

**FORMER SLF FIRE AND RESCUE BUILDING
SWMU #120**

**PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) SITE
ASSESSMENT WORK PLAN**

KENNEDY SPACE CENTER, FLORIDA

Prepared for:



**National Aeronautics and Space Administration
Kennedy Space Center, Florida**

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LIST OF ACRONYMS AND ABBREVIATIONS

mg/kg	milligrams per kilogram
ng/L	nanograms per liter
AOPC	Area of Potential Concern
bls	below land surface
DPT	Direct Push Technology
EPA	Environmental Protection Agency
FDEP	Florida Department of Environmental Protection
HGL	HydroGeoLogic, Inc.
KSC	John F. Kennedy Space Center
NASA No.	National Aeronautics and Space Administration number
PFAS	Per- and Polyfluoroalkyl Substances
PFBS	Perfluorobutanesulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PRL	Potential Release Location
RCRA	Resource Conservation and Recovery Act
RSL	Regional Screening Level
SLF	Shuttle Landing Facility
SW SL	Surface Water Screening Level
SWMU	Solid Waste Management Unit

FORMER SLF FIRE AND RESCUE BUILDING PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) SITE ASSESSMENT WORK PLAN

1.0 KENNEDY SPACE CENTER, FLORIDA INTRODUCTION

The former Shuttle Landing Facility (SLF) Fire and Rescue Building is located at John F. Kennedy Space Center (KSC), Florida (“the Site;” **Figure 1**) and is designated Potential Release Location (PRL) No. 237, Area of Potential Concern (AOPC) No. 1 under KSC’s Resource Conservation and Recovery Act (RCRA) Corrective Action Program. In accordance with the RCRA Corrective Action Program, HydroGeoLogic, Inc. (HGL) prepared this Per-and Polyfluoroalkyl Substances (PFAS) Site Assessment Work Plan for the National Aeronautics and Space Administration (NASA) under Contract No. 80KSC019D0012, Delivery Order 80KSC021F0168, Technical Directive No. 1. This document presents and summarizes the approach to investigating soil, groundwater, and surface water with PFAS impacts that were previously identified at the Site.

1.1 SITE DESCRIPTION

The former SLF Fire and Rescue Vehicle Building (J5-1299) was located on the south side of Sharkey Road, south of the Air Traffic Control Area (PRL 182) and east of the SLF runway. The building and support structures have been removed and only a concrete pad remains at the Site. The former SLF Fire and Rescue Vehicle Building is located within and near the southeast corner of Solid Waste Management Unit (SWMU) No. 119, Morpheus Test Area and to the northwest of SWMU No. 114.

1.2 SITE HISTORY

Information regarding historical and current property use is summarized below from the *Center-Wide Phase II and III Solid Waste Management Unit Assessment and Confirmatory Sampling Report for Per- and Polyfluorinated Alkyl Substances, Potential Release Location (PRL) No. 237, Kennedy Space Center, Florida* (AECOM, 2022).

The Fire and Rescue building was constructed in 1985. This facility supported landing emergency vehicles from 1985 until 2008 when the building and associated trailers were demolished and removed from the area.

The area on the north side of Sharkey Road was used as an emergency vehicle parking area during Space Shuttle takeoffs and landings. Additionally, the area to the south of Sharkey Road was a possible location for Aqueous Film Forming Foam storage and refractometer testing.

1.3 PREVIOUS INVESTIGATIONS

In 2014, the area surrounding the Site was investigated under PRL 184, Air Traffic Control Tower. Confirmatory sampling, which consisted of soil and direct push technology (DPT) groundwater sampling, did not indicate the presence of any compounds in soil or groundwater above screening

criteria. Analysis for PFAS compounds was not performed during the investigation. The Site was granted No Further Action status in 2015 (IHA, 2014).

In 2018 and 2019, PFAS Phase I activities were completed by Geosyntec in the vicinity of the site (NASA, 2019). During Phase I, four groundwater samples at multiple depths between 10 and 45 feet below land surface (bls) were collected from one location (PFAS-DPT0087) and one surface water sample (PFAS-SW0033) was collected on the west side of the SLF runway. Concentrations in these samples were found to be above Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) and Florida Department of Environmental Protection (FDEP) Surface Water Screening Levels (SW SLs) (NASA, 2019). Based on this information, this area was identified as AOPC No. 1 and additional investigation was recommended. Additionally, to the east of the Site along Kennedy Parkway, five groundwater samples were collected at multiple depths between 10 and 45 feet bls from one location (PFAS-DPT0077). PFAS concentrations were below the EPA RSLs at PFAS-DPT0077 at all depth intervals.

In August and September 2021, as part of Phase II and Phase III investigations, 16 groundwater samples were collected at depths between 8 and 43 feet bls from four DPT locations (PFAS-DPT0217 through PFAS-DPT0220). Additionally, six soil samples were collected from three soil boring locations (PFAS-SB0098 through PFAS-SB0100) at depths of 0 to 0.5 feet bls and 0.5 to 2 feet bls. In October 2021, two surface water samples (PFAS-SW0197 and PFAS-SW0198) were collected.

Phase I through Phase III groundwater analytical results indicate concentrations of one or more PFAS compounds above the EPA RSL in at least one interval at each location except for PFAS-DPT0077. The maximum perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorobutanesulfonic acid (PFBS), perfluorohexanesulfonic acid (PFHxS), and perfluorooctanesulfonic acid (PFOS) concentrations at the Site are located within PFAS-DPT0217 at 8 feet bls at concentrations of 15,800 ng/L, 768 ng/L, 26,400 ng/L, 179,000 ng/L and 288,000 ng/L, respectively. Groundwater analytical results are shown on **Figure 2**. It should be noted that Phase I through Phase III groundwater analytical results were initially screened against the FDEP Provisional Groundwater Cleanup Target Levels.

Analytical results from Phase II and III soil samples collected in August 2021 indicate that the PFOS concentration at PFAS-SB0100 was above the EPA RSL in the 0 to 0.5 feet bls depth interval at a concentration of 2.97 milligrams per kilogram (mg/kg). PFOS concentrations at PFAS-SB0098 were above the EPA RSL at both the 0 to 0.5 feet bls and 0.5 to 2 feet depth intervals at concentrations of 0.406 mg/kg and 0.347 mg/kg. Soil analytical results are shown on **Figure 3**.

Analytical results for the Phase I through Phase III surface water samples indicate that PFOS concentrations were above the SW SL at all three sample locations and PFOA concentrations were below the SW SL at all three sample locations. The maximum PFOS concentration of 826 ng/L were detected at PFAS-SW197. Surface water analytical results are shown on **Figure 2**.

No monitoring wells have been installed at the Site. Based on groundwater elevation data from solid waste management unit (SWMU) 114 located to the southeast, groundwater flow is assumed to be towards the west or southwest (**Figures 4 and 5**).

No lithologic borings have been advanced at the Site. Lithologic borings advanced at SWMU 114 and the Morpheus Test Site, located to the northwest of the Site, indicate that the lithology consists primarily of sand and shell to a depth of 43 to 48 feet bls. This layer is underlain by a semi-confining or retarding layer of silt, shell and/or clay.

2.0 SITE ASSESSMENT ACTIVITIES

The proposed site assessment approach and activities are described in the following sections.

2.1 SITE ASSESSMENT APPROACH

Site assessment activities will be performed using a phased approach. Initial site assessment activities will consist of the following activities:

- Collection of soil samples at depths of 0 to 0.5 feet bls and 0.5 feet to 2 feet bls from eight soil sample locations and collection of a soil sample at a depths of 2 to 4 feet bls from PFAS-SB098;
- Advancement of a lithologic boring to 60 feet bls for lithologic description;
- Installation of one staff gauge to monitor surface water levels at the Site;
- Installation of four shallow monitoring wells screened across the water table (5' to 15' unless water table is less than 5') to determine the groundwater flow direction;
- Collection of groundwater samples from the four new monitoring wells;
- Collection of DPT groundwater samples at five depths (3'-7', 13'-17', 23'-27', 33'-37', and 43'-47') from seven DPT groundwater sample locations to continue the delineation of PFAS compounds; and
- Collection of one surface water sample.

Based on the results of the activities listed above, additional soil, groundwater, and/or surface water sample locations may be proposed. Additional proposed groundwater and surface water samples may be specific to the former SLF Fire and Rescue Building Site or as part of the greater SLF study area investigation.

Additionally, on a quarterly basis for 1 year, water level measurements will be collected from the four newly installed monitoring wells and the staff gauge, one monitoring well will be sampled, and one surface water sample will be collected.

All collected samples will be analyzed by EPA Method 537.1.1 Mod for the 25 PFAS compounds listed below.

Analyte	Acronym	CAS No.
Perfluorobutanoic acid	PFBA	375-22-4
Perfluoropentanoic acid	PFPeA	2706-90-3
Perfluorohexanoic acid	PFHxA	307-24-4
Perfluoroheptanoic acid	PFHpA	375-85-9
Perfluorooctanoic acid	PFOA	335-67-1
Perfluorononanoic acid	PFNA	375-95-1
Perfluorodecanesulfonic acid	PFDA	335-76-2
Perfluoroundecanoic acid	PFUnA	2058-94-8
Perfluorodecanoic acid	PFDoA	307-55-1
Perfluorotridecanoic acid	PFTriA	72629-94-8

Analyte	Acronym	CAS No.
Perfluorotetradecanoic acid	PFTeA	376-06-7
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluoropentanesulfonic acid	PFPeS	2706-91-4
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluoroheptanesulfonic acid	PFHpS	375-92-8
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluorononanesulfonic acid	PFNS	68259-12-1
Perfluorododecanoic acid	PFDS	335-77-3
Perfluorooctanesulfonamide	PFOSA	754-91-6
N-methylperfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9
N-ethylperfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6
4:2 Fluorotelomer sulfonate	4:2 FTS	757124-72-4
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4
Hexafluoropropylene oxide dimer acid	GenX	13252-13-6

Additionally, select samples may be analyzed for branched and linear PFOS, PFOA, PFNA, and/or PFHxS analysis.

Laboratory analytical results for soil and groundwater samples will be screened against the EPA RSLs. Laboratory analytical results for surface water samples will be screened against the FDEP SW SLs. The screening levels for specific PFAS compounds are summarized below.

Compound	EPA Soil RSL ⁽¹⁾ (mg/kg)	EPA Groundwater RSL ⁽²⁾ (ng/L)	FDEP SW SL (ng/L)
PFOA	0.19	6	500
PFNA	0.19	6	-
PFBS	19	601	-
PFHxS	1.3	39	-
PFOS	0.13	4	10
GenX	0.23	6	-

(1): EPA, 2022. Regional Screening Level Resident Soil Table (TR=1E-06, HQ=1.0)

(2): EPA, 2022. Regional Screening Level Resident Tapwater Table (TR=1E-06, HQ=0.1)

2.2 INITIAL SITE ASSESSMENT ACTIVITIES

The proposed initial site assessment activities are summarized in the following sections. The rationale for the proposed sample locations is given in **Table 1**.

2.2.1 Soil Sampling

During initial site assessment activities, 17 soil samples from nine locations are proposed to delineate the horizontal extent of PFOS in soil above the RSL. Soil samples will be collected at eight locations at depths of 0 to 0.5 feet bls and 0.5 feet to 2 feet bls using a hand auger. At PFAS-SB0098, a soil sample will be collected at a depth of 2 to 4 feet bls. **Figure 3** depicts the proposed soil sample locations.

2.2.2 Lithologic Boring

One soil boring will be advanced to a depth of 60 feet using a roto-sonic drill rig for lithologic description. Photographs will be taken of the soil cores. The proposed boring (PLB-1) is located on the north side of the Site in an area where high PFAS concentrations are not expected (**Figure 2**). No soil samples will be collected from the boring for laboratory analysis. It is anticipated that deep soil samples will be collected during a future phase during installation of a deep monitoring well. The borehole will be pressure grouted from total depth to land surface immediately following completion of the boring.

2.2.3 Staff Gauge Installations

One staff gauge will be installed in the canal located between the former SLF Fire Rescue Building Site and the SLF runway. The proposed location of the staff gauge (PSG-1) is shown on **Figure 2**. The water level elevation at the staff gauge will be measured on a quarterly basis for 1 year to assess temporal variations in water level elevations.

2.2.4 Monitoring Well Installations

Four shallow monitoring wells are proposed to be installed using a DPT drilling rig to determine the groundwater flow direction at the Site. The wells will be 1-inch in diameter and set so that the screened interval intersects the water table (screened 5' to 15' unless water table is less than 5'). No intermediate monitoring wells are proposed at this time. The locations of the four proposed wells (PMW-1 through PMW-4) are shown on **Figure 2**. The locations and elevations of the wells will be surveyed by a Florida-licensed surveyor. Water levels will be measured from the four new monitoring wells on a quarterly basis for 1 year to assess temporal variations in water table elevations and the groundwater flow direction.

2.2.5 Monitoring Well Sampling

Groundwater samples will be collected from the four newly installed monitoring wells. Additionally, proposed monitoring well PMW-4 will be sampled on a quarterly basis for 1 year to assess temporal variations in PFAS concentrations.

2.2.6 DPT Groundwater Sampling

The objective of the initial groundwater investigation is to gain an understanding of the magnitude of PFAS impacts in the vicinity of the Site. Concurrent with the monitoring well installations, groundwater sampling at seven DPT groundwater sample locations are proposed. At each sample location, groundwater samples will be collected at intervals of 3 to 7 feet (or water table), 13 to 17 feet, 23 to 27 feet, 33 to 37 feet, and 43 to 47 feet bls. The boreholes will be pressure grouted from total depth to land surface immediately following sample collection. No samples from these proposed locations will be collected below the 43 to 47 feet bls interval. Prior to groundwater sampling, a lithologic boring will be advanced to a depth of 60 feet bls. Groundwater sample intervals may be revised based on the lithologies encountered during the advancement of the lithologic soil boring. The proposed DPT groundwater sample locations are shown on **Figure 2**.

2.2.7 Surface Water Sampling

Surface water sample location PSW-1 will be sampled at the immediate surface on a quarterly basis for 1 year to assess temporal variations in PFAS concentrations. The proposed surface water sample location is shown on **Figure 2**.

2.3 SUBSEQUENT SITE ASSESSMENT ACTIVITIES

After data from the initial round of site assessment activities has been reviewed by HGL and NASA KSC, additional soil and DPT groundwater sample locations may be proposed to complete horizontal delineation, complete vertical delineation, reduce the footprint of the interpreted area of PFAS above RSLs and/or investigate groundwater/surface water interactions. Additional surface water sampling locations will be proposed as part of a SLF area-wide surface water investigation to be performed after the initial site assessment activities have been completed at the former SLF Fire Rescue Building Site and other sites in the SLF study area. All currently proposed DPT groundwater sample and monitoring well locations for the SLF study area are shown on **Figure 6**.

3.0 REFERENCES

AECOM, 2022. *Center-Wide Phase II and III Solid Waste Management Unit Assessment and Confirmatory Sampling Report for Per- and Polyfluorinated Alkyl Substances, Potential Release Location (PRL) No. 237*, Kennedy Space Center, Florida. 2022.

IHA. 2014. *Air Traffic Control Tower Area (ATCT) J5-1197 PRL 184 Confirmatory Sampling Report (Revision 0)*. 2014.

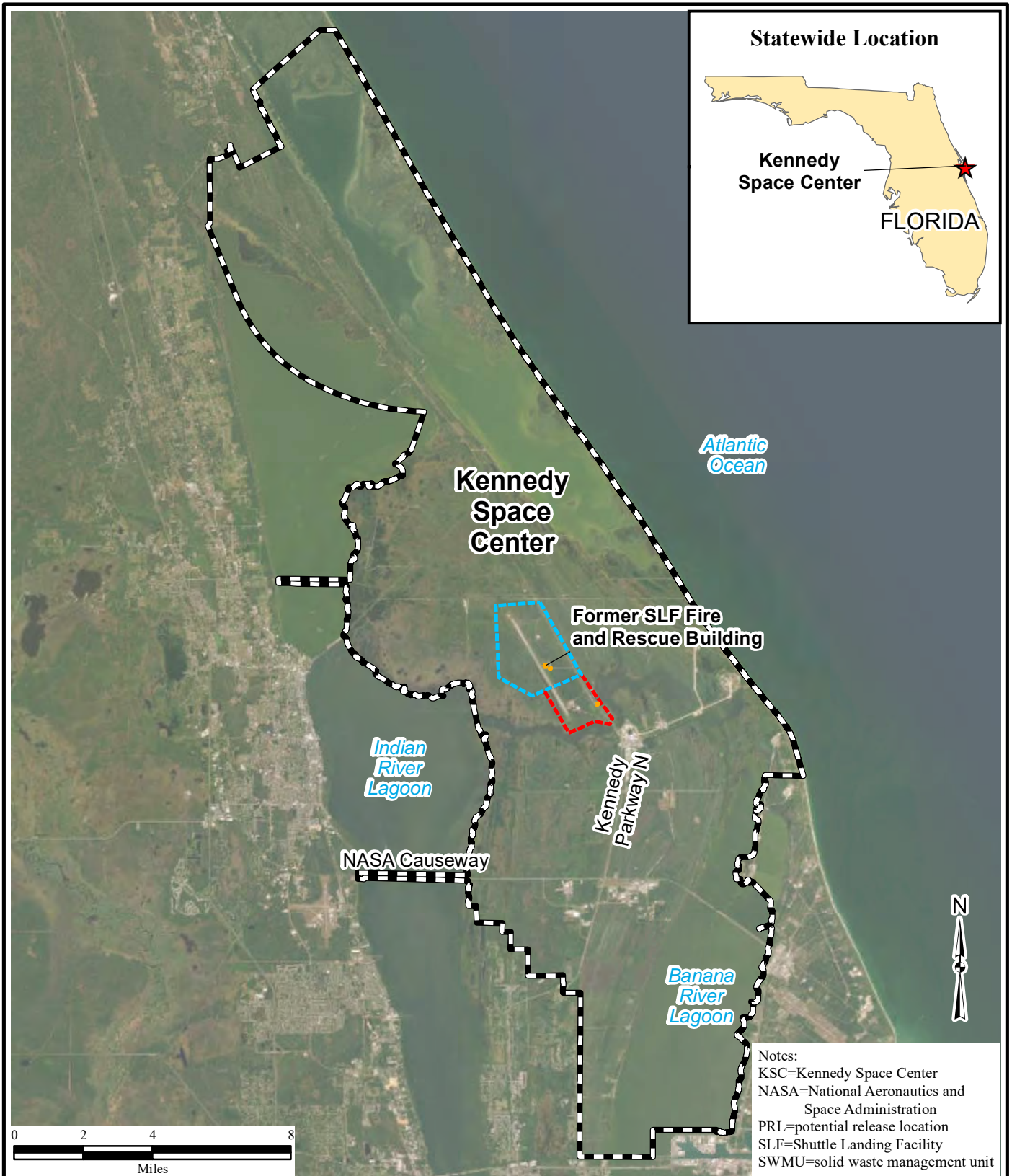
National Aeronautics and Space Administration (NASA). 2019. *Phase I Solid Waste Management Unit Assessment and Confirmatory Sampling Report Center-Wide Per- and Polyfluoroalkyl Substances (PFAS) Potential Release Location 237*, John F. Kennedy Space Center, Florida (Revision 0). Prepared by Geosyntec Consultants. September 2019.

TABLE

Table 1
Former SLF Fire and Rescue Building Work Plan
Sample Location Rationale

Proposed Sample Location	Rationale
PSB-1	Assess soil quality north of PFAS-SB0100
PSB-2	Assess soil quality west of PFAS-SB0100
PSB-3	Assess soil quality southwest of PFAS-SB0100
PSB-4	Assess soil quality west of PFAS-SB0098
PSB-5	Assess soil quality south of PFAS-SB0098
PSB-6	Assess soil quality east of PFAS-SB0098
PSB-7	Assess soil quality southeast of PFAS-SB0100
PSB-8	Assess soil quality east of PFAS-SB0100
PFAS-SB0098	Delineate soils above RSL vertically
PDPT-1	Assess groundwater quality northwest of PFAS-DPT0217-0219 Hotspot
PDPT-2	Assess groundwater quality north of PFAS-DPT0217-0219 Hotspot
PDPT-3	Assess groundwater quality southeast of PFAS-DPT0217-0219 Hotspot
PDPT-4	Assess groundwater quality southwest of PFAS-DPT0217-0219 Hotspot
PDPT-5	Assess groundwater quality northwest of PFAS-DPT00220
PDPT-6	Assess groundwater quality east of PFAS-DPT0217-0219 Hotspot
PDPT-7	Assess groundwater quality south of PFAS-DPT0217-0219 Hotspot
PMW-1	Shallow monitoring well at PFAS-DPT0217-0219 Hotspot for groundwater flow
PMW-2	Shallow monitoring well north of PFAS-DPT0217-0219 Hotspot for groundwater flow
PMW-3	Shallow monitoring well east of PFAS-DPT0217-0219 Hotspot for groundwater flow
PMW-4	Shallow monitoring well southwest of PFAS-DPT0217-0219 Hotspot for groundwater flow
PSG-1	Staff Gauge adjacent to PMW-4

FIGURES



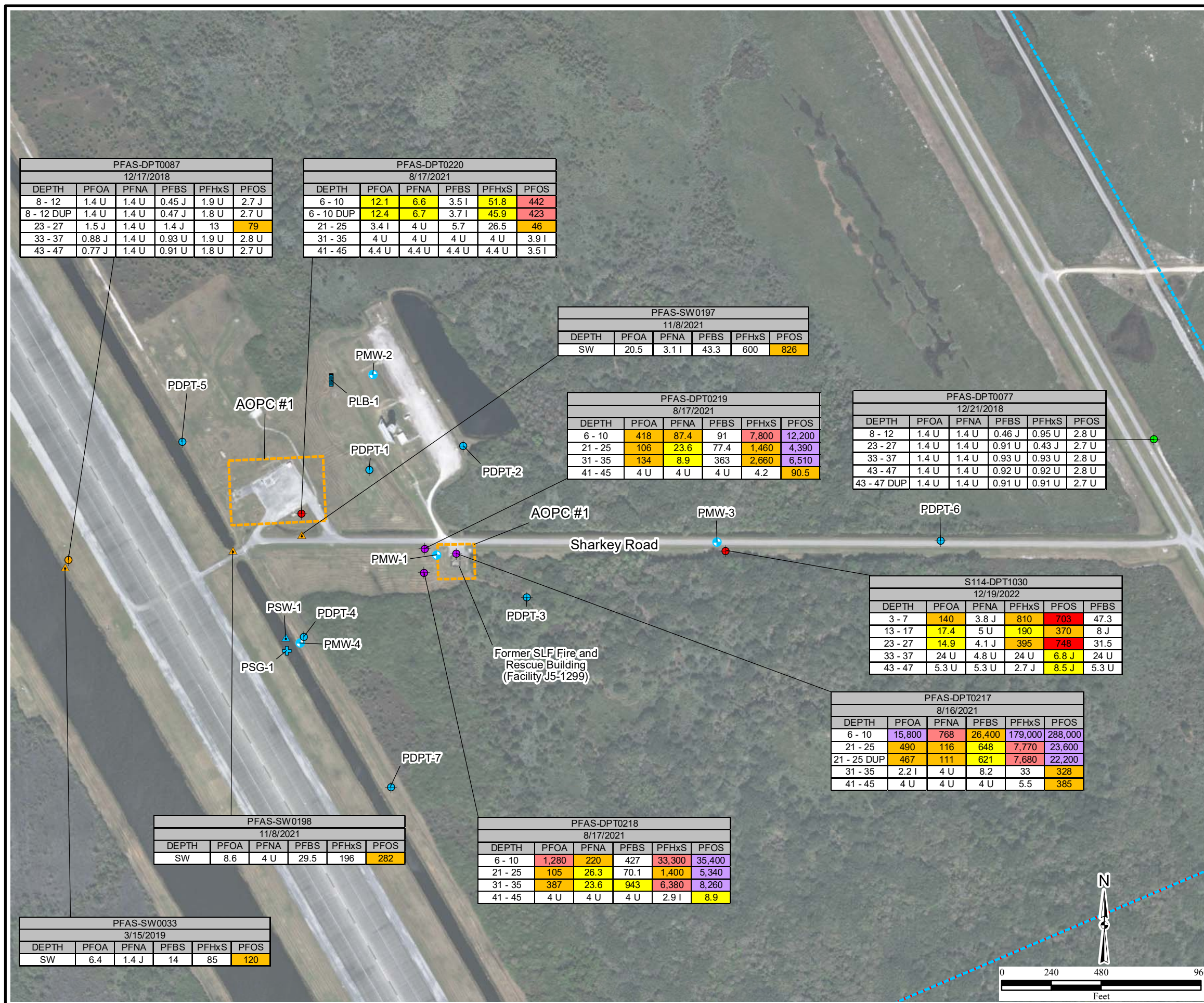
Notes:
 KSC=Kennedy Space Center
 NASA=National Aeronautics and Space Administration
 PRL=potential release location
 SLF=Shuttle Landing Facility
 SWMU=solid waste management unit

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 Source: HGL, 3E Consultants
 ArcGIS Online Imagery

Legend	
	Site Location
	SWMU 114 Boundary
	SWMU 119 Boundary
	PRL 237 Boundary
	Kennedy Space Center

Figure 1
Former SLF Fire and Rescue Building
Site Location Map

Figure 2
Former SLF Fire and Rescue Building
Surface Water and Groundwater
Analytical Results



Legend

- DPT Sample Concentration Less than RSLs
- DPT Sample Concentration Greater than 10 x RSLs
- DPT Sample Concentration Greater than 100 x RSLs
- DPT Sample Concentration Greater than 1,000 x RSLs
- ▲ Surface Water Sample Concentration Greater than 10 x SW SLs
- ⊕ Proposed DPT Sample
- ⊕ Proposed Lithologic Boring Location
- ⊕ Proposed Monitoring Well
- + Proposed Staff Gauge
- ▲ Proposed Surface Water Sample Location
- Former Building
- SWMU 114 Boundary
- SWMU 119 Boundary
- PRL 237 Boundary

Notes:
■ = concentration greater than RSLs
■ = concentration greater than 10 x RSLs
■ = concentration greater than 100 x RSLs
■ = concentration greater than 1000 x RSLs
 Results in nanograms per liter (ng/L)
 AOPC=area of potential concern
 I=estimated value
 J=estimated value
 PFOA=perfluorooctanoic acid
 PFNA=perfluorononanoic acid
 PFHxS=perfluorohexanesulfonic acid
 PFOS=perfluorooctanesulfonic acid
 PFBS=perfluorobutanesulfonic acid
 RSL=regional screening level
 SLF=Shuttle Landing Facility
 SWMU=solid waste management unit
 SW SL=surface water screening level
 U=not detected

Sample Location					
Sample Date					
Depth	PFOA	PFNA	PFHxS	PFOS	PFBS
Groundwater RSLs					
PFOA	PFNA	PFHxS	PFOS	PFBS	Surface Water SLs
6	6	40	4	600	PFOS 10 ng/L
					PFOA 500 ng/L

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 Source: HGL, ArcGIS Online Imagery

Figure 3
Former SLF Fire and Rescue Building
Soil Sample Analytical Results



Legend

- Soil Sample Concentration Less than RSLs
- Soil Sample Concentration Greater than RSLs
- Soil Sample Concentration Greater than 10 x RSLs
- Proposed Soil Sample (0-0.5', 0.5'-2')
(A 2' to 4' Sample will be collected at PFAS-SB098)
- Dirtpile Footprint
- Former Building
- PRL 237 Boundary

Notes:

Yellow=concentration greater than RSLs
 Orange=concentration greater than 10 x RSLs
 Results in milligrams per kilogram (mg/kg)

AOPC=area of potential concern
 I=estimated value
 J=estimated value
 PFOS=perfluorooctanesulfonic acid
 RSL=regional screening level
 SLF=Shuttle Landing Facility
 SWMU=solid waste management unit
 U=not detected

Sample Location	
Sample Date	
Depth	PFOS Concentration

Soil RSLs	
PFOS	0.13 mg/kg

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 Source: HGL, ArcGIS Online Imagery

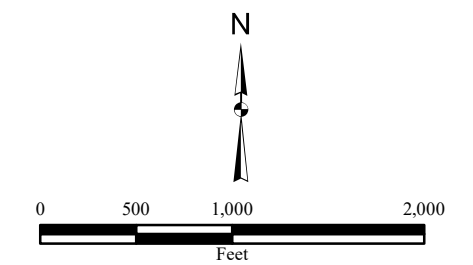
Figure 4
SWMU #114
Groundwater Elevation Map
Shallow Zone



Legend

- + Staff Gauge Location
- Shallow Zone Monitoring Well
- MW0001S
 (1.8 - 11.8)
 -0.49
 Monitoring Well Identification
 Screened Interval (ft)
 Groundwater Elevation (ft amsl, NAVD88)
- Generalized Groundwater Flow Direction
- 1.50- Groundwater Elevation Contour (ft amsl, NAVD88)
- SWMU 114 Boundary

Notes:
 ft amsl=feet above mean sea level
 NAVD88=North American Vertical Datum of 1988
 SWMU=solid waste management unit



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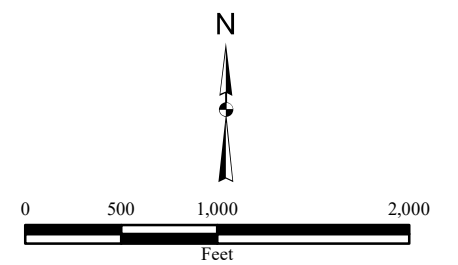
Figure 5
SWMU #114
Groundwater Elevation Map
Intermediate Zone



Legend

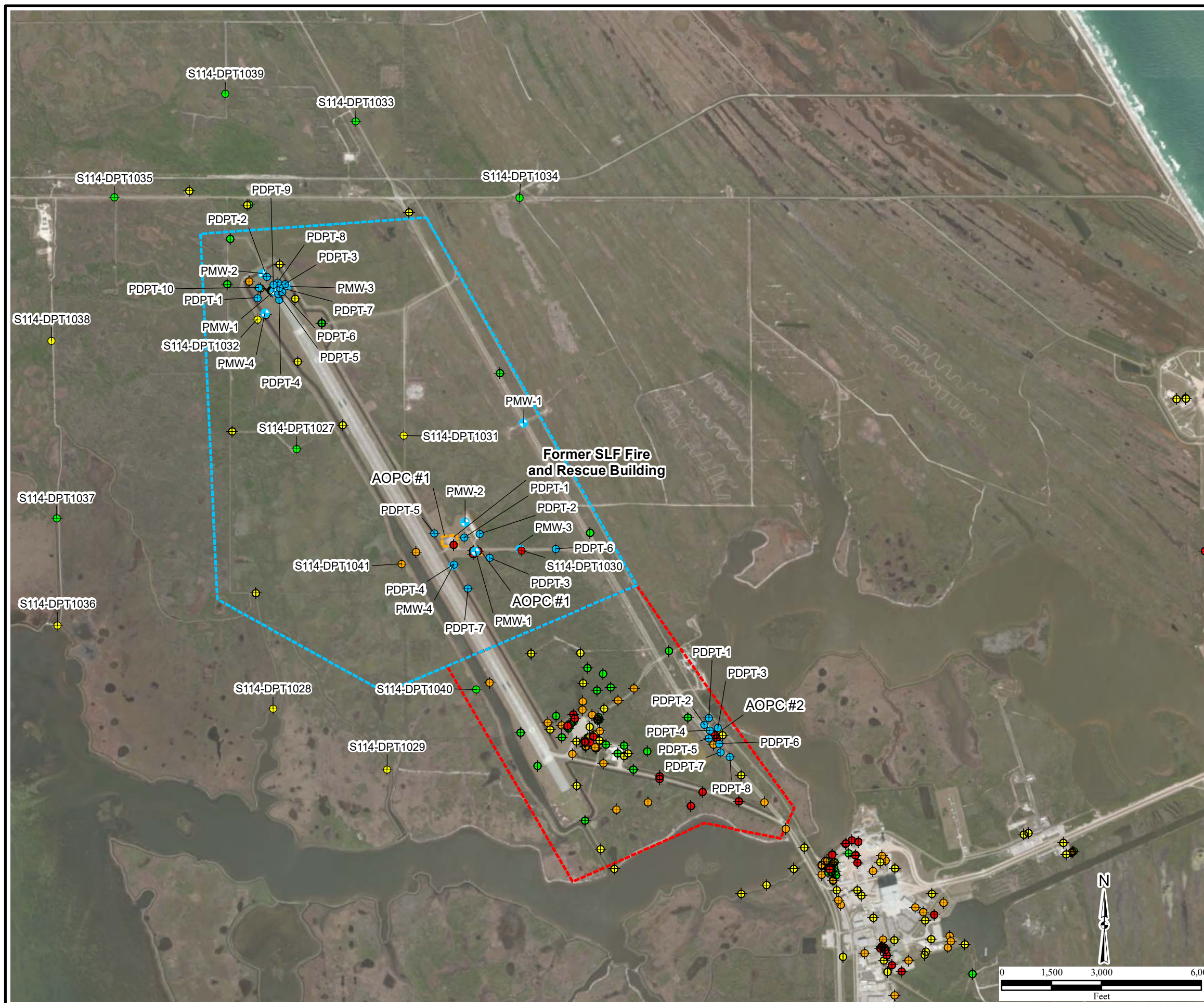
- Intermediate Zone Monitoring Well
- MW00011 Monitoring Well Identification
 (24.6 - 34.6) Screened Interval (ft)
-0.44 Groundwater Elevation (ft amsl, NAVD88)
- Generalized Groundwater Flow Direction
- 1.50- Groundwater Elevation Contour (ft amsl, NAVD88)
- SWMU 114 Boundary

Notes:
 ft amsl=feet above mean sea level
 NAVD88=North American Vertical Datum of 1988
 SWMU=solid waste management unit



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 Source: HGL, ArcGIS Online Imagery

Figure 6
SLF Area
Regional Proposed DPT Locations
and Monitoring Wells



Legend

- DPT Sample Concentration Less than RSLs
- DPT Sample Concentration Greater than RSLs
- DPT Sample Concentration Greater than 10 x RSLs
- DPT Sample Concentration Greater than 100 x RSLs
- DPT Sample Concentration Greater than 1000 x RSLs
- Proposed DPT Sample
- Proposed Monitoring Well
- SWMU 114 Boundary
- SWMU 119 Boundary
- PRL 237 Boundary

Notes:
PRL=potential release location
RSL=regional screening level
SLF=Shuttle Landing Facility
SWMU=solid waste management unit

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Source: HGL,
ArcGIS Online Imagery