Contact	SS/SB	5E-07	6 (23)	0.007	2 (17)
Inhalation	SS/SB	2E-12	0.00003 (0.0001)	0.001	0.3 (3)
Soil Subtotal		***2E-06***		***0.04***	
Ingestion	SL	3E-06	42 (58)	0.1	25 (56)
Dermal Contact	SL	2E-06	30 (42)	0.08	20 (44)
Sludge Subtotal		***5E-06***		***0.2***	
Dermal Contact	WW	---	--- ---	0.001	0.2 (100)
Waste Water Subtotal		***---***		***0.2***	
Site Total	SS/SB+SL+WW	**8E-06**		**0.4**	
Future Construction Worker (See Appendix D Tables D-30 & D-36)[b]					
Ingestion	SS/SB	2E-07	25 (88)	0.1	10 (91)
Dermal Contact	SS/SB	3E-08	3 (12)	0.009	0.9 (8)
Inhalation	SS/SB	5E-14	0.00001 (0.00002)	0.0006	0.06 (1)
Soil Subtotal		***2E-07***		***0.1***	
Ingestion	SL	4E-07	48 (76)	0.3	32 (74)
Dermal Contact	SL	1E-07	15 (24)	0.1	11 (26)
Sludge Subtotal		***5E-07***		***0.4***	
Dermal Contact	WW	---	--- ---	0.002	0.2 (100)
Waste Water Subtotal		***---***		***0.4***	
Site Total	SS/SB+SL+WW	**7E-07**		**1**	
Future Age-adjusted Resident (See Appendix D Tables D-31 & D-37)[b]					
Ingestion	SS/SB	1E-05	4 (88)		
Dermal Contact	SS/SB	2E-06	0.5 (12)		
Inhalation	SS/SB	1E-11	0.000003 (0.00007)		
Soil Subtotal		***2E-05***			
Ingestion	SD	NC	--- ---		
Dermal Contact	SD	NC	--- ---		
Sediment Subtotal		***---***			
Ingestion	SW	---	--- ---		
Dermal Contact	SW	---	--- ---		
Surface Water Subtotal		***---***			
Site Total	SS/SB+SD+SW	**2E-05**			

TABLE 2-1
RISK SUMMARY
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Exposure Scenario by Exposure Subunit	Medium	Site Health Effects			
		ILCR	Percent of Total Site Risk[a]	HI	Percent of Total Site Risk[a]
Future Adult Resident (See Appendix D Tables D-32 & D-38)[b]					
Ingestion	SS/SB	4E-06	2 (85)	0.09	3 (85)
Dermal Contact	SS/SB	8E-07	0.3 (15)	0.01	0.4 (10)
Inhalation	SS/SB	1E-08	0.004 (0.2)	0.005	0.2 (5)
Soil Subtotal		***5E-06***		***0.1***	
Ingestion	SD	NC	--- ---	NC	--- ---
Dermal Contact	SD	NC	--- ---	NC	--- ---
Sediment Subtotal		***---***		***---***	
Ingestion	SW	---	--- ---	0.003	0.1 (56)
Dermal Contact	SW	---	--- ---	0.003	0.09 (44)
Surface Water Subtotal		***---***		***0.006***	
Site Total	SS/SB+SD+SW	**5E-06**		**0.1**	
Future Child Resident (See Appendix D Tables D-33 & D-39)[b]					
Ingestion	SS/SB			0.9	11 (92)
Dermal Contact	SS/SB			0.07	1 (8)
Inhalation	SS/SB			0.005	0.07 (1)
Soil Subtotal				***0.9***	
Ingestion	SD			NC	--- ---
Dermal Contact	SD			NC	--- ---
Sediment Subtotal				***---***	
Ingestion	SW			0.016	0.2 (72)
Dermal Contact	SW			0.006	0.08 (28)
Surface Water Subtotal				***0.02***	
Site Total	SS/SB+SD+SW			**0.9**	

Note: Shaded areas equal site ILCR greater than 1E-04 or HI greater than 1 (none)

Numbers in parenthesis represent percent of medium risk.

These tables represent the RAGS Part D format 7 and 9, respectively.

HI = Hazard Index

ILCR = Lifetime incremental cancer risk

NC = Not calculated. In this medium and reach, there were no COPCs.

SB = Subsurface soils (0.5 to 6.0 ft)

SD = Sediment

SL = Sludge

SS = Surface soils (0 to 2.0 ft)

SW = Surface Water

WW = Waste Water

TABLE 2-2

SUMMARY OF CHEMICALS OF POTENTIAL CONCERN

OLD WASTEWATER TREATMENT PLANT

WALLOPS FLIGHT FACILITY, VIRGINIA

PAGE 1 OF 2

Exposure Point	Chemical of Potential Concern	Frequency of Detection	Screening Toxicity Value[(1) (2)]	Maximum Concentration Detected	Exposure Point Concentration	Units	Statistical Measure
Subsurface Soil – ingestion and dermal contact, and inhalation	Dibenz(a,h)anthracene	1/10	1.50E-02 C	4.60E-02	4.60E-02	mg/kg	Maximum[(3)]
	Aluminum	10/10	7.70E+03 N	1.14E+04	9.70E+03	mg/kg	95% Student's-t UCL[(4)]
	Arsenic	7/10	3.90E-01 C	2.50E+00	3.50E+00	mg/kg	95% KM (t) UCL[(4)]
	Iron	8/10	5.50E+03 N	6.50E+03	4.15E+03	mg/kg	95% KM (t) UCL[(4)]
Surface Soils – ingestion, dermal contact, and inhalation	Benzo(a)pyrene	1/14	1.50E-02 C	3.40E-02	3.40E-02	mg/kg	Maximum[(3)]
	Dibenz(a,h)anthracene	2/14	1.50E-02 C	5.00E-02	5.00E-02	mg/kg	Maximum[(3)]
	Aroclor-1260	1/14	2.20E-01 C	2.90E-01	2.90E-01	mg/kg	Maximum[(3)]
	Aluminum	14/14	7.70E+03 N	1.30E+04	1.30E+04	mg/kg	Maximum[(3)]
	Antimony	4/14	3.10E+00 N	3.20E+00	3.20E+00	mg/kg	Maximum[(3)]
	Arsenic	14/14	3.90E-01 C	5.40E+00	5.40E+00	mg/kg	Maximum[(3)]
	Cobalt	14/14	2.30E+00 N	3.30E+00	3.30E+00	mg/kg	Maximum[(3)]
	Iron	14/14	5.90E+03 N	1.00E+04	1.00E+04	mg/kg	Maximum[(3)]
	Lead	14/14	4.0E+02 N	4.60E+02	4.60E+02	mg/kg	Maximum[(3)]
	Manganese	14/14	1.8E+02 N	3.20E+02	3.20E+02	mg/kg	Maximum[(3)]
Sludge – ingestion, dermal contact, and inhalation	Benzo[a]anthracene	3/3	1.50E-01 C	2.10E+00	2.10E+00	mg/kg	Maximum[(3)]
	Benzo[a]pyrene	3/3	1.50E-02 C	9.10E-01	9.10E-01	mg/kg	Maximum[(3)]
	Benzo[b]fluoranthene	3/3	1.50E-01 C	4.80E+00	4.80E+00	mg/kg	Maximum[(3)]
	Benzo[k]fluoranthene	3/3	1.50E+00 C	2.40E+00	2.40E+00	mg/kg	Maximum[(3)]
	Carbazole	1/3	NBA	5.30E-02	5.30E-02	mg/kg	Maximum[(3)]
	Dibenz(a,h)anthracene	1/3	1.50E-02 C	7.60E-02	7.60E-02	mg/kg	Maximum[(3)]
	2-Hexanone	1/3	NBA	1.30E-01	1.30E-01	mg/kg	Maximum[(3)]
	Indeno[1,2,3-cd]pyrene	3/3	1.50E-01 N	1.40E+00	1.40E+00	mg/kg	Maximum[(3)]
	Antimony	2/3	3.10E+00 N	2.00E+01	2.00E+01	mg/kg	Maximum[(3)]
	Arsenic	2/3	3.90E-01 C	3.20E+00	3.20E+00	mg/kg	Maximum[(3)]
	Chromium	2/3	2.30E+01 N	6.50E+01	6.50E+01	mg/kg	Maximum[(3)]
	Cobalt	2/3	2.30E+00 N	2.60E+00	2.60E+00	mg/kg	Maximum[(3)]
	Iron	3/3	5.50E+03 N	1.50E+04	1.50E+04	mg/kg	Maximum[(3)]

TABLE 2-2
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Exposure Point	Chemical of Potential Concern	Frequency of Detection	Screening Toxicity Value(1) (2)	Maximum Concentration Detected	Exposure Point Concentration	Units	Statistical Measure
Sludge – ingestion, dermal contact, and inhalation	Lead	3/3	4.00E+02 N	5.30E+02	5.30E+02	mg/kg	Maximum(3)
	Manganese	3/3	1.80E+02 N	2.70E+02	2.70E+02	mg/kg	Maximum(3)
	Mercury	3/3	2.30E+00 N	2.80E+01	2.80E+01	mg/kg	Maximum(3)
Surface Water - ingestion/ dermal contact	Iron	1/1	3.00E+02	7.20E+03	7.20E+03	µg/L	Maximum(3)
	Manganese	1/1	5.00E+01	4.60E+02	4.60E+02	µg/L	Maximum(3)
Waste Water - ingestion, dermal contact, and inhalation	Iron	1/1	3.00E+02	1.50E+04	1.50E+04	µg/L	Maximum(3)
	Lead	1/1	1.50E+01	2.90E+01	2.90E+01	µg/L	Maximum(3)
	Manganese	1/1	5.00E+01	1.70E+02	1.70E+02	µg/L	Maximum(3)

µg/L – micrograms per liter.
C - Cancerous.
mg/kg - milligrams per kilogram.
KM - Kaplan-Meier
N - Noncancerous.
NBA - No Benchmark Available
RBC - risk based concentration.
RCRA - Resource Conservation and Recovery Act
THQ - target hazard quotient
TR - target risk
UCL: Upper confidence limit.

(1) Soil and Sediment Screening Toxicity - Region 3 residential soil RBC with a TR of 1E-06 and THQ of 0.1. USEPA has not assigned toxicity values to lead, therefore the RCRA corrective lead level for soil is used.
(2) Surface water Screening Toxicity - Region 3 tap water RBC with a TR of 1E-06 and THQ of 0.1. The Screening Toxicity Value for lead is based on the drinking water action level.
(3) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for Exposure Point Concentration.
(4) Based on ProUCL recommendation, data is normally distributed.

TABLE 2-3

CANCER TOXICITY DATA -- ORAL/DERMAL

OLD WASTEWATER TREATMENT PLANT

WALLOPS FLIGHT FACILITY, VIRGINIA

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal (1)		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (2) (MM/DD/YYYY)
Benzo[a]anthracene	7.30E-01	1/mg/kg/day	1.00E+00	7.30E-01	1/mg/kg/day	B2	IRIS	11/10/2009
Benzo[a]pyrene	7.30E+00	1/mg/kg/day	1.00E+00	7.30E+00	1/mg/kg/day	B2	IRIS	11/10/2009
Benzo[b]fluoranthene	7.30E-01	1/mg/kg/day	1.00E+00	7.30E-01	1/mg/kg/day	B2	IRIS	11/10/2009
Benzo[k]fluoranthene	7.30E-02	1/mg/kg/day	1.00E+00	7.30E-02	1/mg/kg/day	B2	IRIS	11/10/2009
Carbazole	NA	---	---	NA	---	---	---	---
Dibenz(a,h)anthracene	7.30E+00	1/mg/kg/day	1.00E+00	7.30E+00	1/mg/kg/day	B2	IRIS	11/10/2009
2-Hexanone	NA	---	---	NA	---	---	---	---
Indeno[1,2,3-cd]pyrene	7.30E-01	1/mg/kg/day	1.00E+00	7.30E-01	1/mg/kg/day	B2	IRIS	11/10/2009
PCB-1260	2.00E+00	1/mg/kg/day	1.00E+00	2.00E+00	1/mg/kg/day	B2	IRIS	11/10/2009
Aluminum	NA	---	---	NA	---	---	--- ---	---
Antimony	NA	---	---	NA	---	---	--- ---	---
Arsenic	1.50E+00	1/mg/kg/day	1.00E+00	1.50E+00	1/mg/kg/day	A	IRIS	11/10/2009
Chromium	NA	---	---	NA	---	---	--- ---	---
Cobalt	NA	---	---	NA	---	---	--- ---	---
Iron	NA	---	---	NA	---	---	--- ---	---
Lead	NA	---	---	NA	---	---	--- ---	---
Manganese (Diet)	NA	---	---	NA	---	---	--- ---	---
Manganese (Water)	NA	---	---	NA	---	---	--- ---	---
Mercury	NA	---	---	NA	---	---	--- ---	---
Silver	NA	---	---	NA	---	---	--- ---	---

(1) EPA, 2009a.

(2) Represents date source was searched.

Definitions: Cal EPA = California Environmental Protection Agency.
HEAST = Health Effects Assessment Summary Table.
IRIS = Integrated Risk Information System.
NA = Not available.

A - Human carcinogen.
B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.

TABLE 2-4

CANCER TOXICITY DATA -- INHALATION

OLD WASTEWATER TREATMENT PLANT

WALLOPS FLIGHT FACILITY, VIRGINIA

Chemical of Potential Concern	Unit Risk		Weight of Evidence/ Cancer Guideline Description	Unit Risk: Inhalation CSF	
	Value	Units		Source(s)	Date(s) (1) (MM/DD/YYYY)
Benzo[a]anthracene	1.10E-04	1/µg/m3	B2	Cal EPA	RSL Table (05/09)
Benzo[a]pyrene	1.10E-03	1/µg/m3	B2	Cal EPA	RSL Table (05/09)
Benzo[b]fluoranthene	1.10E-04	1/µg/m3	B2	Cal EPA	RSL Table (05/09)
Benzo[k]fluoranthene	1.10E-04	1/µg/m3	B2	Cal EPA	RSL Table (05/09)
Carbazole	NA	---	---	---	---
Dibenz(a,h)anthracene	1.20E-03	1/µg/m3	B2	Cal EPA	RSL Table (05/09)
2-Hexanone	NA	---	---	---	---
Indeno[1,2,3-cd]pyrene	1.10E-04	1/µg/m3	B2	Cal EPA	RSL Table (05/09)
PCB-1260	5.71E-04	1/µg/m3	B2	IRIS	11/10/2009
Aluminum	NA	---	---	---	---
Antimony	NA	---	---	---	---
Arsenic	4.30E-03	1/µg/m3	A	IRIS	11/10/2009
Chromium	1.20E-02	1/µg/m3	A	IRIS	11/10/2009
Cobalt	9.00E-03	1/µg/m3	NA	PPRTV	RSL Table (05/09)
Iron	NA	---	---	---	---
Lead	NA	---	---	---	---
Manganese (Diet)	NA	---	---	---	---
Manganese (Water)	NA	---	---	---	---
Mercury	NA	---	---	---	---
Silver	NA	---	---	---	---

(1) Represents date source was searched.

Definitions:

Cal EPA = California Environmental Protection Agency.

HEAST = Health Effects Assessment Summary Table.

IRIS = Integrated Risk Information System.

NA = Not available.

PPRTV = EPA provisional peer-reviewed toxicity value

TABLE 2-5
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal (1)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD: Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (2) (MM/DD/YYYY)
Benzo[a]anthracene	---	NA	---	---	NA	---	---	---	---	---
Benzo[a]pyrene	---	NA	---	---	NA	---	---	---	---	---
Benzo[b]fluoranthene	---	NA	---	---	NA	---	---	---	---	---
Benzo[k]fluoranthene	---	NA	---	---	NA	---	---	---	---	---
Carbazole	---	NA	---	---	NA	---	---	---	---	---
Dibenz(a,h)anthracene	---	NA	---	---	NA	---	---	---	---	---
2-Hexanone	---	NA	---	---	NA	---	---	---	---	---
Indeno[1,2,3-cd]pyrene	---	NA	---	---	NA	---	---	---	---	---
PCB-1260	---	NA	---	---	NA	---	---	---	---	---
Aluminum	Chronic	1.00E+00	mg/kg/day	1.00E+00	1.00E+00	mg/kg/day	CNS	---	PPRTV	RSL Table (05/09)
Antimony	Chronic	4.00E-04	mg/kg/day	1.50E-01	6.00E-05	mg/kg/day	Blood	1,000	IRIS	11/10/2009
Arsenic	Chronic	3.00E-04	mg/kg/day	1.00E+00	3.00E-04	mg/kg/day	Skin	3	IRIS	11/10/2009
Chromium	Chronic	NA	mg/kg/day	---	NA	mg/kg/day	NOEL	900	IRIS	11/10/2009
Cobalt	Chronic	3.00E-04	mg/kg/day	1.00E+00	3.00E-04	mg/kg/day	---	---	PPRTV	RSL Table (05/09)
Iron	Chronic	7.00E-01	mg/kg/day	1.00E+00	7.00E-01	mg/kg/day	---	---	PPRTV	RSL Table (05/09)
Lead	---	NA	---	---	NA	---	---	---	---	---
Manganese (Diet)	Chronic	1.40E-01	mg/kg/day	4.00E-02	5.60E-03	mg/kg/day	CNS	1	IRIS	11/10/2009
Manganese (Water)	Chronic	2.40E-02	mg/kg/day	4.00E-02	9.60E-04	mg/kg/day	CNS	1	IRIS	11/10/2009
Mercury	Chronic	3.00E-04	mg/kg/day	7.00E-02	2.10E-05	mg/kg/day	Immune System	---	IRIS	11/10/2009
Silver	Chronic	5.00E-03	mg/kg/day	4.00E-02	2.00E-04	mg/kg/day	Skin	3	IRIS	11/10/2009

(1) EPA, 2009a.

(2) Represents date source was searched.

Definitions:
CNS=Central nervous system.
IRIS=Integrated Risk Information System.
NA=Not available.
PPRTV = EPA provisional peer-reviewed toxicity value

TABLE 2-6
NON-CANCER TOXICITY DATA -- INHALATION
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC: Target Organ(s)	
		Value	Units			Source(s)	Date(s) (1) (MM/DD/YYYY)
Benzo[a]anthracene	---	NA	---	---	---	---	---
Benzo[a]pyrene	---	NA	---	---	---	---	---
Benzo[b]fluoranthene	---	NA	---	---	---	---	---
Benzo[k]fluoranthene	---	NA	---	---	---	---	---
Carbazole	---	NA	---	---	---	---	---
Dibenz(a,h)anthracene	---	NA	---	---	---	---	---
2-Hexanone	---	NA	---	---	---	---	---
Indeno[1,2,3-cd]pyrene	---	NA	---	---	---	---	---
PCB-1260	---	NA	---	---	---	---	---
Aluminum	Chronic	5.00E-03	mg/m3	---	---	PPRTV	RSL Table (05/09)
Antimony	---	NA	---	---	---	---	---
Arsenic	Chronic	1.50E-05	mg/m3	---	---	Cal EPA	RSL Table (05/09)
Chromium	---	NA	---	Lung	300	IRIS	11/10/2009
Cobalt	Chronic	6.00E-06	mg/m3	---	---	PPRTV	RSL Table (05/09)
Iron	---	NA	---	---	---	---	---
Lead	---	NA	---	---	---	---	---
Manganese (Diet)	Chronic	5.00E-05	mg/m3	CNS	1,000	IRIS	11/10/2009
Manganese (Water)	Chronic	5.00E-05	mg/m3	CNS	1,000	IRIS	11/10/2009
Mercury	---	NA	---	CNS	30	IRIS	11/10/2009
Silver	---	NA	---	---	---	---	---

(1) Represents date source was searched.

ATSDR = Agency for Toxic Substances and Disease Registry.

Cal EPA = California Environmental Protection Agency.

CNS=Central nervous system

IRIS=Integrated Risk Information System

NA=Not available

PPRTV = EPA provisional peer-reviewed toxicity value

TABLE 2-7A
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
AGE-ADJUSTED RESIDENT
REASONABLE MAXIMUM EXPOSURES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA
PAGE 1 OF 1

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Age-adjusted

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface/Subsurface Soils	Surface/Subsurface Soils at WWTP	Benzo(a)pyrene	3.89E-07	8.68E-15	1.59E-07	5E-07	---	---	---	---	---
			Dibenz(a,h)anthracene	5.71E-07	1.39E-14	2.35E-07	8E-07	---	---	---	---	---
			PCB-1260	9.08E-07	3.85E-14	4.01E-07	1E-06	---	---	---	---	---
			Aluminum	---	---	---	---	---	---	---	---	---
			Antimony	---	---	---	---	---	---	---	---	---
			Arsenic	1.27E-05	5.39E-12	1.20E-06	1E-05	---	---	---	---	---
			Cobalt	---	6.90E-12	---	7E-12	---	---	---	---	---
			Iron	---	---	---	---	---	---	---	---	---
			Lead	---	---	---	---	---	---	---	---	---
			Manganese	---	---	---	---	---	---	---	---	---
			Chemical Total	1.45E-05	1.23E-11	2.00E-06	2E-05		---	---	---	---
		Exposure Point Total					2E-05					
	Exposure Medium Total						2E-05					
Soil Total							2E-05					
Sediment	Sediment	Sediment at WWTP	No COPCs									
			Chemical Total									
		Exposure Point Total										
	Exposure Medium Total											
Sediment Total												
Surface Water	Surface Water	Surface Water at WWTP	Iron	---	---	---	---	---	---	---	---	---
			Manganese	---	---	---	---	---	---	---	---	---
			Chemical Total	---	---	---	---		---	---	---	---
		Exposure Point Total					---					---
	Exposure Medium Total						---					---
Surface Water Total							---					---
Receptor Total							2E-05					---
						Total Risk Across All Media	2E-05				Total Hazard Across All Media	---

TABLE 2-7B
2022 REVISED SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
AGE-ADJUSTED RESIDENT
REASONABLE MAXIMUM EXPOSURES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA
PAGE 1 OF 1

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Age-adjusted

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface/Subsurface Soils	Surface/Subsurface Soils at WWTP	Benzo(a)pyrene	2.2E-07	1.1E-11	7.3E-08	3E-07	---	---	---	---	---
			Dibenzo(a,h)anthracene	3.3E-07	1.7E-11	1.1E-07	4E-07	---	---	---	---	---
			PCB-1260	8.3E-07	3.5E-08	3.2E-07	1E-06	---	---	---	---	---
			Aluminum	---	---	---	---	---	---	---	---	---
			Antimony	---	---	---	---	---	---	---	---	---
			Arsenic	7.0E-06	4.7E-09	9.6E-07	8E-06	---	---	---	---	---
			Cobalt	---	6.0E-09	---	6E-09	---	---	---	---	---
			Iron	---	---	---	---	---	---	---	---	---
			Lead	---	---	---	---	---	---	---	---	---
			Manganese	---	---	---	---	---	---	---	---	---
			Chemical Total	8.4E-06	4.6E-08	1.5E-06	1E-05		---	---	---	---
		Exposure Point Total					1E-05					
	Exposure Medium Total						1E-05					
Soil Total							1E-05					
Sediment	Sediment	Sediment at WWTP	No COPCs									
			Chemical Total									
		Exposure Point Total										
	Exposure Medium Total											
Sediment Total												
Surface Water	Surface Water	Surface Water at WWTP	Iron	---	---	---	---	---	---	---	---	---
			Manganese	---	---	---	---	---	---	---	---	---
			Chemical Total	---	---	---	---		---	---	---	---
		Exposure Point Total					---					---
	Exposure Medium Total						---					---
Surface Water Total							---					---
Receptor Total							1E-05					---
					Total Risk Across All Media		1E-05			Total Hazard Across All Media		---

TABLE 2-8A
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
FUTURE ADULT RESIDENT
REASONABLE MAXIMUM EXPOSURES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface/Subsurface Soils	Surface/Subsurface Soils at WWTP	Benzo(a)pyrene	1.17E-07	6.95E-12	6.05E-08	2E-07	---	---	---	---	---
			Dibenz(a,h)anthracene	1.71E-07	1.11E-11	8.89E-08	3E-07	---	---	---	---	---
			PCB-1260	2.72E-07	3.08E-11	1.52E-07	4E-07	---	---	---	---	---
			Aluminum	---	---	---	---	CNS	1.78E-02	1.41E-03	7.11E-04	2E-02
			Antimony	---	---	---	---	Blood	1.10E-02	---	2.92E-03	1E-02
			Arsenic	3.80E-06	4.31E-09	4.55E-07	4E-06	Skin	2.47E-02	1.95E-04	2.95E-03	3E-02
			Cobalt	---	5.52E-09	---	6E-09	---	1.51E-02	2.98E-04	6.01E-04	2E-02
			Iron	---	---	---	---	---	1.96E-02	---	7.81E-04	2E-02
			Lead	---	---	---	---	---	---	---	---	---
			Manganese	---	---	---	---	CNS	3.13E-03	3.47E-03	3.12E-03	1E-02
			Chemical Total	4.36E-06	9.88E-09	7.57E-07	5E-06		9.12E-02	5.37E-03	1.11E-02	1E-01
		Exposure Point Total					5E-06					1E-01
	Exposure Medium Total						5E-06					1E-01
Soil Total							5E-06					1E-01
Sediment	Sediment	Sediment at WWTP	No COPCs									
			Chemical Total									
		Exposure Point Total										
	Exposure Medium Total											
Sediment Total												

TABLE 2-8A
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
FUTURE ADULT RESIDENT
REASONABLE MAXIMUM EXPOSURES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Surface Water at WWTP	Iron	---	---	---	---	---	2.62E-03	---	2.98E-04	3E-03
			Manganese	---	---	---	---	CNS	8.36E-04	---	2.38E-03	3E-03
			Chemical Total	---	---	---	---		3.45E-03	---	2.68E-03	6E-03
		Exposure Point Total					---					6E-03
	Exposure Medium Total						---					6E-03
Surface Water Total							---					6E-03
Receptor Total							5E-06					1E-01
						Total Risk Across All Media	5E-06				Total Hazard Across All Media	1E-01
											Total CNS HI Across All Media	3E-02
											Total Blood HI Across All Media	1E-02
											Total Skin HI Across All Media	3E-02

TABLE 2-8B
2022 REVISED SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
FUTURE ADULT RESIDENT
REASONABLE MAXIMUM EXPOSURES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface/Subsurface Soils	Surface/Subsurface Soils at WWTP	Benzo(a)pyrene	2.3E-08	6.3E-12	1.2E-08	4E-08	Developmental, Immune, Reproductive	1.4E-04	9.2E-06	7.0E-05	2E-04
			Dibenzo(a,h)anthracene	3.4E-08	9.3E-12	1.8E-08	5E-08	---	---	---	---	---
			PCB-1260	2.0E-07	2.7E-08	1.1E-07	3E-07	---	---	---	---	---
			Aluminum	---	---	---	---	CNS	1.6E-02	1.4E-03	6.2E-04	2E-02
			Antimony	---	---	---	---	Hematologic	9.6E-03	---	2.6E-03	1E-02
			Arsenic	1.7E-06	3.6E-09	3.3E-07	2E-06	Dermal, CVS	1.3E-02	2.0E-04	2.6E-03	2E-02
			Cobalt	---	4.6E-09	---	5E-09	Thyroid, Respiratory	1.3E-02	3.0E-04	5.3E-04	1E-02
			Iron	---	---	---	---	GS	1.7E-02	---	6.8E-04	2E-02
			Lead	---	---	---	---	---	---	---	---	---
			Manganese	---	---	---	---	CNS	1.6E-02	3.5E-03	1.6E-02	4E-02
			Chemical Total	1.9E-06	3.5E-08	4.7E-07	2E-06		8.5E-02	5.4E-03	2.3E-02	1E-01
		Exposure Point Total					2E-06					1E-01
	Exposure Medium Total						2E-06					1E-01
Soil Total							2E-06					1E-01
Sediment	Sediment	Sediment at WWTP	No COPCs	---	---	---	---					---
			Chemical Total	---	---	---	---					---
		Exposure Point Total					---					---
	Exposure Medium Total						---					---
Sediment Total							---					---

TABLE 2-8B
2022 REVISED SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
FUTURE ADULT RESIDENT
REASONABLE MAXIMUM EXPOSURES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Surface Water at WWTP	Iron	---	---	---	---	GS	2.3E-03	---	2.8E-04	3E-03
			Manganese	---	---	---	---	CNS	4.3E-03	---	1.3E-02	2E-02
			Chemical Total	---	---	---	---		6.6E-03	---	1.3E-02	2E-02
		Exposure Point Total					---					2E-02
	Exposure Medium Total						---					2E-02
Surface Water Total							---					2E-02
Receptor Total						Receptor Risk Total	2E-06				Receptor HI Total	1E-01
						Total Risk Across All Media	2E-06				Total Hazard Across All Media	1E-01
											Total Nervous System HI Across All Media	7E-02
											Total CVS HI Across All Media	2E-02
											Total Dermal HI Across All Media	2E-02
											Total Developmental HI Across All Media	2E-04
											Total GS HI Across All Media	2E-02
											Total Hematologic HI Across All Media	1E-02
											Total Immune HI Across All Media	2E-04
											Total Respiratory HI Across All Media	1E-02
											Total Thyroid HI Across All Media	1E-02
											Total Reproductive HI Across All Media	2E-04

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

TABLE 2-9A
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
FUTURE CHILD RESIDENT
REASONABLE MAXIMUM EXPOSURES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA
PAGE 1 OF 2

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface/Subsurface Soil	Surface/Subsurface Soil at WWTP	Benzo(a)pyrene	---	---	---	---	---	---	---	---	---
			Dibenz(a,h)anthracene	---	---	---	---	---	---	---	---	--
			PCB-1260	---	---	---	---	---	---	---	---	--
			Aluminum	---	---	---	---	CNS	1.66E-01	1.41E-03	4.65E-03	2E-01
			Antimony	---	---	---	---	Blood	1.02E-01	---	1.91E-02	1E-01
			Arsenic	---	---	---	---	Skin	2.30E-01	1.95E-04	1.93E-02	2E-01
			Cobalt	---	---	---	---	---	1.41E-01	2.98E-04	3.94E-03	1E-01
			Iron	---	---	---	---	---	1.83E-01	---	5.11E-03	2E-01
			Lead	---	---	---	---	---	---	---	---	--
			Manganese	---	---	---	---	CNS	2.92E-02	3.47E-03	2.05E-02	5E-02
			Chemical Total	---	---	---	---		8.51E-01	5.37E-03	7.260E-02	9E-01
		Exposure Point Total					---					9E-01
	Exposure Medium Total						---					9E-01
Soil Total							---					9E-01
Sediment	Sediment	Sediment at WWTP	No COPCs									
			Chemical Total									
		Exposure Point Total										
	Exposure Medium Total											
Sediment Total												

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

TABLE 2-9A
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
FUTURE CHILD RESIDENT
REASONABLE MAXIMUM EXPOSURES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA
PAGE 2 OF 2

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Surface Water at WWTP	Iron	---	---	---	---	---	1.22E-02	--	6.84E-04	1E-02
			Manganese	---	---	---	---	CNS	3.90E-03	--	5.46E-03	9E-03
			Chemical Total	---	---	---	---		1.61E-02	--	6.15E-03	2E-02
		Exposure Point Total					---					7E-02
	Exposure Medium Total						---					7E-02
Surface Water Total							---					7E-02
Receptor Total							---					1E+00
						Total Risk Across All Media	---				Total Hazard Across All Media	1E+00
											Total CNS HI Across All Media	2E-01
											Total Blood HI Across All Media	1E-01
											Total Skin HI Across All Media	2E-01

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

TABLE 2-9B
2022 REVISED SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
FUTURE CHILD RESIDENT
REASONABLE MAXIMUM EXPOSURES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA
PAGE 1 OF 2

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface/Subsurface Soil	Surface/Subsurface Soil at WWTP	Benzo(a)pyrene	---	---	---	---	Developmental, Immune, Reproductive	1.4E-03	9.2E-06	4.5E-04	2E-03
			Dibenzo(a,h)anthracene	---	---	---	---	---	--	--	--	--
			PCB-1260	---	---	---	---	---	--	--	--	--
			Aluminum	---	---	---	---	CNS	1.7E-01	1.4E-03	3.9E-03	2E-01
			Antimony	---	---	---	---	Hematologic	1.0E-01	--	1.6E-02	1E-01
			Arsenic	---	---	---	---	Dermal, CVS	1.4E-01	2.0E-04	1.6E-02	2E-01
			Cobalt	---	---	---	---	Thyroid	1.4E-01	3.0E-04	3.3E-03	1E-01
			Iron	---	---	---	---	GS	1.8E-01	--	4.3E-03	2E-01
			Lead	---	---	---	---	---	--	--	--	--
			Manganese	---	---	---	---	CNS	1.7E-01	3.5E-03	1.0E-01	3E-01
			Chemical Total	---	---	---	---		9.0E-01	5.4E-03	1.46E-01	1E+00
		Exposure Point Total					---					1E+00
	Exposure Medium Total						---					1E+00
Soil Total							---					1E+00
Sediment	Sediment	Sediment at WWTP	No COPCs	---	---	---	---					---
			Chemical Total	---	---	---	---					---
		Exposure Point Total					---					---
	Exposure Medium Total						---					---
Sediment Total							---					---

TABLE 2-9B
2022 REVISED SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
FUTURE CHILD RESIDENT
REASONABLE MAXIMUM EXPOSURES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water	Surface Water	Surface Water at WWTP	Iron	---	---	---	---	GS	1.2E-02	--	6.8E-04	1E-02
			Manganese	---	---	---	---	CNS	2.3E-02	--	3.2E-02	5E-02
			Chemical Total	---	---	---	---		3.5E-02	--	3.3E-02	7E-02
		Exposure Point Total					---					7E-02
	Exposure Medium Total						---					7E-02
Surface Water Total							---					7E-02
Receptor Total						Receptor Risk Total	---				Receptor HI Total	1E+00
						Total Risk Across All Media	---				Total Hazard Across All Media	1E+00
											Total Nervous System HI Across All Media	5E-01
											Total CVS HI Across All Media	2E-01
											Total Dermal HI Across All Media	2E-01
											Total Developmental HI Across All Media	2E-03
											Total GS HI Across All Media	2E-01
											Total Hematologic HI Across All Media	1E-01
											Total Immune HI Across All Media	2E-03
											Total Thyroid HI Across All Media	1E-01
											Total Reproductive HI Across All Media	2E-03

TABLE 2-10
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL
ECOLOGICAL CONCERN - SLUDGE
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILTY, VIRGINIA

CAS Number	Analyte	Number of Samples Analyzed[1]	Number of Detected Samples	Minimum Detected Concentration	Maximum Detected Concentration [1]	Location of Maximum	Upper Depth of Maximum (feet)	Lower Depth of Maximum (feet)	Ecological Screening Benchmark										Final Screening Benchmark	No. Samples Exceeding Benchmark
									ECO-SSL[2]				ORNL[3,4,5]				BTAG			
									Avian	Invertebrate	Mammalian	Plant	Invertebrate	Microbe	Plant	Wildlife	Flora	Fauna		
	INORGANICS (MG/KG)																			
7429-90-5	Aluminum, Total	3	3	680	6900	WFF1-SL03	0	2	NA	NA	NA	NA	NA	6.00E+02	5.00E+01	NA	1.00E+00	NA	1.00E+00	3
7440-36-0	Antimony, Total	3	2	12	20	WFF1-SL02	0	2	NA	7.80E+01	2.70E-01	NA	NA	NA	5.00E+00	NA	4.80E-01	NA	2.70E-01	2
7440-38-2	Arsenic, Total	3	2	2.6	3.2	WFF1-SL03	0	2	4.30E+01	NA	4.60E+01	1.80E+01	6.00E+01	1.00E+02	1.00E+01	9.90E+00	3.28E+02	NA	1.80E+01	0
7440-39-3	Barium, Total	3	3	130	270	WFF1-SL03	0	2	NA	3.30E+02	2.00E+03	NA	NA	3.00E+03	5.00E+02	2.83E+02	4.40E+02	4.40E+02	3.30E+02	0
7440-41-7	Beryllium, Total	3	2	0.36	0.46	WFF1-SL03	0	2	NA	4.00E+01	2.10E+01	NA	NA	NA	1.00E+01	NA	2.00E-02	NA	2.10E+01	0
7440-43-9	Cadmium, Total	3	2	2.2	3.7	WFF1-SL03	0	2	7.70E-01	1.40E+02	3.60E-01	3.20E+01	2.00E+01	2.00E+01	4.00E+00	4.20E+00	2.50E+00	NA	3.60E-01	2
7440-70-2	Calcium, Total	3	3	3900	13000	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
7440-47-3	Chromium, Total	3	2	36	65	WFF1-SL02	0	2	2.60E+01	NA	3.40E+01	NA	4.00E-01	1.00E+01	1.00E+00	1.61E+01	2.00E-02	7.50E-03	2.60E+01	2
7440-48-4	Cobalt, Total	3	2	2	2.6	WFF1-SL03	0	2	1.20E+02	NA	2.30E+02	1.30E+01	NA	1.00E+03	2.00E+01	NA	1.00E+02	2.00E+02	1.30E+01	0
7440-50-8	Copper, Total	3	3	11	180	WFF1-SL03	0	2	2.80E+01	8.00E+01	4.90E+01	7.00E+01	5.00E+01	1.00E+02	1.00E+02	3.70E+02	1.50E+01	NA	2.80E+01	1
57-12-5	Cyanide, Total	3	2	1.5	1.5	WFF1-SL03	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
7439-89-6	Iron, Total	3	3	12000	15000	WFF1-SL01	0	2	NA	NA	NA	NA	NA	2.00E+02	NA	NA	3.26E+03	1.20E+01	1.20E+01	3
7439-92-1	Lead, Total	3	3	130	530	WFF1-SL02	0	2	1.10E+01	1.70E+03	5.60E+01	1.20E+02	5.00E+02	9.00E+02	5.00E+01	4.05E+01	2.00E+00	1.00E-02	1.10E+01	3
7439-95-4	Magnesium, Total	3	3	730	950	WFF1-SL03	0	2	NA	NA	NA	NA	NA	NA	NA	NA	4.40E+03	4.40E+03	4.40E+03	0
7439-96-5	Manganese, Total	3	3	160	270	WFF1-SL01	0	2	4.30E+03	4.50E+02	4.00E+03	2.20E+02	NA	1.00E+02	5.00E+02	NA	3.30E+02	3.30E+02	2.20E+02	1
7439-97-6	Mercury, Total	3	3	0.17	28	WFF1-SL03	0	2	NA	NA	NA	NA	1.00E-01	3.00E+01	3.00E-01	5.10E-04	5.80E-02	5.80E-02	5.10E-04	3
7440-02-0	Nickel, Total	3	3	4	8.9	WFF1-SL03	0	2	2.10E+02	2.80E+02	1.30E+02	3.80E+01	2.00E+02	9.00E+01	3.00E+01	1.21E+02	2.00E+00	NA	3.80E+01	0
7440-09-7	Potassium, Total	3	3	640	1300	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
7782-49-2	Selenium, Total	3	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-22-4	Silver, Total	3	2	110	130	WFF1-SL02	0	2	4.20E+00	NA	1.40E+01	5.60E+02	NA	5.00E+01	2.00E+00	NA	9.80E-06	NA	4.20E+00	2
7440-23-5	Sodium, Total	3	3	130	680	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
7440-28-0	Thallium, Total	3	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-62-2	Vanadium, Total	3	3	7.2	18	WFF1-SL03	0	2	7.80E+00	NA	2.80E+02	NA	NA	2.00E+01	2.00E+00	5.50E+01	5.00E-01	5.80E+01	7.80E+00	2
7440-66-6	Zinc, Total	3	3	420	680	WFF1-SL01	0	2	4.60E+01	1.20E+02	7.90E+01	1.60E+02	1.00E+02	1.00E+02	5.00E+01	8.50E+00	1.00E+01	NA	4.60E+01	3
	PESTICIDES (UG/KG)																			
72-54-8	4,4'-DDD	3	3	110	1200	WFF1-SL03	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3
72-55-9	4,4'-DDE	3	3	67	1400	WFF1-SL02	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	2
50-29-3	4,4'-DDT	3	3	110	1100	WFF1-SL03	0	2	9.30E+01	NA	2.10E+01	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	2.10E+01	3
60-57-1	Dieldrin	3	2	5.6	9.9	WFF1-SL02	0	2	2.20E+01	NA	4.90E+00	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	4.90E+00	2
	PCBS (UG/KG)																			
	Not Detected																			
	SVOCS (UG/KG)																			
106-46-7	1,4-Dichlorobenzene	3	2	84	84	WFF1-SL03	0	2	NA	NA	NA	NA	2.00E+04	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	0
120-12-7	Anthracene	3	3	64	630	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	1
56-55-3	Benzo[a]anthracene	3	3	290	2100	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3
50-32-8	Benzo[a]pyrene	3	3	290	910	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3
205-99-2	Benzo[b]fluoranthene	3	3	550	4800	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3
191-24-2	Benzo[g,h,i]perylene	3	3	270	1200	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3
207-08-9	Benzo[k]fluoranthene	3	3	290	2400	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3
117-81-7	Bis(2-ethylhexyl) phthalate	3	1	79	79	WFF1-SL02	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
86-74-8	Carbazole	3	1	53	53	WFF1-SL02	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
218-01-9	Chrysene	3	3	480	4700	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3
53-70-3	Dibenz(a,h)anthracene	3	1	76	76	WFF1-SL03	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	0
84-74-2	Di-n-butyl phthalate	3	2	89	110	WFF1-SL02	0	2	NA	NA	NA	NA	NA	NA	2.00E+05	NA	NA	NA	2.00E+05	0
206-44-0	Fluoranthene	3	3	410	9000	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3
86-73-7	Fluorene	3	1	360	360	WFF1-SL01	0	2	NA	NA	NA	NA	3.00E+04	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	1
193-39-5	Indeno[1,2,3-cd]pyrene	3	3	230	1400	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3
85-01-8	Phenanthrene	3	3	170	3000	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3
129-00-0	Pyrene	3	3	360	6300	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	1.00E+02	1.00E+02	1.00E+02	3

TABLE 2-10
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN - SLUDGE
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

CAS Number	Analyte	Number of Samples Analyzed[1]	Number of Detected Samples	Minimum Detected Concentration	Maximum Detected Concentration [1]	Location of Maximum	Upper Depth of Maximum (feet)	Lower Depth of Maximum (feet)	Ecological Screening Benchmark										Final Screening Benchmark	No. Samples Exceeding Benchmark
									ECO-SSL[2]				ORNL[3,4,5]				BTAG			
									Avian	Invertebrate	Mammalian	Plant	Invertebrate	Microbe	Plant	Wildlife	Flora	Fauna		
	VOCS (UG/KG)																			
79-34-5	1,1,2,2-Tetrachloroethane	3	1	29	29	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
591-78-6	2-Hexanone	3	1	130	130	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
67-64-1	Acetone	3	3	55	740	WFF1-SL02	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
78-93-3	Methyl Ethyl Ketone	3	2	77	210	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
108-10-1	Methyl isobutyl ketone	3	1	91	91	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--
127-18-4	Tetrachloroethene	3	1	5.1	5.1	WFF1-SL02	0	2	NA	NA	NA	NA	NA	NA	NA	NA	3.00E+02	3.00E+02	3.00E+02	0
108-88-3	Toluene	3	2	6.2	1200	WFF1-SL01	0	2	NA	NA	NA	NA	NA	NA	2.00E+05	NA	1.00E+02	1.00E+02	1.00E+02	1

Notes:
[shaded box] Maximum concentrations for shaded chemicals exceed screening benchmark.
BTAG - Biological Technological Assistant Group
CAS = Chemical Abstracts Service
MG/KG = milligram per kilogram
NA = Not available
PCBs = Polychlorinated biphenyls
UG/KG = microgram per kilogram
SVOCs = Semivolatile organic compounds
VOCS = Volatile organic compounds
[1] Maximum detected concentration used for screening.
[2] EPA Ecological Soil Screening Levels (ECO-SSL) (http://www.epa.gov/ecotox/ecossl/).
[3] Oak Ridge National Laboratory (ORNL). Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. ORNL. ES/ER/TM-126/R2. November.
[4] ORNL. Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. ORNL. ES/ER/TM-85/R3. November.
[5] ORNL. Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals for Ecological Endpoints. ORNL. ES/ER/TM-162/R2. August.

TABLE 2-11
HAZARD QUOTIENT AND PRELIMINARY REMEDIATION GOAL SUMMARY FOR
TERRESTIAL RECEPTORS - SLUDGE
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Contaminant	Red Fox LOAEL HQ	Red-tailed Hawk LOAEL HQ	American Robin LOAEL HQ	Short-tailed Shrew LOAEL HQ	PRG mg/kg
Metals					
Aluminum, Total	2.0E-05	1.9E-05	1.1E-01	3.3E-02	NC
Antimony, Total	5.0E-06	NC	NC	8.5E-03	NC
Cadmium, Total	7.9E-07	1.6E-06	8.9E-03	1.3E-03	NC
Chromium, Total	1.7E-05	1.9E-04	1.1E+00	1.5E-02	6.11E+01
Copper, Total	2.5E-06	3.4E-06	1.9E-02	4.7E-03	NC
Iron, Total	NC	NC	NC	NC	NC
Lead, Total	7.4E-07	2.2E-05	1.2E-01	1.3E-03	NC
Manganese, Total	5.1E-08	6.1E-08	3.4E-04	8.6E-05	NC
Mercury, Total	4.4E-03	9.4E-03	5.2E+01	1.5E+00	5.38E-01
Silver, Total	NC	NC	NC	NC	NC
Vanadium, Total	5.4E-07	3.9E-07	2.2E-04	9.3E-04	NC
Zinc, Total	1.2E-06	1.9E-05	1.0E-01	3.1E-03	NC
Pesticides					
4,4'-DDD	1.1E-06	6.4E-04	3.5E+00	1.8E-03	3.42E-01
4,4'-DDE	3.0E-06	1.8E-03	9.8E+00	5.0E-03	1.43E-01
4,4'-DDT	1.4E-07	8.7E-05	4.8E-01	2.5E-04	NC
Dieldrin	1.7E-07	1.9E-06	1.1E-02	3.0E-04	NC
Polynuclear Aromatic Hydrocarbons (PAHs)					
Total LMW PAHs	1.3E-06	6.7E-07	3.7E-03	8.9E-03	NC
Total HMW PAHs	1.9E-08	2.4E-08	1.3E-04	1.4E-04	NC
Volatile Organic Compounds (VOCs)					
Toluene	2.2E-06	NC	NC	3.7E-03	NC

Notes:
Shaded area indicates an exceedance of an HQ of 1.
HQ = Hazard Quotient (Dose/LOAEL or NOAEL).
LOAEL = Lowest Observed Adverse Effect Level (Sample, 1996).
mg/kg = milligrams per kilogram.
NC = Not Calculated
NOAEL = No Observed Adverse Effect Level (Sample, 1996).
PRG = Preliminary Remediation Goal

TABLE 2-12
ASSESSMENT AND MEASUREMENT ENDPOINTS
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Target Receptors or Communities	Assessment Endpoints	Measurement Endpoints
Vegetation in the terrestrial areas of the Site.	Survival, germination, and growth of plants in the terrestrial areas of the Site.	Comparison of chemical concentrations in soils with phytotoxic effects thresholds found in literature for plants.
Soil fauna in the terrestrial areas of the Site.	Survival, reproduction, and growth of soil fauna in the terrestrial areas of the Site.	Comparison of chemical concentrations in soils with toxic effects thresholds found in literature for soil invertebrates and microbial processes. Comparison of chemical concentrations in earthworm tissue with toxic effects residue concentrations.
Insectivorous birds foraging in the terrestrial areas of the Site.	Survival, reproduction, and growth of birds foraging in the terrestrial areas of the Site.	Modeling of soil invertebrate chemical accumulation, and avian (American robin) dietary exposure modeling. Comparison of dietary exposure doses with reference toxicity values for birds.
Insectivorous and carnivorous mammals foraging the terrestrial areas of the Site.	Survival, reproduction, and growth of mammals foraging in the terrestrial areas of the Site.	Analysis of soil invertebrate and small mammal tissue chemical accumulation, and mammalian (short-tailed shrew and red fox) dietary exposure modeling. Comparison of dietary exposure doses with reference toxicity values for mammals.
Benthic invertebrate community in the unnamed tributary of Little Mosquito Creek.	Survival, reproduction, growth, and indigenous community composition of benthic organisms in the unnamed tributary of Little Mosquito Creek.	Comparisons of chemical concentrations in sediment and surface water with criteria and guidance values for freshwater and estuarine sediments and surface waters as appropriate.
Fish community in Little Mosquito Creek and potentially its unnamed tributary.	Survival, reproduction, growth, and indigenous community composition of fish species in Little Mosquito Creek and potentially its unnamed tributary.	Comparisons of chemical concentrations in surface water to freshwater and estuarine criteria and guidance values as appropriate. Comparison of chemical concentrations in fish tissue with toxic effects residue concentrations.
Piscivorous birds foraging in the unnamed tributary.	Survival, reproduction, and growth of piscivorous birds foraging in the unnamed tributary.	Modeling fish tissue concentrations using site-specific data. Avian (great blue heron) dietary exposure modeling. Comparison of dietary exposure doses with reference toxicity values for birds.
Piscivorous birds foraging in Little Mosquito Creek.	Survival, reproduction, and growth of piscivorous birds foraging in Little Mosquito Creek.	Analysis of site-specific benthic invertebrate, crustacean, and fish tissue concentrations and avian (kingfisher and great blue heron) dietary exposure modeling. Comparison of dietary exposure doses with reference toxicity values for birds.
Piscivorous mammal foraging in the drainage ditch or Little Mosquito Creek.	Survival, reproduction, and growth of piscivorous mammal foraging in the drainage ditch or Little Mosquito Creek.	Analysis of site-specific benthic invertebrate, crustacean, and fish tissue concentrations and mammalian (mink) dietary exposure modeling. Comparison of dietary exposure doses with reference toxicity values for mammals.

TABLE 2-13
SUMMARY OF FEDERAL AND STATE ARARs OLD WASTEWATER TREATMENT PLANT WALLOPS FLIGHT FACILITY, VIRGINIA

FEDERAL		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status[(1)]**
Federal Endangered Species Act 1973: 16 U.S.C. §1536 (a) (1) and (2)		
50 CFR Sections 402.10 (a) and (c)	Requires a determination as to whether any action is likely to jeopardize the continued existence of any endangered species or the critical habitat designated for such species. Endangered or threatened species have not been documented as roosting, nesting or living in the area of the WWTP actions, but the possibility of an incidental occurrence exists during the implementation of the remedial action. If endangered species are identified at the WWTP during the remedial action, construction activities will be suspended and the USEPA and VDEQ will be consulted on the path forward.	R/A
STATE		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status**
Title 4 – Conservation and Natural Resources		
Agency 15 – Department of Wildlife Resources		
Chapter 20 – Definitions and Miscellaneous in General		
4 VAC 15-20-130 and -140	These regulations adopt the federal list of endangered or threatened species and expand upon that list for purposes of actions in the Commonwealth of Virginia. Endangered or threatened species have not been documented as roosting, nesting or living in the area of the WWTP actions, but the possibility of an incidental occurrence exists during the implementation of the remedial action. If endangered species are identified at the WWTP during the remedial action, construction activities will be suspended and the USEPA and VDEQ will be consulted on the path forward.	R/A
Title 9 – Environment		
Agency 50 – Virginia State Water Control Board		
Chapter 840 – Erosion and Sediment Control Regulations and Chapter 870 – Virginia Stormwater Management Plan Regulations		
9 VAC 25-840-10 et seq	Establishes minimum standards for the control of erosion, sediment deposition, and runoff, and requires that an erosion and sediment control plan be implemented and maintained. The Remedial Design/Remedial Action Work Plan will identify erosion and sedimentation controls in accordance with State requirements.	R/A
9 VAC 25-870-10 et seq	Establishes the minimum requirements for the control of releases to state waters of stormwater from land disturbing activities. The Remedial Design/Remedial Action Work Plan will identify any stormwater controls in accordance with State requirements.	R/A
Agency 5 – State Air Pollution Control Board		
Chapter 30 – Ambient Air Quality Standards		
9 VAC 5-30-10, -60, -65, and -66	These regulations are designed to ensure that ambient concentrations of air pollutants are consistent with established criteria, and, unless specified otherwise, apply throughout the Commonwealth of Virginia. Any air emissions from the remedial activities at the Site must meet these standards. If during remedial actions, sustained visible dust emissions are noted, NASA will control these releases by reducing dust generation operations and/or hydrating the materials. Dust control measures will be detailed in the Remedial Design/Remedial Action Work Plan.	R/A
Chapter 50 – New and Modified Stationary Sources		
9 VAC 5-50-80 and -90	Identifies standards for the discharge of visible emissions into the atmosphere. If during remedial actions, sustained visible dust emissions are noted, NASA will control these releases by reducing dust generation operations and/or hydrating the materials. Dust control measures will be detailed in the Remedial Design/Remedial Action Work Plan.	R/A

STATE		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status**
Title 9 – Environment		
Agency 20 – Virginia Waste Management Board		
Chapter 60 – Hazardous Waste Management Regulations		
9 VAC 20-60-261	These regulations incorporate by reference 40 CFR 261 regulations. Solid wastes generated during this remedial action that are identified for disposal in a Virginia landfill will be characterized for potential as a characteristic hazardous waste prior to offsite disposal. Based on the existing site data, contaminated sludge at the Site have not exhibited evidence of hazardous waste characteristics.	R/A
Chapter 81 – Solid Waste Management Regulations		
9 VAC 20-81-10 and 95	Section 10 defines "remediation waste." Section 95 defines a solid waste as any discarded material (by referencing 40 CFR 261.2 as incorporated by 9 VAC 20-60-261). These definitions would apply to wastes generated by the remedial action.	A
Chapter 110 – Regulations Governing the Transportation of Hazardous Materials		
9 VAC 20-110-10, -20.C, -50, -80, -110	These regulations apply to any person who transports hazardous materials or hazardous radioactive materials, or offers such materials for shipment. Based on the existing site data, contaminated soil and sediment at the site have not exhibited evidence of hazardous waste characteristics.	A
Agency 25 – State Water Control Board		
Chapter 31 – Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation		
9 VAC 25-31-50, -100.G.7, -220.A.1,-220.B.1, -220.D, and -220.E	Regulates the discharge of wastes and deleterious substances into State water. Prohibits discharges of wastes that would alter the physical, chemical, or biological properties of a State water and result in detrimental effects on the beneficial use of the water. Under CERCLA, an onsite discharge of waste water to surface water must meet the substantive requirements of VPDES, but it is not necessary to obtain a permit or comply with the administrative requirements of the permitting process. For an offsite discharge, it would be necessary to comply with the administrative requirements of the regulation. There is no planned discharge of wastes or water to State water under the selected remedy. Liquid and solid wastes will be containerized for offsite disposal. Although releases during the remedial action to State waters are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work Plan will be used to control potential releases.	A

Chapter 32 – Virginia Pollution Abatement (VPA) Permit Regulation		
9 VAC 25-32-30, -80, and -100	Prohibits direct discharges into water except in accordance with Virginia Pollution Abatement permits issued pursuant to the State Water Quality Control Law. While CERCLA does not require that permits be obtained for remedial activities, it is necessary for the remedial action to comply with effluent limitations that would be established under a permit and notification requirements in the event of exceedances of limits. There is no planned discharge of wastes or water to State water under the selected remedy. Liquid and solid wastes will be containerized for offsite disposal. Although releases during the remedial action to State waters are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work Plan will be used to control potential releases.	R/A
STATE		
Environmental Laws and Regulations	**Requirement Synopsis/Action Taken**	**Status**
Chapter 210 – Virginia Water Protection Permit Program Regulation		
9 VAC 25-210-10, -45, -50, and -110	Prohibition on discharging any pollutant into, or adjacent to surface waters that would alter the physical, chemical or biological properties of surface waters and make them detrimental to the public health, or to animal or aquatic life. Includes Section 115 for substantive requirements only and does not include administrative permitting requirements. There is no planned discharge of wastes or water to State water under the selected remedy. Liquid waters and wastes and contaminated soil will be containerized for offsite disposal. Although releases during the remedial action to State waters are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work Plan will be used to control potential releases. Also, the wetlands to be remediated will be delineated during the Remedial Design.	A
Chapter 390 – Water Resources Policy		
9 VAC 25-390-20 (2), (9) and -30.3a, .3b, .4f, and .8.	Establishes requirements to protect water resources and the ecosystems from unnecessary pollution, degradation or destruction. There is no planned extraction of State water or discharge of wastes or water to wetlands or waters under the selected remedy. Liquid and solid wastes will be containerized for offsite disposal. Although releases during the remedial action to State water are not anticipated, erosion and sedimentation control measures to be identified during the Remedial Design/Remedial Action Work will be used to control potential releases.	R/A

(1) A=Applicable; R/A=Relevant and Appropriate

TABLE 2-14
SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTENATIVES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Criteria	Alternative 1 No Action	Alternative 2 Land Use Controls	Alternative 3 Low-Permeability Cap Installation	Alternative 4 Sludge Removal and Off-Site Disposal
OVERALL PROTECTIVENESS				
Human Health Protection	Human health risks associated with residential exposure to WWTP Site sludge were not evaluated. No action will be taken to protect from the unknown risk.	Human health risks associated with residential exposure to WWTP Site sludge were not evaluated. LUCs and access restrictions will reduce potential risk by deterring direct contact and ingestion of contaminated sludge.	Human health risks associated with residential exposure to WWTP Site sludge were not evaluated. Capping, LUCs, and access restrictions will reduce potential risk by preventing direct contact and ingestion of contaminated sludge.	Human health risks associated with residential exposure to WWTP Site sludge were not evaluated. Removal of contaminated sludge and disposal at a permitted facility will eliminate the potential risk.
Environmental Protection	No reduction in risk because no migration actions are performed.	LUCs and Access restrictions (fine mesh fencing and avian netting) will reduce risks to ecological receptors from contaminated sludge by deterring direct contact and ingestion of invertebrates.	A low-permeability clay cap and geotextile liner will provide environmental protection because contact with the contaminated sludge by ecological receptors will be prevented.	Removal of contaminated sludge will eliminate ecological risks.
COMPLIANCE WITH ARARs				
Chemical-Specific ARARs	Although no chemical-specific ARARs were identified, the alternative will not achieve PRGs. Contaminated sludge above PRGs will remain on-site.	Although no chemical-specific ARARs were identified, the alternative will not achieve PRGs. Contaminated sludge above the PRGs will remain on-site.	Although no chemical-specific ARARs were identified, the alternative will not achieve the PRGs. Contaminated sludge above the PRGs will remain on-site.	Although no chemical ARARs were identified, the alternative will achieve the PRGs. Contaminated sludge will not be treated to meet PRGs; it will be removed from the WWTP Site.
Action-Specific ARARs	Will achieve action-specific ARARs because no actions will be performed.	Will achieve action-specific ARARs.	Will achieve action-specific ARARs.	Will achieve action-specific ARARs.

Criteria	Alternative 1 No Action	Alternative 2 Land Use Controls	Alternative 3 Low-Permeability Cap Installation	Alternative 4 Sludge Removal and Off-Site Disposal
LONG-TERM EFFECTIVENESS AND PERMANENCE				
Magnitude of Residual Risk	Contaminated sludge will not be removed and existing risks will remain.	LUCs and access restrictions (fine mesh fencing and avian netting) will minimize the potential for ecological receptors to contact the sludge.	Risks currently associated with the contaminated sludge will be reduced through sludge cap installation because contact with the contaminated sludge is highly unlikely.	Ecological risks currently associated with the contaminated sludge and unknown risk to residential receptors will be eliminated.
Adequacy and Reliability of Controls	No controls over remaining contamination will be implemented.	LUCs and access restrictions will deter human receptors. Fine mesh fencing and avian netting will deter ecological receptors.	Installation of low-permeability cap and geotextile liner will be an adequate and reliable control to reduce the potential ecological risk because it will provide a barrier to ecological receptors, including burrowing mammals such as the short-tailed shrew.	Removal of sludge above PRGs will provide an effective and permanent means of eliminating potential exposure of ecological and residential receptors to the contaminated sludge.
Need for Five-Year Review	No five-year review will be conducted for this alternative.	A five-year review will be required because contaminants above PRGs will be left on-site. LTM will be required to ensure adequate protection of the environment is maintained.	A five-year review will be required to ensure adequate protection of the environment is maintained through use of the low-permeability cap. A five-year review will be required because contaminants above PRGs will be left on-site.	No contaminants above PRGs will be left on-site. Five-year review will not be required.

Criteria	Alternative 1 No Action	Alternative 2 Land Use Controls	Alternative 3 Low-Permeability Cap Installation	Alternative 4 Sludge Removal and Off-Site Disposal
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT				
Treatment Process Used	None	None	None	None
Reduction of Toxicity, Mobility, or Volume	TMV will not be reduced.	Inherent toxicity will not be reduced. Risks to ecological receptors via direct contact will be reduced. Mobility and volume of COPECs will not be reduced.	Mobility will be reduced; however, toxicity and volume will not be reduced.	TMV at the WWTP site will be reduced because sludge will not remain on-site. The inherent toxicity and volume of the contaminated sludge will not be reduced because the sludge will be transferred to an off-site disposal facility
Type and Quantity of Residuals Remaining After Treatment	Sludge COPECs above PRGs will remain on-site.	Sludge COPECs above PRGs will remain on-site.	Sludge COPECs above PRGs will remain on-site.	Sludge will not remain on-site.
SHORT-TERM EFFECTIVENESS				
Community Protection	No additional risks posed to the community.	No additional risks to the community during fencing and netting installation.	Minimal additional risks to the community during low-permeability cap construction.	Minimal additional risk to the community during sludge removal and transport off-site.
Worker Protection	Not applicable	Potential risks to workers during fencing and netting installation will be minimized by use of dust control measures, PPE, and safety procedures.	Potential risks to workers during grading and low-permeability clay cap installation will be minimized by use of dust control measures, PPE, and safety procedures.	Potential risks to workers during sludge removal and WWTP site restoration will be minimized by use of dust control measures, PPE, and safety procedures.

TABLE 2-14
SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTENATIVES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Criteria	Alternative 1 No Action	Alternative 2 Land Use Controls	Alternative 3 Low-Permeability Cap Installation	Alternative 4 Sludge Removal and Off-Site Disposal
Environmental Impacts	No additional risk but continued impact from existing conditions.	Protection of environmental receptors achieved immediately by preventing contact with the contaminated sludge.	Areas affected during remedial operations will be restored.	Areas affected during remedial operations will be regraded and revegetated.
IMPLEMENTABILITY				
Ability to Construct and Operate	No construction or operation.	Materials and services needed to install fencing and netting are readily available.	Materials and services required to implement construction of a low-permeability clay cap and geotextile liner are readily available.	Materials and services required to implement sludge removal and off-site disposal are readily available.
Ability to Monitor Effectiveness	No monitoring will be conducted.	Revisions to NASA's Master Plan easily implemented because property owner is knowledgeable of current documents and conditions.	Effectiveness of the low-permeability cap can be monitored through periodic WWTP site inspections.	Post-removal monitoring not required. Effectiveness of the post-removal vegetative cover in preventing erosion can be easily implemented.
Availability of Services and Capacities	No services or capacities required.	Materials, equipment, and services required to implement Alternative 2 are readily available.	Materials, equipment, and services required to implement Alternative 3 are readily available.	Materials, equipment, and services required to implement Alternative 4 are readily available.

TABLE 2-14
SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTENATIVES
OLD WASTEWATER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA

Criteria	Alternative 1 No Action	Alternative 2 Land Use Controls	Alternative 3 Low-Permeability Cap Installation	Alternative 4 Sludge Removal and Off-Site Disposal
Availability of Equipment, Specialists, and Materials	None required.	Equipment, specialists, and materials required to implement Alternative 2 are readily available.	Equipment, specialists, and materials required to implement Alternative 3 are readily available.	Equipment, specialists, and materials required to implement Alternative 4 are readily available.
Availability of Technologies	None required.	Avian netting and fine mesh fencing are readily available from a large number of vendors.	Low-permeability cap is a proven technology that has been implemented at other sites and is often used on landfills.	Contaminant removal is a common practice and often used for small sites such as the WWTP site.
COST ESTIMATE (rounded to nearest $1,000)				
Capital Cost	$ -	$117,000	$305,000	$316,000
First Annual O&M Cost	$ -	$50,000	$44,000	$0
Present Worth Cost (2015)	$ -	$365,000	$563,000	$316,000
Present Worth Cost (2023)	$ -	564,000	$870,000	$487,000

TABLE 2-15

CAPITAL COST ESTIMATE
ALTERNATIVE 4 - SLUDGE REMOVAL AND OFF-SITE DISPOSAL

OLD WASTEWATWER TREATMENT PLANT
WALLOPS FLIGHT FACILITY, VIRGINIA
PAGE 1 OF 1

Process	2015 Cost	2023 Cost	Quantity	Unit of Measure	Subtotal	Description
Planning Documents						
Work Plan Preparation	$15,000	$23,000	1	LS	$23,000	125 hours x $150/hour + expenses.
APP/SSHP Preparation	$12,000	$19,000	1	LS	$19,000	100 hours x $150/hour + expenses.
Erosion Control Plan Preparation	$5,000	$8,000	1	LS	$8,000	45 hours x $150/hour + expenses.
Site Preparation						
Brush Clearing	$4,000	$6,000	1	ACRE	$6,000	Vegetation removal in the area of the soil cover installation and any access roads = approx. 1 acre
Installation of erosion controls (silt fence)	$2	$3	300	LF	$900	Installation of silt fencing around the site and around former Wastewater Treatment Plant
Installation of access roads	$10,000	$15,000	1	LS	$15,000	Costs include heavy equipment, labor, and stone.
Dust suppression with Water Truck	$500	$770	1	WK	$770	Costs only include water truck rental (labor costs included in cover placement).
Sludge Sampling for Off-Site Disposal						
Sludge Sampling For Off-Site Disposal Requirements	$80	$120	30	HR	$3,600	Assumes two engineers and one SSHO for one 10-hr day with collection of 8 samples
Sludge Sample Analysis	$545	$840	2	EA	$1,680	Analysis of (2) sludge samples for landfill requirements ($545 total for each sample). Pesticides ($150 per sample), TPH-DRO ($110 per sample), EOX-total extractable organic halides ($80 per sample), BTEX ($70 per sample), and TCLP metals ($135 per sample)
Sludge Excavation						
Excavate Sludge from Drying Beds	$27,600	$43,000	1	WK	$43,000	Costs include $9,000 per week for equipment and $33,400 for personnel (labor and per diem). Personnel will include site superintendent, 3 equipment operators, 1 SSHO, and 4 laborers. Volume estimated at 66 CY for both sludge drying beds. 66 CY x 1.3 tons/CY = 85.8 tons.
Vacuum Sludge from Settling Tanks	$15,000	$23,000	1	WK	$23,000	Costs include $7,700 per day for equipment and $15,000 for personnel (labor and per diem). Personnel will include site superintendent, equipment operator, and SSHO. Volume of sludge in the settling tanks estimated at 16.5 CY (16.5 CY x 1.3 tons/CY = 21.45 tons.
Surveying Support for Final Grade	$1,000	$1,500	1	DAY	$1,500	Survey costs equal $1500 per for two-man team and effort is estimated at one day.
Off-Site Transportation and Disposal						
Off-Site Transportation	$8	$10	107.25	TON	$1,073	Costs include $10 per ton for transport of sludge to landfill.
RCRA Subtitle D Landfill Disposal	$30	$50	107.25	TON	$5,363	Costs include $50 per ton for disposal in Subtitle D landfill.
Confirmation Sampling and Analysis						
Work Plan/APP Preparation	$12,000	$19,000	1	LS	$19,000	100 hours x $150/hour + expenses
Planning/Mobilization/Demobilization	$100	$150	24	HR	$3,600	8 hours of planning and 16 hours of mobilization/demobilization for two personnel.
Sludge Sampling	$80	$120	30	HR	$3,600	Assumes two engineers and one SSHO for one 10-hr day with collection of 8 samples
Sludge Sample Analysis	$250	$390	8	EA	$3,120	Analysis of sludge samples for Pesticides ($150/sample) and metals ($100/sample)
Sampling Equipment/Supplies	$500	$770	1	DAY	$770	Equipment (hand auger) and supplies (decon and scoops/bowls) needed for sludge sampling.
Data Validation	$50	$80	8	EA	$640	Data validation of sludge samples.
Data Evaluation	$80	$120	8	HR	$960	Evaluation of analytical data
Report Preparation	$100	$150	40	HR	$6,000	35 hours x $150/hour + expenses.
Site Restoration						
Excavation Areas Re-grading	$10,000	$15,000	1	v	$15,000	Costs include front end loader and labor
Vegetate Cover	$5,000	$8,000	0.5	ACRE	$4,000	Costs include $7,700 per acre for seed and labor.
Access Road Restoration	$10,000	$15,000	1	LS	$15,000	Costs include estimated heavy equipment use, labor, and disposal of any stone.
Remedial Action Report						
Report	$40,000	$62,000	1	LS	$62,000	300 hours x $150/hour + expenses. Includes inspection event to document vegetative restoration.

Subtotal :	$285,575
Mobilization/Demobilization (10%):	$28,558
Subtotal :	$314,133
Remedial Contractor Profit and Overhead (15%):	$47,120
Engineering and Administration (20%):	$62,827
Contingency (20%):	$62,827
TOTAL :	**$487,000**

Notes:
EA - Each
LF- Linear foot
LS - Lump sum
HR - Hour
WK - Week

Original 2015 values were updated to January 2023 values using the hisitorical cost indices from Mechanical Costs with RS Means Data, 2023, 46th Annual Edition (The Guardian Group 2022).

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Figures

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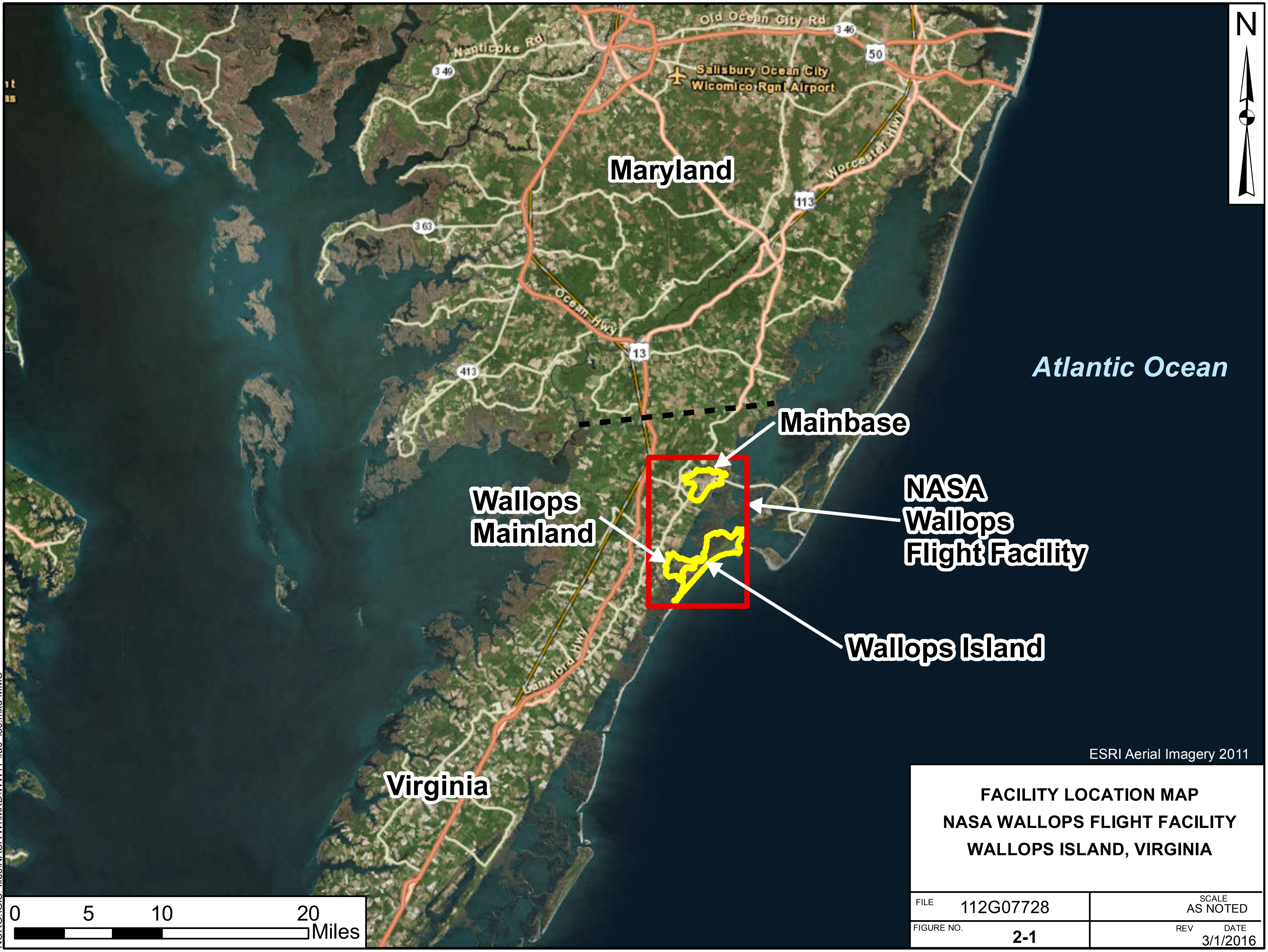

FACILITY LOCATION MAP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

FILE 112G07728	SCALE AS NOTED
FIGURE NO. 2-1	REV DATE 3/1/2016

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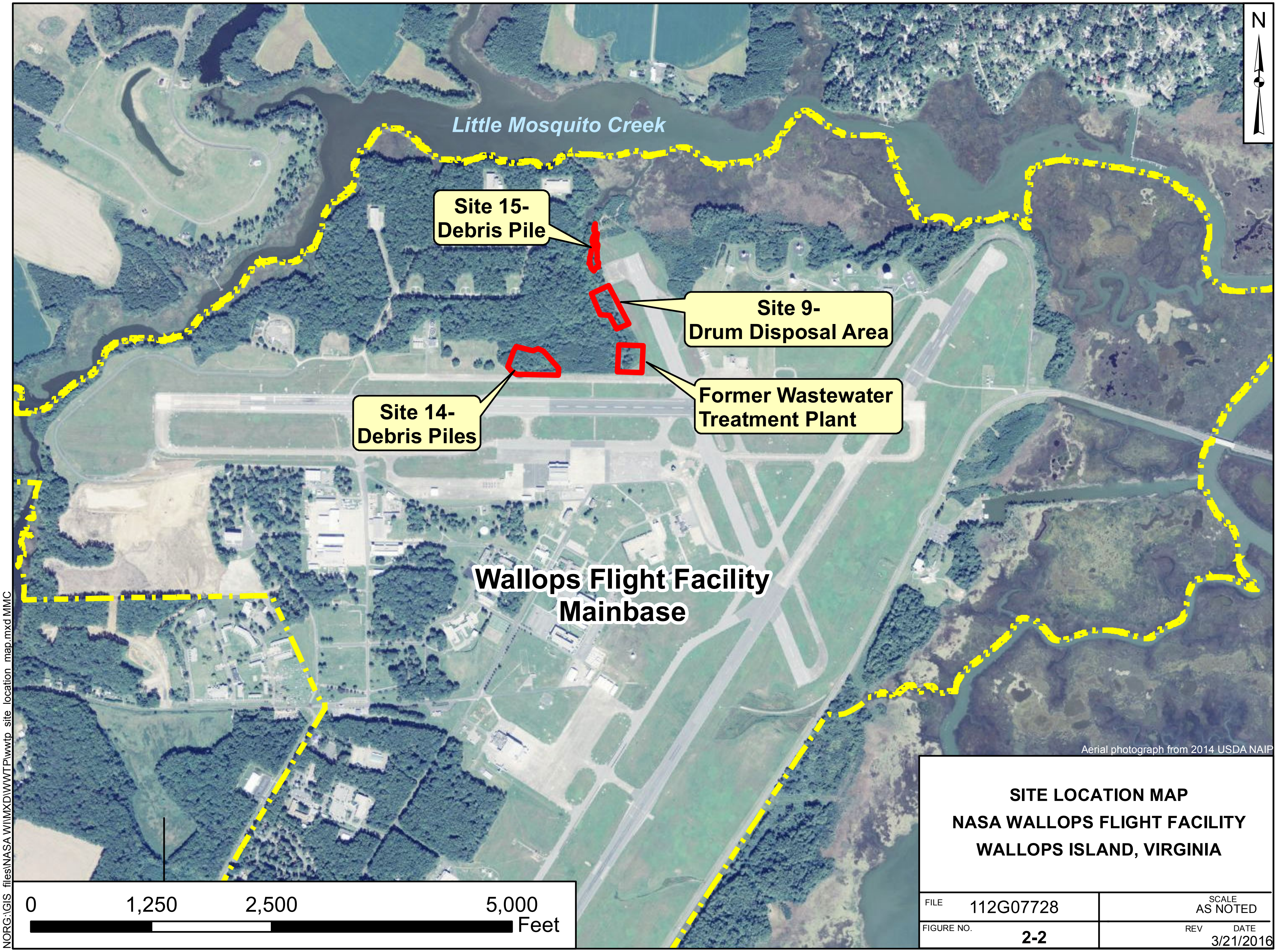

SITE LOCATION MAP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

FILE 112G07728	SCALE AS NOTED
FIGURE NO. 2-2	REV DATE 3/21/2016

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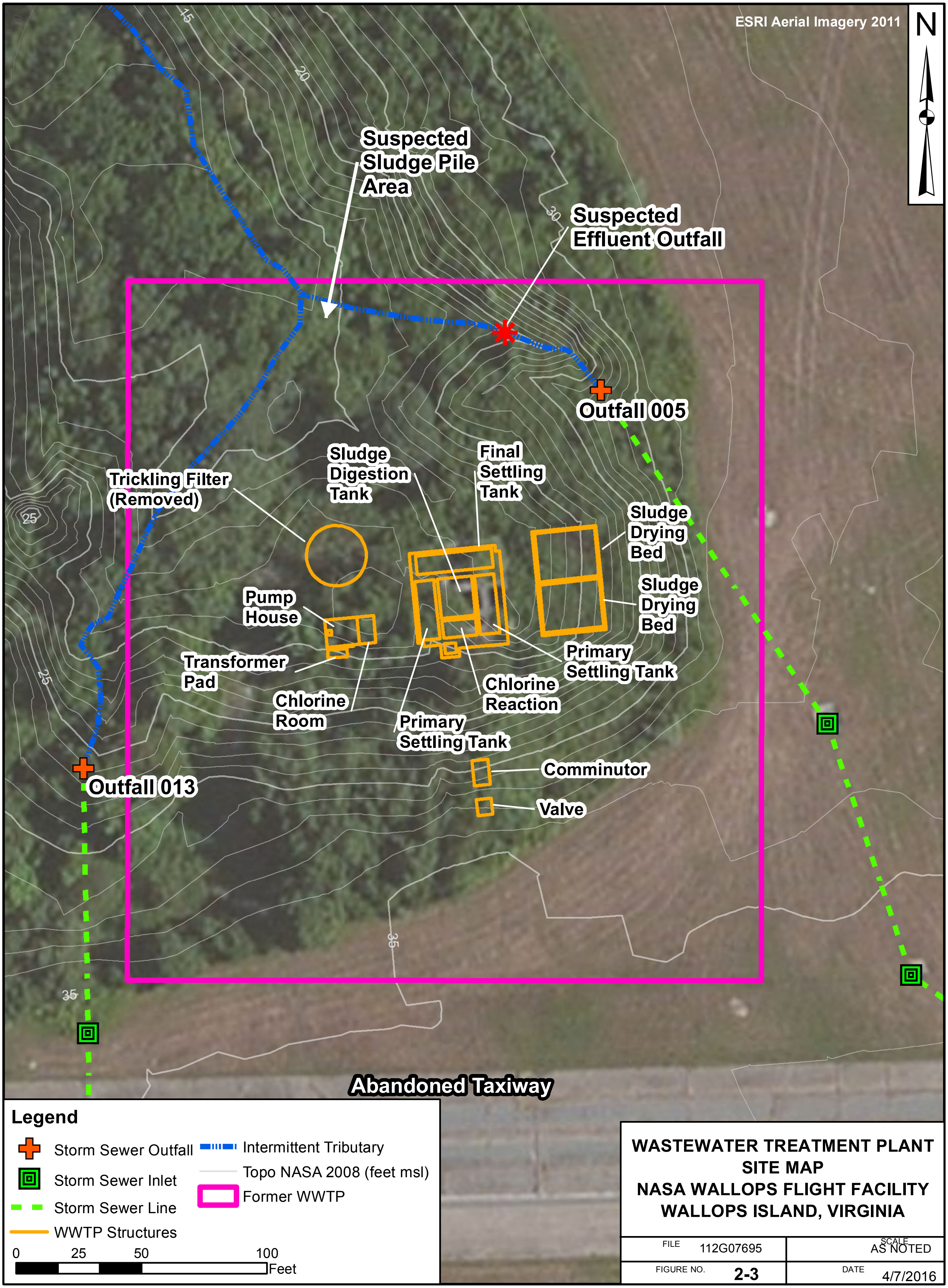
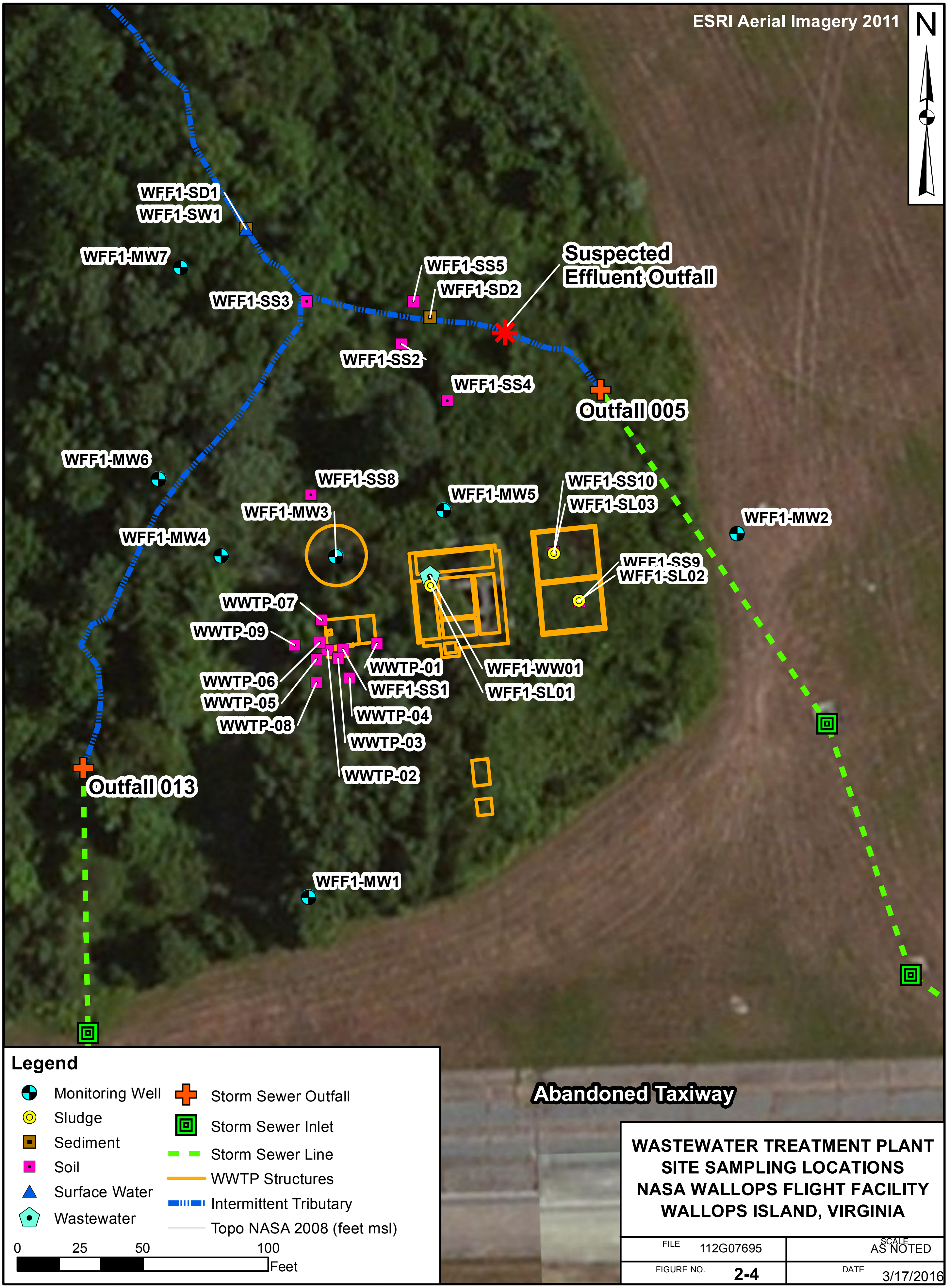
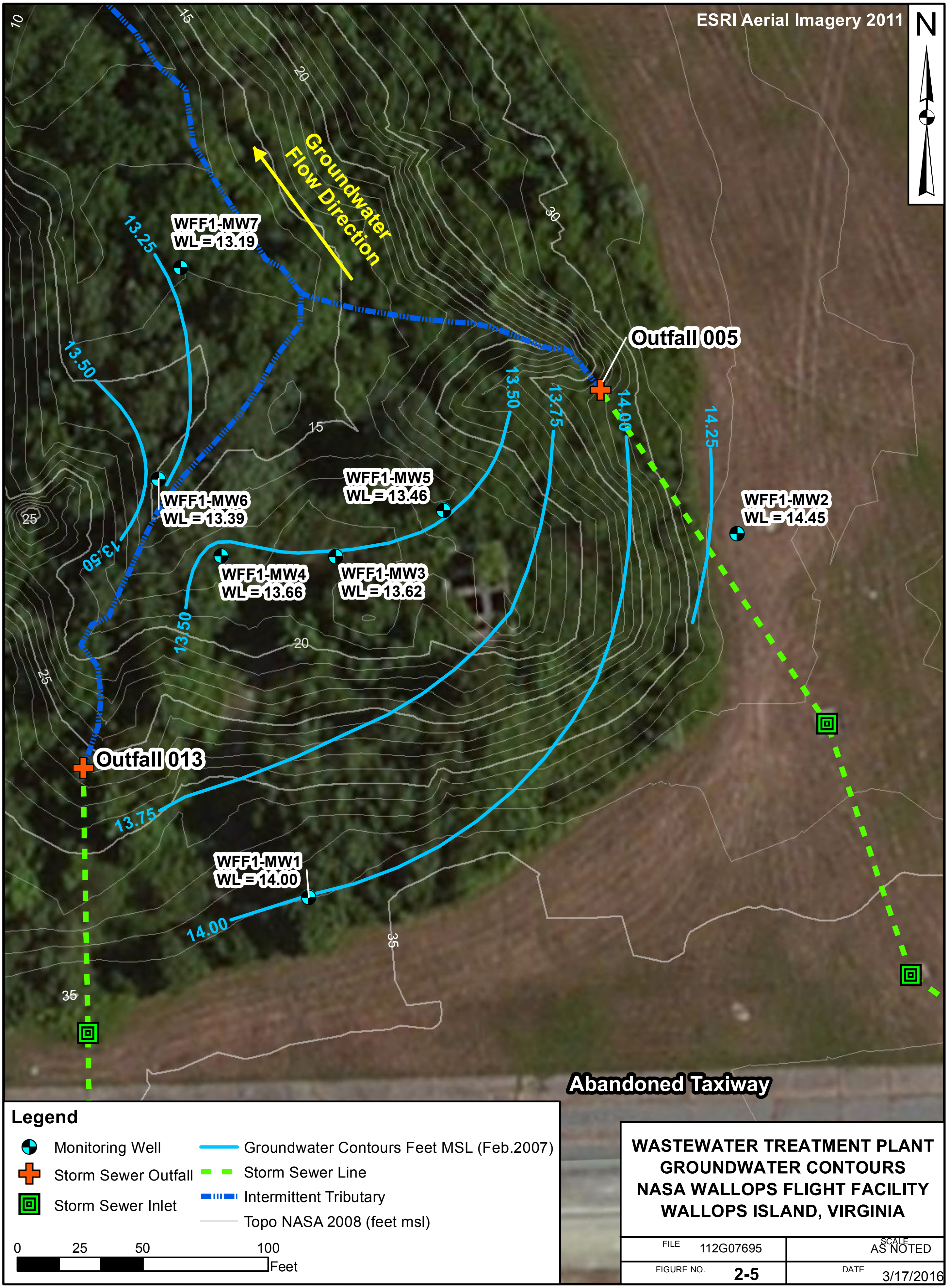


WASTEWATER TREATMENT PLANT SITE MAP
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

FILE	112G07695	SCALE	AS NOTED
FIGURE NO.	2-3	DATE	4/7/2016



ESRI Aerial Imagery 2011
N
WFF1-SD1
WFF1-SW1
WFF1-MW7
WFF1-SS3
WFF1-SS5
WFF1-SD2
Suspected Effluent Outfall
WFF1-SS2
WFF1-SS4
Outfall 005
WFF1-MW6
WFF1-SS8
WFF1-MW5
WFF1-SS10
WFF1-SL03
WFF1-MW3
WFF1-MW2
WFF1-MW4
WFF1-SS9
WFF1-SL02
WWTP-07
WWTP-09
WWTP-01
WFF1-WW01
WWTP-06
WFF1-SS1
WFF1-SL01
WWTP-05
WWTP-04
WWTP-08
WWTP-03
WWTP-02
Outfall 013
WFF1-MW1
Abandoned Taxiway
Legend
Monitoring Well
Sludge
Sediment
Soil
Surface Water
Wastewater
Storm Sewer Outfall
Storm Sewer Inlet
Storm Sewer Line
WWTP Structures
Intermittent Tributary
Topo NASA 2008 (feet msl)
0 25 50 100
Feet
WASTEWATER TREATMENT PLANT
SITE SAMPLING LOCATIONS
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA
FILE 112G07695
SCALE AS NOTED
FIGURE NO. 2-4
DATE 3/17/2016



WASTEWATER TREATMENT PLANT
GROUNDWATER CONTOURS
NASA WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

FILE 112G07695	SCALE AS NOTED
FIGURE NO. 2-5	DATE 3/17/2016

FIGURE 2-6

Human Health Conceptual Site Model

Former Wastewater Treatment Plant

NASA Wallops Flight Facility

Wallops Island, Virginia

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Soil	Surface Soil (0-2 ft)	Surface Soil	Trespasser	Adolescent Child	Ingestion Dermal Contact	On-Site On-Site	Quantitative Quantitative	Trespasser incidentally ingests soil Trespasser contacts soils
		Air	Airborne dust and VOCs from soil			Inhalation	On-Site	Quantitative	Trespasser inhales outdoor dust and VOCs from soil
	Sludge	Sludge	Sludge			Ingestion Dermal Contact	On-Site On-Site	Quantitative Quantitative	Trespasser incidentally ingests sludge Trespaser contacts sludge
	Sediment	Sediment	Intermittent Stream Sediment			Ingestion Dermal Contact	Off-site Off-site	Quantitative Quantitative	Trespasser ingests sediment while wading Trespasser contacts sediment while wading
	Surface water	Surface water	Intermittent Stream Surface Water			Ingestion Dermal Contact	Off-site Off-site	Quantitative Quantitative	Child ingests surface water while wading Child contacts surface water while wading
	Waste water	Waste water	Waste water in settling tank			Dermal Contact	On-Site	Quantitative	Child contacts waste water from settling tank while trespassing
Future	Surface Soil	Surface Soil (0-2 ft)	Surface Soil	Industrial Worker	Adult	Ingestion Dermal Contact	On-Site On-Site	Quantitative Quantitative	Worker incidentally ingests soils Worker contacts soils
		Air	Airborne dust and VOCs from soil			Inhalation	On-Site	Quantitative	Worker inhales dust and VOCs from soil
		Air	Vapor Intrusion			Inhalation	On-Site	Quantitative	Worker inhales VOCs from vapor intrusion into basement of building.
	Subsurface Soil	Subsurface Soil (2-10 ft)	Subsurface Soil			Ingestion Dermal Contact	On-Site On-Site	Quantitative Quantitative	Worker incidentally ingests soils Worker contacts soils
		Air	Airborne dust and VOCs from soil			Inhalation	On-Site	Quantitative	Worker inhales dust and VOCs from soil
		Air	Vapor Intrusion			Inhalation	On-Site	Quantitative	Worker inhales VOCs from vapor intrusion into basement of building.
	Sludge	Sludge	Sludge			Ingestion Dermal Contact	On-Site On-Site	Quantitative Quantitative	Worker incidentally ingests sludge Worker contacts sludge
	Waste water	Waste water	Waste water in settling tank			Dermal Contact	On-Site	Quantitative	Worker contacts waste water from settling tank
	Surface Soil	Surface Soil (0-2 ft)	Surface Soil	Construction Worker	Adult	Ingestion Dermal Contact	On-Site On-Site	Quantitative Quantitative	Worker incidentally ingests soils Worker contacts soils
		Air	Airborne dust and VOCs from soil			Inhalation	On-Site	Quantitative	Worker inhales outdoor dust and VOCs from soil
	Subsurface Soil	Subsurface Soil (2-10 ft)	Subsurface Soil			Ingestion Dermal Contact	On-Site On-Site	Quantitative Quantitative	Worker incidentally ingests soils Worker contacts soils
		Air	Airborne dust and VOCs from soil			Inhalation	On-Site	Quantitative	Worker inhales outdoor dust and VOCs from soil

FIGURE 2-6

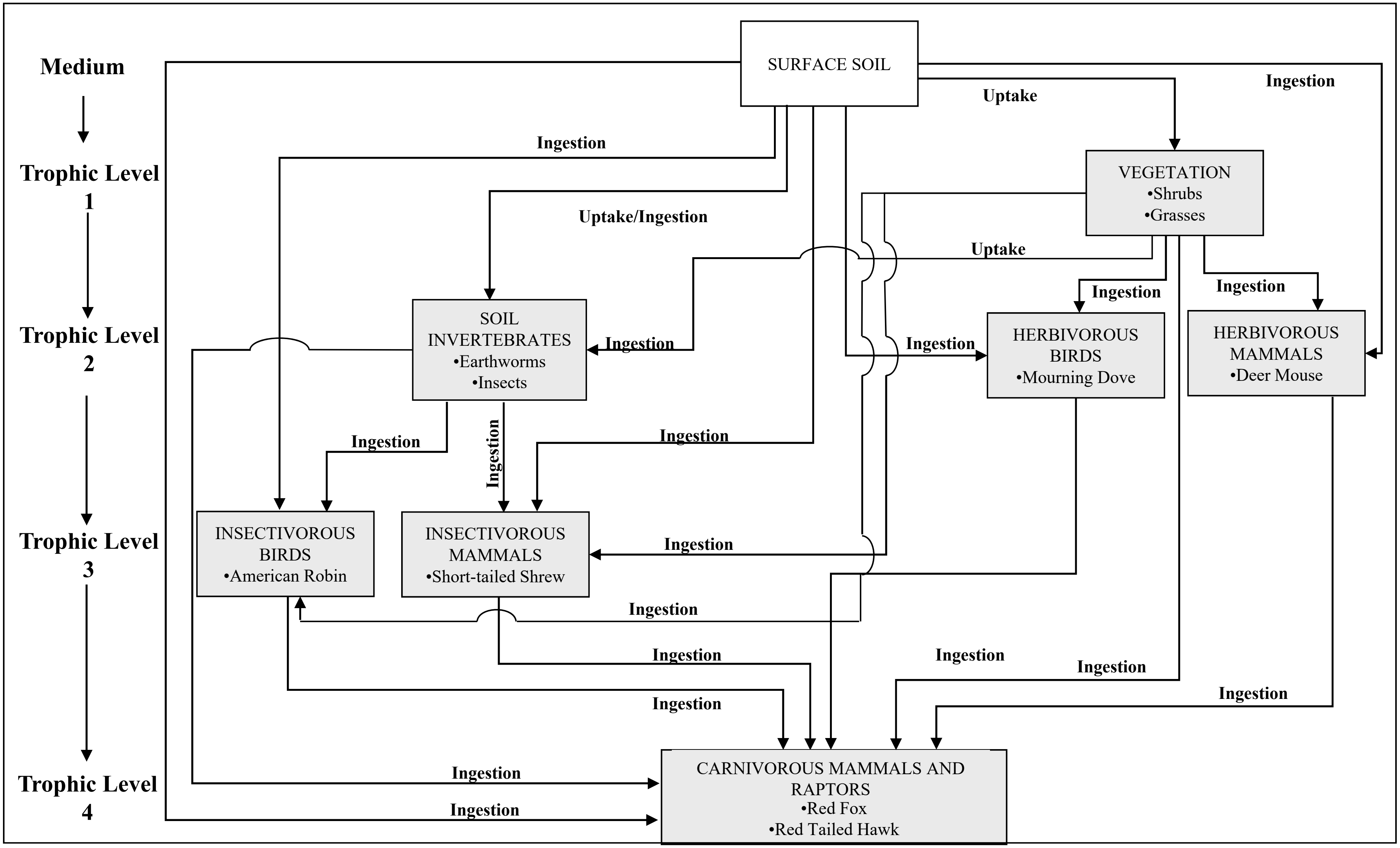
Human Health Conceptual Site Model

Former Wastewater Treatment Plant

NASA Wallops Flight Facility

Wallops Island, Virginia

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future (continued)	Sludge	Sludge	Sludge	Construction Worker	Adult	Ingestion Dermal Contact	On-Site On-Site	Quantitative Quantitative	Worker incidentally ingests sludge Worker contacts sludge
	Waste water	Waste water	Waste water in settling tank			Dermal Contact	On-Site	Quantitative	Worker contacts waste water from settling tank during construction activities
	Surface Soil	Surface Soil (0-2 ft)	Surface Soil	Resident	Child/Adult	Ingestion Dermal Contact	On-Site On-Site	Quantitative Quantitative	Resident incidentally ingests soils Resident contacts soils
		Air	Airborne dust and VOCs from soil		Child/Adult	Inhalation	On-Site	Quantitative	Resident inhales outdoor dust and VOCs from soil
		Air	Vapor Intrusion		Child/Adult	Inhalation	On-Site	Quantitative	Resident inhales VOCs from vapor intrusion into basement of building.
	Subsurface Soil	Subsurface Soil (2-10 ft)	Subsurface Soil		Child/Adult	Ingestion Dermal Contact	On-Site On-Site	Quantitative Quantitative	Resident incidentally ingests soils Resident contacts soils
		Air	Airborne dust and VOCs from soil		Child/Adult	Inhalation	On-Site	Quantitative	Resident inhales outdoor dust and VOCs from soil
		Air	Vapor Intrusion		Child/Adult	Inhalation	On-Site	Quantitative	Resident inhales VOCs from vapor intrusion into basement of building.
	Sediment	Sediment	Intermittent Stream Sediment		Child/Adult	Ingestion Dermal Contact	Off-site Off-site	Quantitative Quantitative	Resident ingests sediment while wading Resident contacts sediment while wading
	Surface water	Surface water	Intermittent Stream Surface Water		Child/Adult	Ingestion Dermal Contact	Off-site Off-site	Quantitative Quantitative	Resident ingests surface water while wading Resident contacts surface water while wading



LEGEND

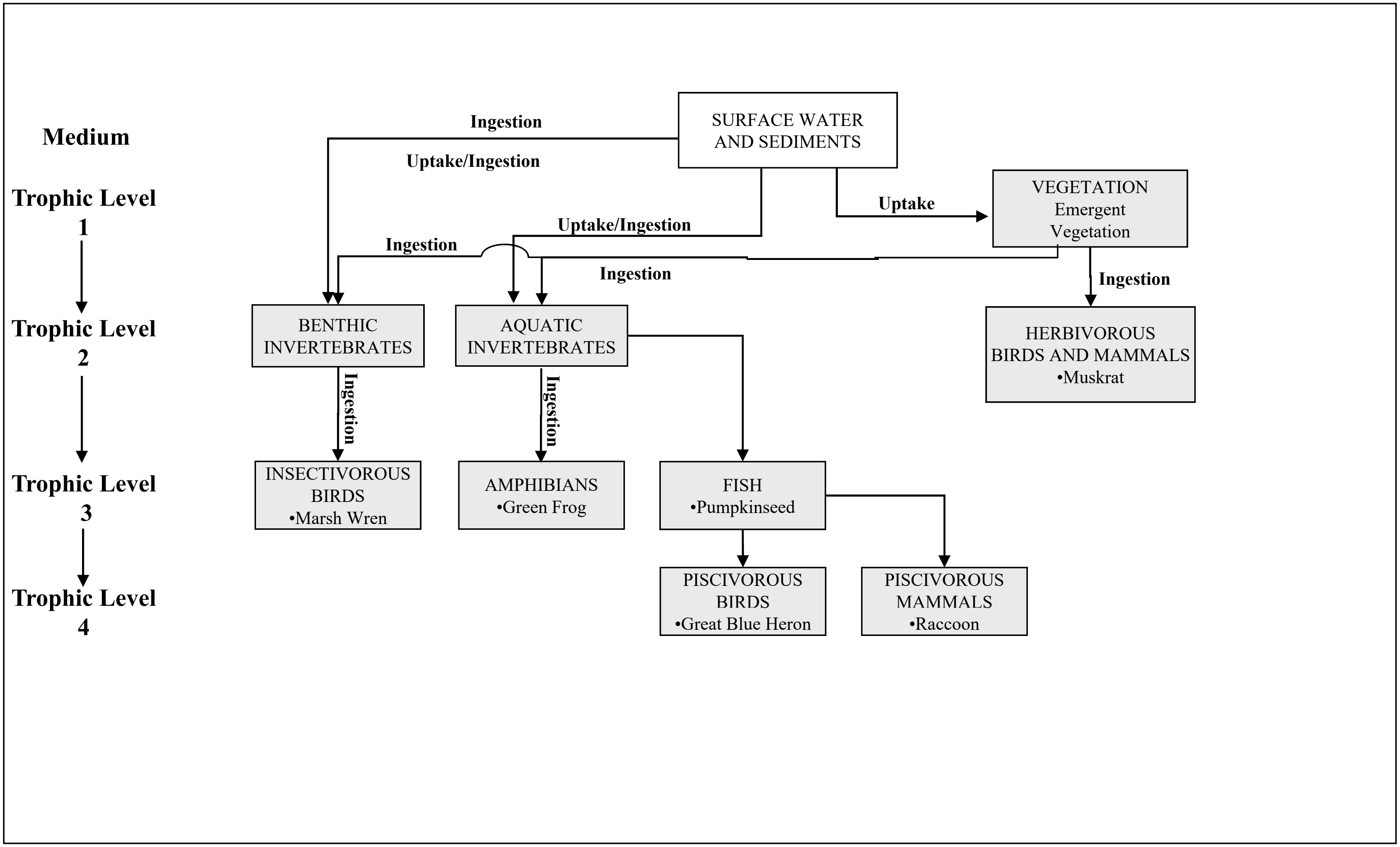
• Representative species

→ Pathway evaluated for at least one species in feeding guild

▭ Feeding guild to be evaluated

Figure 2-7

Site Conceptual Model for the Terrestrial Ecosystem
Former Wastewater Treatment Plant
NASA Wallops Flight Facility
Wallops Island, Virginia



LEGEND

• Representative species

→ Pathway evaluated for at least one species in feeding guild

▭ Feeding guild to be evaluated

Figure 2-8

Site Conceptual Model for the Aquatic Ecosystem
Former Wastewater Treatment Plant
NASA Wallops Flight Facility
Wallops Island, Virginia