DRAFT

REMEDIAL INVESTIGATION SITE CHARACTERIZATION SUMMARY REPORT

PER- AND POLYFLUOROALKYL SUBSTANCES RESPONSE
FORMER LORING AIR FORCE BASE
LIMESTONE, MAINE

Prepared for:

Air Force Civil Engineer Center

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ACRONYMS/ABBREVIATIONS

8:2FTS	1H,1H, 2H, 2H-Perfluorodecane sulfonic acid
4:2FTS	1H,1H, 2H, 2H-Perfluorohexane sulfonic acid
6:2FTS	1H,1H, 2H, 2H-Perfluorooctane sulfonic acid
5:3FTCA	2H,2H,3H,3H-Perfluorooctanoic acid
3:3FTCA	3-Perfluoropropyl propanoic acid
7:3FTCA	3-Perfluoroheptyl propanoic acid
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AFFF	Aqueous Film Forming Foam
ANWR	Aroostook National Wildlife Refuge
ARAR	Applicable or Relevant and Appropriate Requirements
AWI	Air-water Interface
BERA	Baseline Ecological Risk Assessment
bgs	Below Ground Surface
BHHRA	Baseline Human Health Risk Assessment
BIA	Bureau of Indian Affairs
C-F	Carbon Fluorine
CB&I	Chicago Bridge and Iron Federal Services LLC
CDC	Center for Disease Control
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CFS	Crash Fire Station
COC	Contaminant of Concern
COPC	Chemicals of Potential Concern

CSM	Conceptual Site Model
CUD	Caribou Utilities District
CVOCs	Chlorinated Volatile Organic Compounds
CZTE	Environmental Restoration Technical Support Branch
DAF	Department of the Air Force
DFAS	Defense Finance and Accounting Services
DoD	Department of Defense
DQI	Data Quality Indicators
DQO	Data Quality Objectives
EBGB	East Branch Greenlaw Brook
ELL	East Loring Lake
EPM	Equivalent Porous Media
ERA	Ecological Risk Assessment
EVS	Earth Volumetric Studio
°F	[Degrees] Fahrenheit
FBR	Fractured Bedrock
FDA	Fuel Dump Area
FFA	Federal Facility Agreement
FJETC	Former Jet Engine Test Cell
FLDD	Flightline Drainage Ditch
FS	Feasibility Study
FTA	Fire Training Area
FTF	Fuel Tank Farm
FYR	Five-Year Review
GAC	Granular Activated Carbon
GMZ	Groundwater Management Zone

1	gpm	gallons per minute
2		
3	HA	Health Advisory
4	HFPO-DA	Hexafluoropropylene Oxide Dimer Acid
5		
6	IDW	Investigation Derived Waste
7	I&I	Infiltration and Inflow
8	IRP	Installation Restoration Program
9		
10	JEMS	Jet Engine Maintenance Shop
11		
12	LDA	Loring Development Authority
13	LEAF	Leaching Environmental Assessment Framework
14	LF-2	Landfill 2
15	LF-3	Landfill 3
16	LNAPL	Light Non-Aqueous Phase Liquid
17	Loring	Former Loring Air Force Base
18		
19	MCL	Maximum Contaminant Level
20	MDL	Method Detection Limit
21	MEDEP	Maine Department of Environmental Protection
22	Method 537M	Modified Method 537
23	mg/kg	Milligrams per Kilogram
24	MODFLOW	Groundwater flow model
25		
26	NAVD88	North American Vertical Datum of 1988
27	NEtFOSA	N-ethyl perfluorooctanesulfonamide
28	NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
29	NEtFOSE	N-ethyl perfluorooctanesulfonamidoethanol

NMeFOSA	N-methyl perfluorooctanesulfonamide
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
NMeFOSE	N-methyl perfluorooctanesulfonamidoethanol
NCP	National Contingency Plan
NDA	Nose Dock Area
ng/g	Nanograms per Gram
ng/L	Nanograms per Liter
NPDWR	National Primary Drinking Water Regulations
NWI	National Wetlands Inventory
OU	Operable Unit
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PFAS	Per- and Polyfluoroalkyl Substances
PFBA	Perfluorobutanoic acid
PFBS	Perfluorobutanesulfonic Acid
PFCA	Perfluoroalkyl carboxylate
PFDA	Perfluorodecanoic Acid
PFDoA	Perfluorododecanoic acid
PFDoS	Perfluorododecanesulfonic acid
PFDS	Perfluorodecanesulfonic acid
PFHpA	Perfluoroheptanoic Acid
PFHpS	Perfluoroheptanesulfonic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic Acid
PFNA	Perfluorononanoic Acid
PFNS	Perfluorononanesulfonic acid

PFMBA	Perfluoro-4-methoxybutanoic acid
PFMPA	Perfluoro-3-methoxypropanoic acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctanesulfonic Acid
PFOSA	Perfluorooctane sulfonamide
PFPeA	Perfluoropentanoic acid
PFPeS	Perfluoropentanesulfonic acid
PFSA	Perfluoroalkane sulfonate
PFTeDA	Perfluorotetradecanoic acid
PFTrDA	Perfluorotridecanoic acid
PFUnA	Perfluoroundecanoic acid
POET	Point-of-Entry Treatment
QPP	Quality Program Plan
RAGs	Remedial Action Guidelines
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Level
SARA	Superfund Amendments and Reauthorization Act
SCF	Spill Containment Facility
SI	Site Inspection
Site	Former Loring Air Force Base
SFS	Structural Fire Station
SL	Screening Level
SLERA	Screening Level Ecological Risk Assessment

SOP	Standard Operating Procedure
SSL	Soil Screening Level
SSL^{Rev}	Revised Soil Screening Level
SVOC	Semi-volatile Organic Compound
TBC	To Be Considered
TCE	Trichloroethene
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOCs	Volatile Organic Compounds
WBGB	West Branch Greenlaw Brook
WWTP	Wastewater Treatment Plant

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1.0 SITE INTRODUCTION

WSP USA Environment and Infrastructure Inc. (WSP), has prepared this Remedial Investigation (RI) Site Characterization Summary Report to define the nature and extent of per- and polyfluoroalkyl substances (PFAS) contaminants in soil, groundwater, surface water, sediment, stormwater, and biota at the former Loring Air Force Base (Loring, or Site) located in Limestone, Maine, **Figure 1-1**. This report has been prepared for the Department of the Air Force (DAF) under Contract Number FA8903-16-D-0027, Task Order FA8903-21-F-1048. This RI Site Characterization Summary Report will be applicable for previously published documents referencing the PFAS RI Report until the PFAS RI Report is issued at a later date.

The PFAS RI has been completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan 40 Code of Federal Regulations (CFR) Part 300 (USEPA, 1988a). The PFAS RI field work was conducted in an iterative approach. The tasks of the PFAS RI were designed to evaluate the nature and distribution of PFAS contaminated media and address data gaps identified during previous investigations.

1.1 PURPOSE OF REPORT

PFAS contamination investigated at Loring in this RI Site Characterization Summary Report resulted primarily from use of aqueous film forming foam (AFFF) for extinguishing petroleum fires, for firefighting training activities, and in fire suppression systems since the mid-1970s. The use of AFFF has resulted in soil, groundwater, surface water, and sediment contamination which has affected nearby drinking water wells.

PFAS are a group of synthetic fluorinated compounds used to make products more resistant to heat, grease, and water, and were detected in various sample media as part of the Site Inspection (SI) investigation (Wood, 2018). Perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) are classified as hazardous substances and are therefore regulated under CERCLA (USEPA, 2024b).

The objectives of the PFAS RI are to:

- Provide information on physical characteristics of the environmental setting.
- Characterize the nature and distribution of PFAS contamination.
- Draw conclusions regarding types of potential contaminants of concern (COCs) present, their sources, nature, and extent.
- Measure contaminant levels in various media.
- Evaluate COC migration pathways, receptors and exposures.
- Provide information for the development of risk assessments and a Feasibility Study (FS) Report.

Environmental investigations at Loring are governed by the guidelines of the DAF Installation Restoration Program (IRP) and the Maine Department of Environmental Protection (MEDEP). The interagency Loring Federal Facility Agreement (FFA) was signed on 30 January 1991, (and modified on 20 December 1993) by the DAF, MEDEP and United States Environmental Protection Agency (USEPA) under CERCLA Section 120

establishing the protocols for conducting the environmental study and cleanup at Loring (DAF, 1998). The IRP requires restoration activities to be conducted in accordance with the CERCLA (42 United States Code Section 9601, et seq.), as amended by the Superfund Amendments and Reauthorization Act (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (CFR 300.400).

As Loring was listed on the USEPA National Priorities List in 1990 (USEPA, 1990), actions conducted by the DAF as the lead agency are coordinated with the MEDEP and the USEPA in accordance with the FFA. The USEPA Identification Number for the Site is ME9570024522.

1.2 SITE BACKGROUND

The following subsections provide a brief site description, a historical summary of investigations conducted for non-PFAS environmental investigations, and a summary of PFAS investigations conducted prior to the PFAS RI.

1.2.1 Site Description

Loring is located in Aroostook County in northeastern Maine, approximately two miles northwest of the town of Limestone, eight miles northeast of Caribou, and three miles west of the Canadian border at New Brunswick, Canada, **Figure 1-1.**

When Loring was active, it occupied approximately 9,000 acres in the lower Aroostook River Basin. The townships of Caswell and Connor border Loring on the north and northwest, respectively. The town of Caribou lies along the western border of the Site, while the town of Limestone is to the east and south. The surrounding land is primarily rural and agricultural. The topography of Loring is gently rolling, with several brooks running through the terrain.

Limestone and Caribou are partially served by public water supplies, while Caswell and Connor rely on private wells. The Limestone water supplies are managed by the Limestone Water and Sewer District. Limestone has two public water supply wells and has designated Durepo Reservoir as a secondary water supply. The Caribou public water supply is managed by Caribou Utilities District (CUD). Caribou has one public water supply well located next to the Aroostook River. The water supply for the Site is managed by the Loring Development Authority (LDA) and is sourced from the Little Madawaska River.

Currently, there is a small residential community and limited commercial and industrial use within Loring. Although Loring is an active airport, the flight control tower on the Site is not operational; plane landings are infrequent and primarily unscheduled.

Figure 1-2 shows the layout of Loring, including the identified potential source areas of PFAS, and surface water features.

1.2.2 Site History

In 1946, the Strategic Air Command developed a plan for a global Air Force which called for an Air Force Base (AFB) to be built at the northeastern tip of the United States. As a result, the Air Force established Limestone AFB which was constructed between 1947 and 1953. In 1954, Limestone AFB was renamed for Korean War aviator Charles J. Loring. Upon completion of construction, Loring AFB became the home of the 42nd Bombardment Wing with state of-the art bombers and support aircraft. In 1955, the 42nd Air Refueling Squadron was activated.

From 1981 through 1991, substantial renovations and improvements were made, including renovations to the alert facility, construction of a new medical center, construction of a new maintenance facility and upgrades to aircraft refueling. A secondary runway was also constructed during this period. Discussions of the runway throughout this report refer to the main runway. In 1991 the Base Realignment and Closure Commission recommended that Loring be closed. Loring was officially deactivated on 30 September 1994.

After the closure of Loring, the Maine State Legislature created the LDA to acquire and manage approximately 3,130 acres of land within the geographic boundaries of the former AFB. The DAF transferred approximately 4,700 acres of land to the United States Fish and Wildlife Service (USFWS) in 1998 for operation as the Aroostook National Wildlife Refuge (ANWR). Additional land was conveyed to construct housing for the Mi'kmaq Nation (Wood, 2018).

1.2.3 Summary of Previous Non-PFAS Investigation and Remedial Activities

In 1990 Loring was listed on the NPL and investigations were conducted under the IRP including SIs, RI/FSs, and Interim Remedial Measures. Based on these investigations, remedial actions were conducted for sites identified as having an environmental impact and/or potential for contaminant migration.

The primary goal of the IRP was to identify and remediate contamination resulting from past disposal practices or accidental releases of hazardous and toxic substances to minimize risk to human and ecological receptors.

Under the FFA for Loring, 15 IRP Operable Units (OUs) were established based on geographic location, disposal type (e.g., landfill), or affected media. The primary COCs at the Loring were:

- volatile organic compounds (VOCs), particularly chlorinated VOCs (CVOCs)
- petroleum hydrocarbons, semi-volatile organic compounds (SVOCs), particularly polycyclic aromatic hydrocarbons (PAHs),
- metals, and
- polychlorinated biphenyls (PCBs).

RI and FS reports were prepared for each of the 15 OUs.

Eleven Records of Decision (ROD) describing selected remedies for Loring were completed between 1994 and 1999 (ABB, 1994, 1996 and 1997a; and Harding Lawson Associates, Inc. [HLA], 1998b and 1999a, b). An amendment to the OU 12 ROD was completed in 2018 to address vapor intrusion issues (DAF, 2018). Remedies implemented included soil removal, capping, and land farming of soils.

Remedy optimization, operation and maintenance, and long-term monitoring activities associated with the IRPs will continue until cleanup goals have been met for fuels and solvent related contamination. The DAF is responsible for five-year reviews (FYR) at Loring to evaluate remedial progress and determine if the implemented remedies are and will continue to be protective of human health and the environment. The latest FYR was completed in 2025 (APTIM, 2025).

1.2.4 Use of PFAS Containing Materials

PFAS have been used since the 1950s to make products resistant to heat, oil, stains, grease, and water (National Institute of Environmental Health Services, 2025). They are found in some fire-fighting foams and consumer products, including nonstick cookware, stain-resistant carpets, fabric coatings, food packaging, cosmetics, and personal care products (National Institute of Environmental Health Services, 2025).

PFAS are currently considered emerging contaminants; ongoing research has identified associations between PFAS exposure and health effects (ATSDR, 2025). People can be exposed to PFAS in the air, indoor dust, food, water, and consumer products. Because of their extensive use, PFAS exposure is common for the general U.S. population (ATSDR, 2025).

PFAS persist in the environment (ATSDR, 2025). Most of these compounds are known to be water-soluble and can be found in soil, sediment, water, plants, and animals. Studies indicate that some PFAS move through the soil and easily enter groundwater, in which they can travel long distances (MDH, 2025a, 2025b).

AFFF containing PFAS compounds were used at Loring for petroleum spills, aircraft crashes, fire suppression systems, and during fire training exercises (Amec Foster Wheeler, 2015). AFFF was introduced to the Air Force inventory in 1970. Therefore, although there are no records, it is assumed that use of AFFF began in the early 1970's, which is consistent with use at other installations such as the former Pease AFB in Portsmouth, New Hampshire (Department of Defense (DoD), 2017).

PFAS-based AFFFs were created in the 1960's. The active ingredients in this AFFF include PFOS as well as perfluorohexanesulfonic acid (PFHxS), however the process to create the AFFF can result in a diverse mixture of PFAS compounds which can end up in the final product. Several PFAS-based AFFF formulations were manufactured that met the specifications of the DOD from the 1970s until 2016. The formulations for AFFF from the initial manufacturer did not include PFOA, however AFFF can include compounds that can degrade to PFOA or other PFAS (ITRC, 2026).

AFFF-containing materials were located at Loring in storage areas, handling areas and usage/release areas (Amec Foster Wheeler, 2015):

- **Storage Area:** An area where AFFF was stored in bulk. Storage containers/areas contained:
  - Unspent AFFF for use, and
  - Spent AFFF/water mixture
- **Handling Area:** An area where AFFF was transferred to or from storage either manually or by pipeline.
- **Usage/Release Area:** An area where AFFF was discharged intentionally or unintentionally, including instances when:
  - AFFF was discharged intentionally (fire training exercises or equipment testing);
  - AFFF was released unintentionally (discharge from fire suppression system); or,
  - AFFF was released through transport mechanisms (overland flow to surface water bodies).

1.2.5 Summary of Previous PFAS Investigations

This section describes previous investigations and preliminary PFAS RI sampling activities conducted in support of characterization of PFAS at Loring.

In the following subsections, the term PFAS may refer to more than one analytical list, as the laboratory capability and Site-specific requirements have evolved over time. This is a result of the science regarding this class of compounds continuing to develop and evolving guidance from Federal and State regulatory agencies. Table notes are included in **Table 1-1,** and a list of the PFAS compounds analyzed in the analytical methods and date ranges they were used is provided in **Table 1-2**. Although PFAS refers to a large class of chemicals, only a subset of PFAS were analyzed for this PFAS RI and a smaller set of these are included in the PFAS RI evaluation based on the regulatory guidance at the time of report publication.

In 2012, the DAF issued guidance on sampling for PFOS and PFOA (DAF, 2012). In the fall of 2013, Chicago Bridge & Iron Federal Services LLC (CB&I) collected and analyzed samples for the presence or absence of PFOS and PFOA as part of ongoing environmental monitoring relative to GMZ-6 (IRP Site SS059) and OU-13 (IRP Site SD010). This effort included the collection of groundwater samples from the Fire Training Area (FTA) and fish tissue and sediment samples from several surface water bodies (CB&I, 2014).

The following five bedrock wells were sampled at the FTA in November 2013 for PFOS and PFOA:

- JBW8007;
- MMW8015;
- RFW1144;
- RFW1147; and,
- MW8012BR.

PFOS and PFOA were detected in these wells, with one sample exceeding the contemporaneous regulatory standard (USEPA lifetime Health Advisory [HA]) for PFOA and four samples exceeding the HA for PFOS (CB&I, 2014).

Fish tissue samples were collected from the following water bodies in October and November 2013 for PFOS and PFOA:

- East Branch of Greenlaw Brook (EBGB);
- Chapman Pit;
- Durepo Reservoir;
- Prestile Brook (background location); and,
- East Loring Lake (ELL).

PFOA was reported below the detection limit in the fish tissue samples. PFOS was detected in the fish tissue samples with the exception the background sample collected from Prestile Brook. PFOS concentrations ranged from 37.8 to 1,080 nanograms per gram (ng/g). A sediment sample was also collected from ELL and analyzed for both PFOS and PFOA; results were non-detect and 0.930 ng/g respectively (CB&I, 2014).

A PFAS Preliminary Assessment (PA) of Loring was prepared by Amec Foster Wheeler on behalf of the Air Force Civil Engineer Center (AFCEC) in 2015 (Amec Foster Wheeler, 2015). The PA evaluated the potential for storage, handling, use, and/or release of AFFF at Loring. Of the 21 areas evaluated, the PA identified 20 potential areas where AFFF was stored, used or released. The evaluation of Base Supply (Area 4) determined no further action was needed.

The following 21 AFFF areas were identified in the PA for potential future action:

- Area 1 - FTA FT-07 (IRP Site FT-07), referred to as “Fire Training Area or FTA”;
- Area 2 - Landfill LF-2 (IRP Site LF-02), referred to as “Landfill 2”;
- Area 3 - Landfill LF-3 (IRP Site LF-20), referred to as “Landfill 3”;
- Area 5 - Building 3005 (Structural Fire Station), referred to as “Structural Fire Station (SFS)”;
- Area 6 - Building 6900 (Fire Department Training/Burn House), referred to as “Burn House”;
- Area 7 - Building 8202 (Crash Fire Station), referred to as “Crash Fire Station (CFS)”;
- Area 8 - Building 8250 (Arch Hangar), referred to as “Arch Hangar”;
- Area 9 - Building 8260 (Jet Engine Maintenance Shop), referred to as “Jet Engine Maintenance Shop (JEMS)”;
- Area 10 - Nose Dock Area (ST011) - Nose Dock 11, referred to as “Nose Dock 11”;
- Area 11 - Nose Dock Area (ST011) – Building 8740/Nose Dock 40, referred to as “Nose Dock 40”;
- Area 12 - Nose Dock Area (ST011) - Building 8744/Nose Dock 44, referred to as “Nose Dock 44”;
- Area 13 - Nose Dock Area (ST011) - Aircraft Hardstands, referred to as “Aircraft Hardstands”;

- Area 14 - Nose Dock Area (ST011) - Hardstand 19, referred to as “Hardstand 19”;
- Area 15 - Nose Dock Area (ST011) - Ramp #1, referred to as “Ramp #1”;
- Area 16 - Fuel Tank Farm, referred to as “Fuel Tank Farm (FTF)”;
- Area 17 - Fuel Dump Area, referred to as “Fuel Dump Area (FDA)”;
- Area 18 - Main Runway Foaming Area, referred to as “Runway”;
- Area 19 - KC-135 Crash Site, referred to as “KC-135 Crash Area”;
- Area 20 - B-52 Crash Site, referred to as “B-52 Crash Area”;
- Area 21 - Flightline Drainage Ditch (FLDD) and Building 6538 (Spill Containment Facility [SCF]), referred to as “Flightline Drainage Ditch and Spill Containment Facility”; and,
- Area 22 - Wastewater Treatment Plant (WWTP) Sludge Drying Beds, referred to as “Wastewater Treatment Plant”.

Based on the PA, an SI was conducted in 2018 (Wood, 2018). The SI included sampling of soil, surface water, sediment, groundwater, drinking water wells, and public water supply wells to determine presence or absence of PFOA and PFOS. Fish tissue was also collected and analyzed during this effort.

SI activities were conducted between 17 August 2015 and 02 June 2017 at 21 AFFF areas identified for inspection during the 2015 PA (Amec Foster Wheeler, 2015). Sampling locations, determined based on discussions between Amec Foster Wheeler, AFCEC, USEPA and MEDEP, were documented in the Final Installation Specific Work Plan (Amec Foster Wheeler, 2016). Sample results in soil showed that sixteen of the 21 areas investigated contain PFAS above the lowest contemporaneous screening levels (SLs). In addition, PFAS were detected in surface water, sediment, and fish tissue samples.

PFOS, PFOA, and perfluorobutanesulfonic acid (PFBS) were not detected above contemporaneous SLs in drinking water samples analyzed from nine private and public drinking water wells sampled as part of SI activities.

Regulatory SLs have become more stringent between the PA, to SI, and ultimately the PFAS RI. Contemporary SLs cited as governing early PA and SI evaluations have since been reduced. This reduction can result in changes in decision making on whether to include source areas for further evaluation. While 16 of the 21 source areas were recommended for further evaluation based on comparison to their contemporary screening levels in the SI, each source area was investigated as part of the PFAS RI.

The only source area that was initially identified in the PA which was not investigated in the PFAS RI was Source Area 4, Base Supply Buildings. The Base Supply Buildings were eliminated based on further desktop evaluation which did not identify documented storage or release of AFFF at these buildings (Amec Foster Wheeler, 2015).

Following the 2018 SI, two additional potential source areas were identified for investigation during the PFAS RI based on research that suggested potential AFFF impacts:

- Area 23 – Base Laundry, referred to as “Base Laundry”; and,
- Area 24 – Former Jet Engine Test Cell, referred to as “Former Jet Engine Test Cell (FJETC)”.

This resulted in 23 total source areas investigated as part of the PFAS RI.

1.2.6 Regulatory Guidance

This section summarizes federal and state regulatory guidance on PFAS, which has evolved since the inception of PFAS investigations at Loring.

USEPA Guidance

In 2009, USEPA published provisional health advisories for PFOS and PFOA (USEPA, 2009). In 2016, USEPA revised these advisories and established a lifetime HA for either PFOS or PFOA or PFOS+PFOA combined where both are detected (USEPA, 2016a). In November 2017, the USEPA included PFBS, PFOA, and PFOS in the Regional Screening Level (RSL) calculator, although they were not published in the generic RSL tables. Toxicity values in the RSL calculator have been updated several times, additional PFAS have been added, and as of November 2024 (the most recent RSL update) PFAS are included in the generic published RSL tables (USEPA, 2025).

In April 2024, the USEPA announced a final National Primary Drinking Water Regulation (NPDWR), also known as a Maximum Contaminant Level (MCL), for the following PFAS (USEPA, 2024a):

- PFOS – 4.0 nanograms per liter (ng/L)
- PFOA – 4.0 ng/L
- PFHxS – 10 ng/L
- Perfluorononanoic acid (PFNA) – 10 ng/L
- Hexafluoropropylene Oxide Dimer Acid (HFPO-DA) – 10 ng/L
- A Hazard Index for PFHxS, PFNA, PFBS, and HFPO-DA – 1 (unitless)

Apart from PFHxS, the USEPA Tapwater RSLs are lower than the USEPA MCLs for PFAS compounds. The RSLs referenced in this report are based on the most updated toxicity values from the USEPA as of November 2024. These RSLs reflect lower SL values than those referenced during the planning and execution of the PFAS RI field work and, in some cases, SL values lower than the laboratory method detection limit (MDL) for certain media.

As PFAS is an emerging contaminant, laboratory analysis methods have evolved alongside regulatory guidance since the inception of PFAS investigations at Loring. USEPA PFAS analysis method, Method 1633, was finalized in January 2024 and used to analyze samples throughout the latter half of the PFAS RI, superseding modified Method 537 (Method 537M) for each media apart from finished drinking water. USEPA Method 1633 can analyze for additional PFAS compounds and has lower MDLs than Method 537M; however, SL values for certain compounds are still below the MDL for certain media even with the updated method.

For this report, groundwater concentrations are compared to USEPA SLs and MCLs in the tables and applicable USEPA MCLs on the figures. This approach allows for the evaluation of nature and extent of PFAS impacts compared to the MCLs, and will inform future study efforts in areas where sufficient delineation of the RSL was not possible due to the current MDL. Concurrence was reached in a meeting between AFCEC, USEPA, and MEDEP on 11 March 2025 to apply the MCLs when presenting contaminant distribution in groundwater. **Table 1-3** presents the project-specific SLs.

Department of Defense Guidance

On 3 September 2024, the DoD issued a policy memorandum entitled Prioritization of Department of Defense Cleanup Actions to Implement the Federal Drinking Water Standards for Per- and Polyfluoroalkyl Substances Under the Defense Environmental Restoration Program, establishing the DoD's plan to incorporate the USEPA NPDWR into ongoing PFAS cleanup efforts. As part of the September 2024 policy memorandum, the DoD stated that it would begin cleanup efforts at installations by addressing wells with PFAS concentrations at or above three times the USEPA MCL values, resulting in the following actionable levels for drinking water:

- PFOS – 12 ng/L
- PFOA – 12 ng/L
- PFHxS – 30 ng/L
- PFNA – 30 ng/L
- HFPO-DA – 30 ng/L
- A Hazard Index for PFHxS, PFNA, PFBS, and HFPO-DA – 3 (unitless)

In January 2025, the DoD adopted the RSLs published by USEPA in November 2024 (DoD, 2025), which are included in **Table 1-3**.

State of Maine Guidance

On 21 June 2021, the State of Maine passed an Emergency Resolve to set an interim drinking water standard for community water systems not to exceed 20 ng/L for six PFAS alone or in combination. The six compounds include PFOS, PFOA, perfluoroheptanoic acid (PFHpA), PFNA, PFHxS, and perfluorodecanoic acid (PFDA) (State of Maine, 2021). This drinking water standard is commonly referred to as the Sum of Six and is referenced as such throughout this report.

A statewide study on background soil concentrations was contracted by the MEDEP and completed in 2022 (Sanborn Head, 2022). The purpose of this study was to collect soil samples and quantify background concentrations of PFAS in Maine shallow soils. The evaluation of soils included samples collected from across the state in various urban and rural settings on state owned land. The report outlines soil background concentrations for nine compounds which had a 10% or greater detection frequency. The report provides a statistical analysis of these samples which allowed for the calculation of an interim background threshold value, intended to be used for comparison of discrete samples, and an interim upper bound of the mean, for comparisons of composite samples. The report notes that a sample

concentration lower than the applicable threshold background value does not necessarily demonstrate a lack of risk or eliminate the need to address that risk at a remediation site. The interim background threshold value and interim upper bound of mean in an urban setting are reported respectively as:

- Perfluorobutanoic acid (PFBA): $4.31*10^{-4}$ milligrams per kilogram (mg/kg) and $1.37*10^{-4}$mg/kg;
- Perfluorohexanoic acid (PFHxA): $1.49*10^{-3}$ mg/kg and $2.19*10^{-4}$ mg/kg;
- PFOA: $2.18*10^{-3}$ mg/kg and $3.94*10^{-4}$ mg/kg;
- PFNA: $1.93*10^{-3}$ mg/kg and $1.45*10^{-4}$ mg/kg:
- PFDA: $3.24*10^{-3}$ mg/kg and $9.4*10^{-5}$ mg/kg;
- PFBS: $7.4*10^{-5}$ mg/kg (an interim upper bound of mean value is not reported);
- PFHxS: $9.7*10^{-5}$ mg/kg (an interim upper bound of mean value is not reported); and
- PFOS: $3.036*10^{-3}$ mg/kg and $1.17*10^{-3}$ mg/kg (Sanborn Head, 2022).

The study was completed to inform decision making regarding future guidance documents and is not recommended for site-specific comparisons or compliance purposes and is not provided for comparison in this report.

1.3 REPORT ORGANIZATION

This document is organized into the following sections, consistent with USEPA guidance (USEPA, 1988c).

Section 1: Introduction

Section 2: Describes the physical characteristics and environmental setting of Loring.

Section 3: Summarizes the investigation approach to the PFAS RI field work.

Section 4: Presents area-specific analytical data results and characterization for Site media.

Section 5: Details the nature and extent of PFAS contamination in groundwater, migration pathways, and contaminant distribution, by areas designated as flow fields.

Section 6. Identifies and discusses Applicable, Relevant and Appropriate Requirements (ARARs).

Section 7: Discusses Site receptors and presents the results of the baseline human health and ecological risk assessments.

Section 8: Provides summary statements and conclusions of the PFAS RI.

Section 9: Lists the report references.

Attachments to this document include supporting PFAS RI figures, analytical data tables, and appendices containing PFAS RI field data records, data summaries, logs, diagrams, and analytical data reports which are referenced throughout the report.

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2.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

Loring is located approximately west longitude 67°89'21" by north latitude 46°94'56" in northeastern Maine, occupying approximately 9,000 acres in the community of Limestone in the lower Aroostook River Basin of Aroostook County. The following sections present the physical setting of Loring and are supported by **Figures 2-1 through 2-12** and **Appendices A through E.**

2.1 TOPOGRAPHY

Topography of the lower Aroostook River Basin is typified by gently rolling to steeply sloping ridges separated by narrow valleys. Elevations of the ridges range from 600 to 800 feet above sea level. Narrow swamps and bogs extend between the ridges. The valleys range in elevation from 500 to 600 feet above sea level. The topography of Loring is shown on **Figure 1-1**, with historic topographic contours displayed on **Figure 2-12**.

Most of Loring is located on a relatively flat plateau, particularly in the central portion between the Runway and Nose Dock Areas (NDA). This is also where the highest elevations generally exist, between 700 and 750 feet above sea level. The greatest changes in relief occur in the western portions of Loring, where westerly flowing drainage with the Little Madawaska has formed incised valleys and swales, resulting in more than 200 feet of relief between the Runway and the southwestern corner of the Site boundary, near Landfill 2.

2.2 DEMOGRAPHY AND LAND USE

Loring is bordered by four towns: Town of Limestone, City of Caribou, Town of Caswell, and Connor. The United States Census Bureau reports the following population statistics (United States Census Bureau, 2020):

- Town of Limestone
  - Population: 1,526
  - Households: 677
  - Racial makeup: 91.4% White, 5.9% Native American, 1.2% Black or African American, 0.8% Asian, 0.5% from two or more races.
- City of Caribou
  - Population: 7,396
  - Households: 3,547
  - Racial makeup: 92.3% White, 5.3% from two or more races, 1.1% Native American, and 0.5% Asian.
- Town of Caswell
  - Population: 293
  - Households: 128

  - Racial makeup: 93.2% White, 5.1% from two or more races, 1.7% Native American.
- Connor
  - Population: 418
  - Households: 166
  - Racial makeup: 89.2% White, 7.7% Native American, 2.9% Black or African American.

Within the Loring boundary, most of the land is owned by LDA, USFWS, and a private entity. Stakeholders owning parcels within the Loring boundary and current or potential future uses of the land are outlined below. Parcel boundaries and ownership, or privately owned property, within the former base boundary are presented on **Figure 2-1.**

- LDA owns one large parcel that encompasses most of the developed areas of Loring. Property uses on LDA parcels include commercial and industrial spaces, offices, a large composting operation, construction storage, a metal fabrication workshop, a hotel, and a potato chip factory (under construction at the time of report publication). A small residential community is also located within LDA parcels.
- USFWS owns largely undeveloped land as part of ANWR.
- A private entity owns several parcels, previously owned by the LDA, some of which have been redeveloped for solar photovoltaic energy production while others are being purposed for various commercial and industrial uses.
- The Bureau of Indian Affairs (BIA) owns several parcels in the southern portion of Loring which are managed by the Mi'kmaq Nation. These parcels are currently used for research study and may be used commercially. The Mi'kmaq Nation indicated they do not currently allow hunting, fishing, or foraging on this land.
- The Job Corps owns six parcels which offer applied job training opportunities to prospective students that live and train in their facilities.
- The Maine Army National Guard owns two parcels, one northwest of the runway, and another within one of the parcels owned by USFWS. These parcels are not currently used; however, they could be used for training purposes in the future.
- The DoD owns a parcel that is used by the Defense Finance and Accounting Services (DFAS). DFAS uses the property as office space for accounting services for the DoD.

Land use in communities surrounding Loring is primarily rural and agricultural. Historical records maintained by MEDEP indicate sludge, the byproduct of wastewater treatment systems, was spread in agricultural fields south of Loring (MEDEP, 2024). **Figure 2-2** shows the extent of agricultural lands surrounding Loring, as well as MEDEP documented sludge utilization sites. There are no records of sludge use within the Site boundary.

2.3 CLIMATE

The following information was collected from the Caribou Weather Forecast Office and reflects a 10-year average from 2014 to 2024.

Loring is located near the 47-degree north latitude in the northern temperate zone. The average annual local temperature is 41.8 degrees Fahrenheit (°F); monthly mean temperatures vary from 14.3°F in January to 68.1°F in July. The mean annual local precipitation is approximately 40.6 inches. Precipitation is distributed throughout the year, with no month averaging less than 2.4 inches. A considerable percentage of precipitation at Loring occurs as snowfall, with an average of 129.5 inches per year (Caribou Weather Forecast Office, 2025). The dominant wind direction at the Site is west, with an average wind speed of 9 miles per hour and gusts up to 25 miles per hour (Windfinder, 2025).

2.4 SITE INFRASTRUCTURE

Loring is partially paved and developed with a runway, roads, and buildings, as well as landscaped fields and open space. Approximately 3,126 acres (36%) of the land surface within Loring is classified as developed based on the 2023 National Land Cover Database (Earth Resources Observation and Science Center, 2024). The undeveloped portions are a mix of mature fir and spruce forests with shrub, forested, and emergent wetlands (Earth Resources Observation and Science Center, 2024).

The western side of the Site includes two capped landfills, Landfill 2 and Landfill 3, occupying 14 acres and 24 acres respectively. Both landfills were built on land historically quarried for gravel during construction of the Site. While Loring was still operating as a base, these landfills were used for disposal of base-related waste before they were subsequently capped. Additional historical quarry sites include a former limestone quarry located west of the NDA (the Quarry Site) and a former sand and gravel quarry in the southwest area of Loring (Chapman Pit).

Subsurface infrastructure features include the storm sewer system and the sanitary sewer system, **Figure 2-3**. The NDA, north and central portions of the flightline discharge to the headwaters of the FLDD through three legs of the storm sewer system and the associated underdrain piping that discharges through three separate culverts. Storm sewers on the southwest side of the flightline area lead to culverts that discharge along the length of the FLDD. Drainage on the western side of the NDA discharges to the West Branch Greenlaw Brook (WBGB) through storm systems, three culverts, drainage swales and intermittent drainages. The north end of the NDA discharges to the Butterfield Brook Drainage through a storm sewer system that drains to the east. The eastern portion of the runway flows toward Butterfield Brook Drainage through a series of storm sewers that lead to small un-named drainages and swales. Storm sewers along the southern end of the flightline discharge to a single culvert in the headwaters of a tributary of the EBGB.

The sanitary sewer system underlies Site structures and ultimately carries wastewater to the WWTP including inflow from roof, foundation, and cellar drains. Evaluation of data from the Limestone Water and Sewer District indicates groundwater is infiltrating the sanitary sewer system. Portions of the sanitary sewer system that are currently unused have been diverted to the storm sewer system (Wright-Pierce, 2006).

Prior to 1960, the bedrock aquifer was the principal source of drinking water for Loring and the surrounding community. Loring operated several deep bedrock production wells throughout the Site (ABB, 1997b). However, the use of bedrock groundwater as the primary drinking water source was discontinued in the 1960s due to insufficient yield from the wells. Until Loring's closure in 1994, bedrock wells still supplied water for non-potable and fire suppression purposes to the East Loring area. The bedrock aquifer is currently used as a non-potable water supply at several locations within Loring and as a drinking water supply for abutting parcels outside of the Site boundary. Caribou is partially served by a public water supply from surface water sources, including water from the Aroostook River. The town of Limestone obtains water from bedrock wells near Limestone Stream, with Durepo Reservoir as a secondary water supply.

The LDA operates a community public water system that serves Loring. The system obtains water from a reservoir on an impounded section of the Little Madawaska River, upstream of Loring.

Loring wastewater is treated at the LDA WWTP at the southwest corner of the boundary. The LDA WWTP also receives and treats sanitary wastewater from the Town of Limestone wastewater system. From the LDA WWTP, treated sanitary wastewater is pumped to the CUD WWTP along Grimes Road in Caribou, and is subsequently discharged to the Aroostook River (Wright Pierce, 2018).

2.5 GEOLOGY

2.5.1 Soils

Regional mapped surface soils include the Caribou-Conant Association, the Easton-Burnham complex, and the Mapleton Series, **Figure 2-4**. The parent material is calcareous till derived from shale or limestone. Other soils mapped in the area have a parent material of till derived from slightly acidic shales and slates. These soils are primarily gravelly loams and silt loams (NRCS, 2022).

Surface soils at Loring are predominantly of the Caribou-Conant Association which includes gravelly loam and silt loam. Reworked surface soils and fill are present in developed areas across Loring. **Figure 2-4** presents "made land" where fill materials have been classified by the Natural Resources Conservation Service National Cooperative Soil Survey (NRCS, 2022).

The hydric soils at Loring correspond with poorly drained wetlands. Shallow groundwater is present in these soils year-round or seasonally with a water table of approximately one foot below ground surface (bgs). These regions have been classified as the Easton-Burnham complex with a silt loam texture transitioning to a higher proportion of gravel with depth (NRCS, 2022).

Lithological characteristics of samples collected during the PFAS RI were logged in the field based on visual examination and manual tests in accordance with the Unified Soil Classification System (USCS). Photographs of select logged samples are included in **Appendix A,** deviations from logging procedure are included in **Appendix B**, and field data records are provided in **Appendix C.** Lithological characteristics of soil vary throughout Loring and range from a heterogenous mixture of silt, sand, and gravel consistent with glacial deposits to mixtures of fine to coarse sand and gravel consistent with glaciofluvial deposits, **Appendix C-2**.

2.5.2 Overburden Geology

The regional overburden geology is presented on **Figure 2-5**. The surficial geology of northeastern Maine is characterized by Pleistocene glacial and post-glacial deposits. These deposits are comprised primarily of glacial tills, stratified sand and gravel, and post-glacial alluvial or peat deposits. The uppermost Pleistocene deposits on or around Loring typically consist of either unstratified till in direct contact with the bedrock, glaciofluvial deposits, or stagnation moraine deposits (Maine Geological Survey, 2002).

Glacial till is the dominant surficial deposit at Loring. Glacial tills are made up of dense, poorly sorted silts, sands, and gravels, with smaller percentages of clay and cobbles. The gravels and cobbles are often angular to subangular clasts in the finer sand and silt matrix. The glacial till typically directly overlies bedrock in widely variable thickness, from a thin cover to much greater thickness in bedrock topographic lows. During base development, the glacial till was often used for fill material to level out the topography and infill low lying areas. This reworked till used as fill material was observed as difficult to differentiate from the underlying native material during PFAS RI field investigation activities.

During the most recent glaciation, glaciofluvial deposits were left by flowing water associated with the melting of the glaciers. As these sediments are deposited, the finer fraction often "washes out" and is carried farther downstream, depositing predominantly sand and gravel locally. These types of deposits are often layered with rounded to subrounded sand and gravel grains. Glaciofluvial deposits have been identified along the western portion of Loring. During construction, the glaciofluvial deposits underlying what is now the landfill areas and Chapman Pit were mined extensively for fill material and to produce concrete. Glaciofluvial sand and gravel deposits are variably present in several stream valleys throughout Loring, most notably within the East Branch of Greenlaw Brook drainage systems and near the landfills along the western side of the Site boundary (Maine Geological Survey, 2002).

Stagnation moraine deposits are identified to the northeast of Loring, in the headwaters of Butterfield Brook. These deposits are characterized as being largely glacial till, however they contain variable percentages of stratified sand and gravels. These deposits are attributed to the deposition of material during the dissipation of stagnant glacial ice (Maine Geological Survey, 2002).

Post glacial deposits of organic rich sediment and peat are locally present in ponds and bogs. Stream alluvium deposits are identified along the Little Madawaska and Aroostook Rivers. While the alluvial deposits are not mapped at Loring, faster flowing sections of Greenlaw Brook and Butterfield Brook have been observed to exhibit a limited extent of alluvial deposits below map scale, **Appendix C-17**.

2.5.3 Bedrock Geology

The bedrock underlying Loring and the surrounding area is mapped as the Carys Mill Formation (Pavlides, 1968), **Figure 2-6.** This formation is described as a sequence of thinly interlayered micritic limestone, called ribbon limestone, and calcareous phyllitic slate and is upper Ordovician to lower Silurian age (Maine Geologic Survey, 1987). The limestone can vary from competent and lightly fractured to heavily fractured and weathered, as recorded in monitoring well boring logs in **Appendix C-4**.

The regional bedrock structural system is mapped in detail to the west and southwest of Loring in the Maine Geological Survey Reconnaissance map (MGS, 1987), **Figure 2-7**. The regional structural geologic setting includes a series of mapped anticlines and synclines, intermittently offset by faults and fault zones of various sizes, oriented generally from the northeast to southwest. Fault zones and deformation are oriented roughly perpendicular to the predominant bedrock orientation, trending roughly northwest to southeast. The extent of the detailed structural mapping from historic sources does not extend to Loring, however the overall structural system will be consistent at Loring (ABB, 1997b).

The structural trends in the bedrock underlying Loring are consistent with the overall regional bedrock structural setting. Base-wide bedrock structural features are presented on **Figure 2-8,** which is a compilation of the bedrock topography, interpreted anticlines and synclines, interpreted photolineaments, and rose diagrams from borehole geophysics completed in bedrock monitoring wells. The Basewide Groundwater Operable Unit (OU 12) RI at Loring included extensive use of borehole geophysical logging and allowed interpretation of the location of several large-scale folds across Loring, as well as areas where the fold limbs had been faulted, which are displayed (ABB, 1997b). The existing structural information collected during the OU-12 RI are supplemented with results from this PFAS investigation, including a refined bedrock topography map and additional borehole geophysical results collected from new monitoring wells, **Appendix D**. These data provide base-wide information of the orientation of sedimentary bedding within the Carys Mills Formation and the orientation of other joint and fracture systems that are important to the movement of groundwater in bedrock.

The identified and interpreted structural features are consistent with the larger regional system, generally trending northeast to southwest. The overall trend of the sedimentary layers in the bedrock, displayed as the strike on the rose diagrams, is generally northeast to southwest, however there is variability consistent with the regional system. The bedrock structure consists of a series of anticlines and synclines, generally oriented northeast to southwest. A portion of these structural features are offset along fault zones. High altitude aerial photography was used to identify fault related lineaments of both local and regional scale throughout Loring (ABB, 1997b). The lineaments and identified structural features are often mapped consistent with the trend of surface water drainages. These surface water drainages can coincide with relative weak zones in the bedrock where the drainages will be preferentially eroded compared to the surrounding area, particularly during glacial periods. The portrayed structural geologic interpretation provides the framework for understanding the bedrock groundwater system (ABB, 1997b).

2.6 HYDROGEOLOGY

Three hydrostratigraphic units, geologic formations characterized by distinct hydrogeologic properties, underly Loring and the surrounding area. These include discontinuous overburden groundwater hosted in glacial tills with low permeability, more transmissive overburden sand and gravel aquifers hosted in several distinct mapped stratified drift deposits, and a fractured bedrock (FBR) aquifer (ABB, 1997b).

In addition to the three primary hydrostratigraphic units, the impacts of Site development, such as the reworking of native material and input from sand or gravel deposits, and activities at the Site quarry, have resulted in changes to the behavior of the groundwater system. Underground piping from the storm and sanitary sewer systems, and the envelope of fill material in the trenching dug to install this piping, can act as preferential pathways for groundwater flow. Loring infrastructure is discussed in **Section 2.4**.

The depth to overburden groundwater typically varies from less than 1 foot to more than 35 feet bgs, **Appendix C-2** and **Appendix C-4**. Artesian conditions in overburden and bedrock wells have been observed within groundwater discharge areas, **Appendix E-1**.

2.6.1 Overburden Groundwater

Overburden groundwater is present in either glacial till or in sand and gravel deposits (ABB, 1997b and **Appendix C-4**).

2.6.1.1 Glacial Till Aquitard

The glacial till that comprises most of the overburden deposits at Loring are considered an aquitard because of their low permeability. Overburden groundwater associated with the till deposits across Loring are generally discontinuous or perched except in the vicinity of major streams and drainages where overburden water table is present. The presence of saturated overburden near drainages is a result of upward hydraulic gradients from bedrock to overburden driven by changes in topography of the land surface and the bedrock surface, **Appendix E-4**.

2.6.1.2 Sand and Gravel Aquifer

Sand and gravel deposits at Loring are associated with glaciofluvial deposits and are generally found on the western side of Loring, with locally stratified sand and gravels associated with the stagnation moraine mapped on the northeast side of Loring. The glaciofluvial deposits are composed predominantly of sand and gravel and have higher permeability than the finer grained till deposits. Glaciofluvial deposits have been mapped as sand and gravel aquifers in the western portion of Loring (in the area of and southeast of Landfill 2, Landfill 3, and Chapman Pit). The sand and gravel stratified deposits associated with the stagnation moraine are more limited in extent than the glaciofluvial deposits, existing locally within a larger system that is predominantly composed of till (Maine Geological Survey, 2002).

2.6.2 Fractured Bedrock Aquifer

Groundwater movement in the bedrock is primarily driven by the presence of open and interconnected fractures and the location of discharge areas. Bedrock groundwater flows preferentially along joints and fractures in the rock, which can be parallel or orthogonal to the primary northeast to southwest trending bedrock structure. Previous investigations at Loring indicate the transmissivity increases in areas with higher degrees of weathering, especially in the vicinity of bedrock groundwater discharge areas coincident with faults and fold structures (ABB, 1997b). Examples of these include the FLDD, EBGB, and WBGB. Areas where there is less weathering and bedrock transmissivity is lower or very low include topographic highs, such as in the area of the Quarry, and the northern end of the flightline and the Nose Dock Area (ABB, 1997b).

The FBR is an aquifer potentially capable of producing large quantities of water, as demonstrated by past pumping tests at Loring (ABB, 1997b). Field investigations at Loring indicate that available groundwater in the bedrock resides in secondary openings (e.g. joints, faults, cleavage planes, and fracture zones) as opposed to primary rock matrix porosity. Because primary porosity is less than one percent of the rock volume in this limestone formation, the yield available to a bedrock well depends on the size, frequency of occurrence, and degree of interconnection between water-filled secondary openings. Some fractures coincide with bedding planes, whereas others cut through those beds. The frequency, orientation, and connectivity of small-scale bedrock features in the rock, such as joints or bedding planes, and the presence of large-scale structural features, such as faults and fracture zones, are important in determining the rate and direction of groundwater movement in bedrock.

Analysis of specific capacity data and other hydrological data collected during the OU12 RI suggest the upper 45 feet of bedrock (shallow bedrock) is well-connected and has greater water-bearing capacity than deeper rock (greater than 100 feet into bedrock) (ABB, 1997b). This increase in the transmissivity in the upper bedrock groundwater system was attributed to the weathering of existing fractures and bedding planes. Based on a comparison of seasonal water level data in shallow and deep bedrock wells with minimal vertical head differences observed during static head packer tests and deep pumping test results, the OU12 RI concluded a weak hydraulic connection exists between the shallow and deep bedrock systems (ABB, 1997b).

2.7 SURFACE WATER HYDROLOGY

Loring is situated on a gently sloping plateau north of the Aroostook River and is in the lower Aroostook River basin within the St. John drainage basin. The Aroostook River flows southeast from Caribou and then northeast into New Brunswick, Canada, where it discharges into the St. John River. Regional drainage features are shown on **Figure 1-1**.

The local drainages that discharge directly to the Aroostook River are Limestone Stream and the Little Madawaska River. Limestone Stream and its tributaries are east and southeast of Loring. The Little Madawaska River and its tributaries are west and southwest of Loring, **Figure 1-1**. Several unnamed tributaries of both river systems pass through the Site, including Greenlaw Brook and Butterfield Brook.

For clarity of discussion in this report, these unnamed tributaries have been designated as Tributaries 1 though 9**.** The headwaters of Greenlaw Brook, which begin within Loring boundaries, include the East Branch and West Branch of Greenlaw Brook**, Figure 2-9**. The headwaters of Butterfield Brook are located to the north and northeast of Loring, however several smaller tributaries begin within the boundaries such as Tributaries 1, 2, and 3.

The Butterfield Brook drainage basin is generally east of the runway. Butterfield Brook and its tributary, Willard Brook, are located on the eastern side of Loring and comprise the primary drainage system for the East Loring area. The headwater of Butterfield Brook is Butterfield Lake, north of Loring. Butterfield Brook flows south and enters ELL. ELL is a manmade lake approximately 27 acres in size with depths approximately 10 feet. This reach of Butterfield Brook receives discharge from the storm sewer system, which drains eastward along the flightline and the FTA and the northern portion of the NDA, as shown in the Butterfield Brook drainage basin depicted on **Figure 2-9**. Much of this runoff eventually flows into ELL. Butterfield Brook continues southeast from the outlet of ELL, merges with Willard Brook, and flows southeast off-base to Durepo Reservoir in the town of Limestone. Durepo Reservoir is manmade and is approximately 30 acres in size. Limestone Stream flows out of the reservoir to the Limestone River, which flows into New Brunswick, Canada, and eventually discharges to the Aroostook River.

The WBGB and EBGB drainage basins are west of the runway. The EBGB originates within Loring and receives drainage from the FLDD, which collects runoff from the NDA, the flightline, and the runway via storm sewer system outfalls, as depicted in the EBGB drainage basin on **Figure 2-9**. The EBGB also drains the southern portion of the flightline, the KC-135 Crash Site, the FTF, Base Laundry, and the Burn House. The WBGB headwaters are north and northwest of the Nose Docks. The brook flows south receiving discharge from the Quarry Site at the northern end of the flightline and NDA. Further downstream, the former North Wherry housing area contributes surface runoff before the east branch and west branch of Greenlaw Brook merge south of Chapman Pit. Several storm sewer outfalls discharge runoff from the northern end of the flightline, the western side of the NDA, and developed areas on the west side of Loring to the WBGB. Malabeam Lake and Chapman Pit are surface water bodies within the drainage area through which the WBGB flows prior to its confluence with the East Branch. Malabeam Lake is a man-made lake approximately 8 acres in size with approximate depths of 13 feet. Chapman Pit, created in the footprint of historic sand and gravel mining operations, is approximately 6 acres in size, with depths approximately 21 feet. A small earthen dam is present on the south end of Chapman pit which maintains the water levels at a constant elevation. The brook flows southwest from Loring, discharging into the Little Madawaska River.

Stream flow fluctuates seasonally and after precipitation events. It has been estimated that for the 40.6 inches of average annual precipitation in the area, approximately 50 percent discharge to streams as direct runoff or as groundwater discharge. Evapotranspiration accounts for 30-40 percent of precipitation within the local hydrologic cycle. The remaining 10-20 percent of the annual precipitation in Maine is estimated to result in groundwater recharge (Maine Geological Survey, 2025).

The distribution of surface water bodies at Loring are the result of the relative changes in topography, driving overland flow, and the discharge of groundwater. This means that the drainage divides provide the basis for the transport from source areas to potential receptors. These divides are used in this report to group source areas into more manageable packages of areas which have common receptors, to facilitate ease of discussion and data presentation. The boundaries of these packages, referred to as flow fields, are presented in **Figure 2-9** in relation to the surface water divides. Further discussion of the flow fields is presented in **Section 3**.

2.8 ECOLOGY

The ecology of Loring is diverse and includes forests, wetlands, protected species, and a range of terrestrial and aquatic wildlife.

Forest trees at Loring and in the surrounding area include balsam poplar, big-tooth aspen, trembling aspen, and tamarack. Many of these wooded areas were once used as fields to farm potatoes. In areas in and around Loring that were unsuitable to use as land for growing crops, red spruce and balsam fir are the dominant tree types. Past disturbances from timber harvesting are evident in forested wetland areas around Loring and these areas are now dominated primarily by tamarack or red maple trees. These forests are home to a large variety of wildlife including animals such as American black bear, moose, and Canada lynx (Aroostook National Wildlife Refuge, 2025a).

The Upland Sandpiper, a protected species within the state, is found at Loring near the Runway, Nose Docks, and a small part of farmland east of Loring. Sandpipers occupy these areas due to their diet, consisting mainly of insects, which leads them to forage in the lower grasslands (Maine Department of Inland Fisheries and Wildlife, 2023). Many of the aspects of their diet can serve as potential ecological receptors for chemicals of potential concern (COPCs) found on Loring.

Wetland environments at and surrounding Loring are shown on **Figure 2-10.** Wetlands found in the areas of the Lower Little Madawaska River and along Limestone Stream are mapped National Wetlands Inventory (NWI) wetlands. These NWI wetlands areas can be found within the former base boundaries and are habitat for inland wading bird and waterfowl, **Figure 2-11**. Much of the land in and around Loring is designated for conservation and is owned by the USFWS, including ANWR, which provides habitats and promotes a diversity of wildlife (Aroostook National Wildlife Refuge, 2025b).

The Aroostook River is habitat for a diverse fish and wildlife population. This includes both rearing and spawning habitats for brook trout and Atlantic Salmon. The Aroostook River supplies habitats for furbearers such as muskrat, beaver, otter, and mink. The Aroostook wood turtle is found in backwaters. Regional water bodies support a large population of native brook trout, also found commonly in the smaller brooks and streams. The Aroostook River supports a small population of Atlantic salmon due in part to restoration efforts by Atlantic Salmon for Northern Maine and the Atlantic Salmon Federation (Bangor Daily News, 2022).

The Maine Center for Disease Control (CDC) has fish consumption advisories for fish from Durepo Pond and Limestone Stream to the Canadian border (Maine Department of Health and Human Services, 2022). The consumption advisories are based on levels of PFAS in fish samples from these water bodies exceeding Maine CDC's recommended levels for regular consumption. The consumption guidelines recommend no more than four meals per year of brook trout and no consumption of smallmouth bass from Durepo Pond and Limestone Stream to the Canadian border (Maine Department of Health and Human Services, 2022).

Fishing for for brook trout at Loring can occur in the following areas:

- Greenlaw Brook
- Malabeam Lake
- Chapman Pit
- Butterfield Brook
- ELL
- Durepo Reservoir and,
- Limestone Stream.

Ecological risk assessments (ERAs) have been conducted on different study areas at Loring. In 1997, ERAs were conducted for OU-13 on study areas including: Wolverton Brook/Brandy Brook, FLDD and FLDD wetlands, SCF, the East and West branches of Greenlaw Brook, Little Madawaska River, and Butterfield Brook/Limestone Stream. These study areas were investigated for COPCs including VOCs, SVOCs, PAHs, pesticides and PCBs, and metals (ABB Environmental Services, 1997a).

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3.0 STUDY AREA INVESTIGATION

This PFAS RI was conducted using an iterative approach, based on the results of the SI conducted in 2018. The results of each investigation informed the basis of additional investigations, which were documented in technical memoranda presenting documentation of field sampling activities, results, and data gaps. Technical memorandums also outlined the investigation approach for the next phase of work. Tasks conducted in this PFAS RI were designed to evaluate the nature and extent of PFAS contaminated media and address data gaps identified during previous investigations, outlined in **Section 1.2.5**. The following section outlines the PFAS RI organization and the work plans implemented to conduct the investigation work.

3.1 FLOW FIELD DESIGNATIONS

To facilitate the discussion of the nature and extent of contamination, PFAS source areas are grouped into six hydrogeologic units called flow fields. Flow fields group source areas that have similar groundwater and surface water flow pathways to common receptors. The flow fields fit within the larger watersheds of Greenlaw Brook and Butterfield Brook. This presentation is intended to facilitate the discussion and presentation of data by grouping source areas based on geography and drainage basin divides. The six flow fields and their respective source areas are outlined in **Table 3-1** and shown on **Figure 3-1.**

The Runway runs northwest to southeast across the length of Loring. A surface water and groundwater drainage divide between the Greenlaw Brook and Butterfield Brook watersheds exists located approximately aligned with the Runway, **Figure 3-1**. These drainage pathways are influenced by the Runway storm sewer system. Portions of the storm sewer transfer runoff from one flow field to another, specifically at the north end of the NDA. The Runway serves as the primary divide between the eastern flow fields, #1 and #2, from the western flow fields, #3 through #6.

3.1.1 Source Areas

The 2018 SI investigated and confirmed 21 source areas with PFAS exceeding the contemporaneous SLs. These source areas were recommended for further investigation (Wood, 2018). These sources included:

- Flow Field #1 - B-52 Crash Area; FTA; and northeast portion of the Runway;
- Flow Field #2 - Southeast portion of the Runway;
- Flow Field #3 – FDA; Nose Dock 11; Aircraft Hardstands; Hardstand 19; Ramp 1; Nose Dock 44 and Nose Dock 40; northwest portion of the Runway;
- Flow Field #4 - CFS; Arch Hangar; JEMS; SFS; the FLDD and SCF; KC-135 Crash Area; southwest portion of the Runway; FTF; the Burn House; and the LDA WWTP;
- Flow Field #5 – Landfill 2; and
- Flow Field #6 – Landfill 3.

Following the 2018 SI, two potential source areas were identified for investigation during the PFAS RI based on research that suggested potential AFFF impacts:

- Area 23 – Base Laundry, referred to as "Base Laundry"; and,
- Area 24 – Former Jet Engine Test Cell, referred to as "Former Jet Engine Test Cell (FJETC)".

These additional source areas are in the following flow fields:

- Flow Field #3 – FJETC
- Flow Field #4 – Base Laundry

3.1.2 Flow Field #1 Source Areas

Flow Field #1 is in the northeast portion of Loring, to the east of the Runway and in the Butterfield Brook drainage basin, **Figure 3-1**. The flow field is characterized by its groundwater and surface water flow towards the northern end of Butterfield Brook, including ELL.

B-52 Crash Area

AFFF was applied at the north end of the Runway in response to a crash of a B-52 aircraft on 28 December 1984; an unknown quantity of AFFF was released. The local storm sewer system that drains the north end of the Runway provides a conduit for AFFF transport from the release area to the stormwater outfall at Tributary 1 of Butterfield Brook.

The 2018 SI confirmed PFAS were present in groundwater above the contemporaneous SLs at two out of three locations and detections at the four soil and two sediment locations were below their respective contemporaneous SLs (Wood, 2018).

Fire Training Area

The FTA was used between 1970 and 1989 for fire training exercises, with AFFF used as the primary extinguishing agent. In 1995, remedial efforts were conducted in the FTA and include excavation of the fire pit area to the bedrock surface and excavation of the nearby drainage ditch. Excavated soils were disposed in Landfill 3 prior to construction of the remedial cap.

Additional remedial efforts in 1995 included a blast fractured recovery trench downgradient of the source area to increase the permeability of the local shallow bedrock to facilitate light non-aqueous phase liquid (LNAPL) recovery. Installation of this recovery trench resulted in the release of groundwater to the land surface from existing monitoring wells in the source area, potentially resulting in the spread of PFAS impacts over already excavated areas (Lane et al., 1996).

Several LNAPL recovery systems were operated through the 1990's with limited success due to the low productivity of the local FBR. The presence of LNAPLs can result in changes to the geochemistry of the aquifer, resulting in reducing conditions that can foul extraction wells and add complexity to treatment systems. LNAPL recovery systems were deemed ineffective in the 1999 OU12 ROD and institutional controls and long-term monitoring were proposed as alternatives. In 2013, a biosparge treatment system was implemented to address remaining petroleum impacts. It was expanded in 2014 and 2017, and continues operation today (APTIM, 2021).

The 2018 SI confirmed PFAS were present in groundwater above the contemporaneous SL at eight out of nine locations with detections in soils below its contemporaneous SL at the five locations sampled (Wood, 2018).

3.1.3 Flow Field #2 Source Areas

Flow Field #2 is on the southeast portion of Loring, to the east of the Runway and in the Butterfield Brook drainage basin, **Figure 3-1**. The flow field is characterized by its location on the east side of the Runway, with groundwater and surface water flow towards the southern end of Butterfield Brook, including the Durepo Reservoir. The Runway is the only source area in this flow field.

Runway

The Runway was subject to at least one testing exercise of a runway foamer, which was designed to distribute a layer of fire suppression foam on the Runway prior to an emergency landing. Testing required discharge of AFFF along the length of the Runway which was subsequently hosed down into drainage ditches, swales, or stormwater basins.

The 2018 SI confirmed PFAS were present in groundwater above the contemporaneous SL at one out of three locations with detections in soils at six locations below the contemporaneous SL (Wood, 2018).

Although the Runway is present on multiple flow fields, the Site history of the source area is detailed in this section, as the Runway is the only identified source area in Flow Field #2.

3.1.4 Flow Field #3 Source Areas

Flow Field #3 is in the northwest corner of Loring, to the west of the Runway and in the Greenlaw Brook Drainage Basin, **Figure 3-1**. The flow field is characterized by its location on the west side of the Runway, with groundwater and surface water flow generally towards the upper portion of the West Branch of Greenlaw Brook, although portions of this flow field are captured by the western side of the Butterfield Brook drainage basin.

Former Jet Engine Test Cell

The FJETC occupied approximately 1.2 acres and is where various tests on jet engines were performed, resulting in potential release of AFFF to the ground surface. A bioventing system was installed in 1995 to treat fuel-related compounds in soil and was operated until 2012; however, this would not be effective at reducing PFAS concentrations. In 2013, trichloroethene (TCE) contaminated soils at the area were excavated, land farmed and returned to the excavation. The exact location of land farmed soils was not reported, however aerial images indicate land farmed soils were placed in the southeast side of the Nose Docks and systems were put in place to capture runoff from the soils.

The FJETC was not identified as a potential source area in the PFAS SI and was not investigated at that time.

Fuel Dump Area

The FDA is located at the north end of Ramp Number 2. An estimated 1,000 gallons of AFFF was applied in response to the release of approximately 20,000-gallons of fuel from a fuel tanker truck to minimize fumes and prevent a potential fire.

The 2018 SI did not identify PFAS at the two groundwater, three soil, two surface water, or two sediment sampling locations above their respective contemporary SLs (Wood, 2018).

Nose Docks and Aircraft Hardstands

The NDA is located west of the Runway. Loring operations in this area included aircraft and munitions maintenance, aircraft fueling, and defueling operations at facilities located within the NDA. The Nose Docks were used for aircraft maintenance and were therefore outfitted with fire suppression systems in the event of a fire. Due to their proximity, the six NDA source areas have interconnected PFAS migration pathways. These specific areas and associated history are summarized below:

- Nose Dock 11: Approximately 100 to 200 gallons of AFFF was used to extinguish a B-52 aircraft fire at this location on 19 July 1970; however, the specific location of the release is unknown.
- Nose Dock 40: It was previously reported that this area contained an AFFF fire suppression system; however, after further research in 2015 it was confirmed that Nose Dock 44 was the actual location for the system. Nose Dock 40 is generally located downgradient from Nose Dock 44.
- Aircraft Hardstands: AFFF was applied periodically to fuel spills at these locations to protect aircraft and sensitive weapons. The northern end is currently utilized by a large-scale commercial composting business.
- Hardstand 19: Approximately 1,000 gallons of AFFF were applied to a fuel spill resulting from a broken fuel line on a B-52 in the early 1970s to minimize fumes and prevent a potential fire; however, the specific location of the release is unknown.
- Ramp #1: Approximately 500 gallons of AFFF were applied to a fuel spill at this location during unloading of a sensitive weapon to protect the aircraft and weapon.
- Nose Dock 44: There were four documented releases of AFFF from the fire suppression system, including one release during initial testing and calibration of the system, as well as three other activations of the system. These releases allowed AFFF to settle in and around the structure, impacting surface or shallow soils and sediment in the drainage swales.

Remedial activities that occurred to address legacy contaminants in this area include landfarming. The exact location of land farmed soils was not reported, however aerial images indicate land farmed soils were placed in the southeast side of the Nose Docks and systems were put in place to capture runoff from the soils.

The storm sewer system at Nose Dock 44 drains a portion of the western side of the Nose Docks, to discharge into one of two drainage swales west of Quarry Road. Floor drains in the Nose Dock Buildings also discharge to the local storm sewer system.

The 2018 SI confirmed PFAS were present at the Nose Docks and Aircraft Hardstands in groundwater above the contemporary HA standard at 18 out of 27 locations and in surface water above the contemporary SLs at the two locations sampled. Detections in soils were below the contemporary SL at the 15 locations sampled (Wood, 2018).

3.1.5 Flow Field #4 Source Areas

Flow Field #4 is the southwest quadrant of Loring, to the west of the Runway and in the Greenlaw Brook Drainage Basin, **Figure 3-1**. The flow field is characterized by its location on the west side of the Runway, with local groundwater and surface water flow to either the EBGB or WBGB and ultimately to their confluence at Greenlaw Brook.

Crash Fire Station

The CFS is located just south of the control tower and historically supported airfield operations with emergency fire suppression. The CFS stored AFFF in 55-gallon drums, 5-gallon buckets, and an approximate 750-gallon aboveground storage tank, and transferred the AFFF onto crash fire trucks. Daily and weekly testing of AFFF equipment was conducted that resulted in releases of approximately 5-gallons of AFFF per test to the concrete pavement or grassy areas outside the building. Annual calibration of the fire suppression system resulted in the release of AFFF in and around the building.

The 2018 SI confirmed PFAS were present at the CFS in groundwater above the contemporary HA standard at the two locations sampled and in soil above its contemporary SLs at one out of four locations sampled (Wood, 2018).

Structural Fire Station

The SFS was used to house vehicles and station personnel equipped to respond to structural fires. AFFF was used at the SFS during equipment calibration activities and testing exercises, resulting in releases to the ground surface in the area near the building. Additional details regarding the volume of AFFF stored at the facility and used for calibration and training exercises is limited.

The 2018 SI confirmed PFAS were present at the SFS in groundwater above the contemporary HA standard at two out three locations and in soil above the contemporary SLs at one out of five locations sampled (Wood, 2018).

Fire Department Training Burn House

The Burn House area was used for firefighter training, including the operation and use of AFFF systems, which resulted in the release of AFFF to the ground surface.

The Burn House is surrounded by a large, paved, relatively flat area with a slight downward slope to the north. A drainage ditch runs parallel to the road to the northeast. Bedrock groundwater flows to the west, towards the EBGB. Overburden groundwater is not present.

The 2018 SI confirmed PFAS were present at the Burn House in groundwater above the contemporary HA standard at the one location sampled and was detected in soil below its contemporary SL at the four locations sampled (Wood, 2018).

Fuel Tank Farm

The FTF is located on the south end of Loring and was constructed in the early 1950s for bulk fuel storage. The 35-acre area had several large aboveground storage tanks that primarily held jet fuel and heating oil. Fuel-related spills and leaks from piping, fueling, and stormwater runoff have been recorded throughout the history of Loring. AFFF was routinely applied to spills to minimize fumes and prevent potential fires. The amount of AFFF used at the FTF is unknown.

LNAPL was measured on the bedrock surface of the FTF and surrounding areas and product recovery wells were installed in the 1980s and operated through 1984. Remediation of the FTF site resumed in 1997 and involved a system designed to alternate between biovent and bioslurp (vacuum-enhanced dewatering) modes to reduce petroleum impacts. These remedial measures would not be effective at reducing PFAS concentrations.

This area is owned by the Mi'kmaq Nation and is currently open space and includes remnant oil storage infrastructure including aboveground tanks and distribution piping.

The 2018 SI confirmed PFAS were present at the FTF in groundwater above the contemporary HA standard at two out of eight locations and was detected at the four soil, two surface water, and two sediment locations below their respective contemporary SLs (Wood, 2018).

Arch Hangar

The Arch Hangar was built to store and maintain two B-36 Bombers at one time. Construction on this building was completed by 1949. Facilities related to aircraft maintenance and cleaning such as the corrosion control shop, the non-destructive inspection lab, and the aircraft wash rack were reportedly located in the Arch Hangar. The facility reportedly stored AFFF periodically throughout its use as a maintenance facility, however there was no AFFF fire suppression system. The Arch Hangar was a hazardous waste accumulation point during base realignment and closure in 1994 and was deactivated shortly thereafter.

Drainage lines connecting the Arch Hangar to a WWTP that pretreated flow prior to discharge to the larger sanitary sewer were excavated in 1995 as part of OU 10 activities. Excavated soils were taken to Landfill 3 and placed under the cap installed as part of the Landfill 3 remediation. Clean soils were used to backfill this area.

The Former Solvent Storage Building was located directly off the northeastern corner of the Arch Hangar. The building was used to store paint thinner and solvents for aircraft maintenance but was removed in 1986. Soils were excavated and removed from an area just northeast of the Arch Hangar in 1995 and 1996 as part of a removal action focused on residual petroleum contaminated soil identified during OU 12 RI activities.

The 2018 SI confirmed PFAS were present at the Arch Hangar in groundwater above the contemporary HA standard at three out of six locations sampled. Detections in surface water were above the contemporary SLs at the one location sampled and detections in sediment were below the contemporary SLs at the one location sampled (Wood, 2018).

Jet Engine Maintenance Shop

The JEMS is located west of the flightline in the industrial area of Loring. Historical activities at the JEMS were associated with the draining, maintenance, repair, teardown, and modification of jet engines. From 1952 to 1991, the types of waste stored at the JEMS included paint waste, chemical waste, and mixed petroleum waste. In June 1994, a 55-gallon drum of AFFF was punctured by a forklift, resulting in a release of drum contents; however, no documentation was available regarding the specific spill location and/or the extent of the material released.

In a 1995 RI, contamination originating from cleaning agents/solvents, greases, oils, and paints were detected in soils in the vicinity of the JEMS. The subsequent response included the removal of contaminated subsurface soil north, south, and southwest of the JEMS building (HLA, 1998a). Excavated soils were taken to Landfill 3 and replaced with clean fill. A soil vapor extraction system was installed and operated until 2008. TCE impacted soils at the JEMS were excavated, treated by land-spreading, and returned to the excavation site.

The 2018 SI confirmed PFAS were present at the JEMS in groundwater above the contemporary HA standard at two out of five locations and was detected at the three soil and surface water locations below their respective contemporary SLs (Wood, 2018).

KC-135 Crash Area

An unknown quantity of AFFF was reportedly applied to a fuel spill resulting from the crash of a KC-135 aircraft off the southern end of the flightline in 1974.

The 2018 SI did not identify PFAS at the KC-135 Crash Area above the respective contemporary SLs at the nine soil, four groundwater, three surface water, or three sediment locations sampled (Wood, 2018).

Base Laundry

The Base Laundry facility became operational in 1971 and dry cleaning was performed as part of laundry operations. Although there is no written documentation of AFFF usage at the Base Laundry, there was the potential for clothing or other material covered in AFFF to go through the dry-cleaning process during

years of operation. Soil vapor extraction as well as soil excavation, landfarming, and the replacement of remediated soils impacted by CVOCs have been completed in this area.

The Base Laundry was not identified as a potential source area in the PFAS SI and was not investigated at that time.

Flightline Drainage Ditch and Spill Containment Facility

The FLDD and SCF are within the Greenlaw Brook drainage area. The FLDD consists of an unlined, open conveyance system in the trace of a perennial stream that was present prior to base development, which received stormwater drainage from a system of catch basins and culverts. Historic AFFF releases to the surface at other source areas would have been hosed down into the storm sewer system. Storm water and drainage from the FLDD ultimately passed through the SCF located at the southern end of the FLDD prior to discharge to the EBGB. The FLDD runs approximately 1 mile to its confluence with the EBGB.

The 2018 SI confirmed PFAS were present at the FLDD and SCF in groundwater above the contemporary HA standard at one out of two locations and was detected in the four sediment and four surface water locations below their respective contemporary SLs (Wood, 2018).

LDA Wastewater Treatment Plant

The LDA WWTP is located on the main stem of Greenlaw Brook and was used for processing wastewater from the sanitary sewer system, which contained AFFF. Sludge from the WWTP digesters was dried on the ground surface on the west side of the WWTP prior to disposal. The Limestone Water and Sewer District operates the WWTP and has a water supply well on the property that is not used as a potable water source but is used for non-potable water applications. Limestone Water District personnel estimated that the well is approximately 70 feet deep with a use of approximately 100-300 gallons a day.

The 2018 SI confirmed PFAS were present at the WWTP in groundwater above the contemporary HA at one out of two locations sampled (Wood, 2018).

3.1.6 Flow Field #5 and #6 Source Areas

Flow Fields #5 and #6 are on the west side of Loring, **Figure 3-1**. Landfill 2 is within Flow Field #5 and Landfill 3 is within Flow Field #6. Flow Field #5 is characterized by its location on the west side of the former sand and gravel mining operations, with local groundwater flow to the northwest towards Wolverton Brook. Flow Field #6 is characterized by its location on the eastern side of the former sand and gravel mining operations, with groundwater flow underlying Landfill 3 flowing to the northwest, towards Wolverton Brook. A minor component of groundwater flow to the southeast is identified on the eastern side of Flow Field #6 towards the WBGB.

Landfill 2 and Landfill 3

The area occupied by Landfill 2 and Landfill 3 was historically quarried for gravel during construction of Loring. From 1956 (when the gravel supply was exhausted) to 1974, the landfills were used as a waste disposal area. Resource Conservation and Recovery Act (RCRA) wastes (i.e., waste oil/fuels, solvents,

paints, thinners, hydraulic fluids) may have been disposed of in Landfill 2 and Landfill 3 prior to enactment of RCRA in 1976 (ABB, 1994). Between 1956 and 1968 wastes were typically burned and buried. In 1968, disposal of hazardous substances in the landfills was terminated. In 1974 Landfill 2 was covered with a foot of clean soil (ABB, 1994).

Approximately 3,500 cubic yards of polychlorinated biphenyl–contaminated soils were disposed of in two designed cells within Landfill 3 to segregate them from other contaminated soils (United States Air Force Conversion Agency, 2001). Other nonhazardous contaminated soil and debris may have been accepted in Landfill 3 between 1995 until closure in 1999. Remedial actions implemented for Landfill 2 and Landfill 3 include the installation of a low-permeability cap. The cap at Landfill 2 was completed in 1996. Construction of the Landfill 3 cap was completed in 2000.

The 2018 SI confirmed PFAS were present in groundwater above the contemporary HA at one out of nine locations in Landfill 2 and at one out of nine locations in Landfill 3 (Wood, 2018).

3.2 PFAS RI WORK PLANS

Investigations associated with the PFAS RI at Loring were conducted using an iterative approach, with the objectives and approach presented in multiple work plans.

The table below shows work plans and technical memoranda which provide the details associated with field activities conducted in association with the PFAS RI. The discussion in the subsections provides a summary of the objectives of each work plan. These plans were prepared in collaboration with and reviewed by the MEDEP and USEPA prior to implementing field work. Field activities were performed in accordance with these work plans and the Quality Program Plan (QPP) (Wood, 2022a; WSP, 2025a) unless otherwise noted in **Appendix B,** which provides a list of work plan deviations. The full references for the following work plans can be found in **Section 9**. Conceptual Site Models (CSMs) are presented in these documents and have been refined in subsequent work plans where necessary.

Document Titles	Date of Finalization	Date of Field Work	Reference
Final Existing Well and Surface Water Sampling Work Plan	15 October 2021	October 2021	Wood, 2021
Final New Well Installation and Existing Well Redevelopment and Sampling Technical Memorandum	03 May 2022	May – July 2022	Wood, 2022b
Final Remedial Investigation Work Plan	04 May 2022	May – October 2022	Wood, 2022c
Final Soil Boring and Bedrock Well Stepout Recommendations Technical Memorandum	26 July 2022	July – September 2022	Wood, 2022d
Final Additional Hydric Soil and Shallow Groundwater Sampling Locations Technical Memorandum	26 July 2022	September 2022	Wood, 2022e
Final Soil Sampling Round 3 Work Plan	09 August 2023	October 2023	WSP, 2023c

Document Titles	Date of Finalization	Date of Field Work	Reference
Final Groundwater Gauging and Sampling Work Plan	11 September 2023	May 2023 – December 2024	WSP, 2023a
Final Supplemental Stormwater Sampling Work Plan	16 October 2023	September – October 2023	WSP, 2023b
Final Well Installation Mobilization Two and Aquifer Testing Plan	18 May 2024	May – August 2024	WSP, 2024a
Final Supplemental Storm Sewer Sampling Plan	03 June 2024	June 2024	WSP, 2024b
Final Supplemental Storm Sewer Sampling Plan	04 February 2025	September – October 2024	WSP, 2025f
Final Forage Sampling Plan	27 June 2025	May – September 2024	WSP, 2025c
Final Sampling Plan to Support the Baseline Ecological Risk Assessment	27 June 2025	August – October 2024	WSP, 2025d
Final Soil Sampling Round 4 Plan	27 June 2025	September – October 2024	WSP, 2025e

Note:
Field work performed prior to finalization of the applicable work plan was approved via email or verbal concurrence with USEPA, MEDEP, and AFCEC.

A summary of the samples collected as part of the PFAS RI, including associated work plans and investigation objectives as outlined in this subsection, is presented in **Table 3-2.** PFAS RI data collection locations are shown on **Figure 3-2**.

3.2.1 Existing Well and Surface Water Sampling Work Plan

The objectives of the activities proposed in this work plan were to evaluate PFAS concentrations in key areas of Loring and nearby private and public drinking water wells to refine the focus and scope of the PFAS RI sampling and analysis program.

Proposed Field Investigation:

- Sampling groundwater from five previously sampled monitoring wells to:
  - confirm 2015 SI data and gain a better understanding of additional potential AFFF areas that were not originally identified during the PA, and
  - provide supporting data to update the CSM to facilitate additional field activity scoping efforts.
- Sampling of 12 offsite private and public water supply wells previously sampled to evaluate:
  - current PFAS concentrations, and
  - PFOS and PFOA migration pathways to potential offsite private and public water supply wells.
- Sampling surface water at eight locations in the Greenlaw Brook Drainage system and Butterfield Brook Drainage System to:

- evaluate surface water conditions on and offsite.

3.2.2 New Well Installation and Existing Well Redevelopment and Sampling Technical Memorandum

This technical memorandum provided recommendations for prioritizing new well installations, as well as redevelopment and sampling of existing wells.

Proposed Field Investigation:

- Redeveloping and sampling 145 existing wells to:
  - evaluate the potential for contaminant migration to impact offsite receptors,
  - evaluate the horizontal and vertical extent of PFAS in downgradient groundwater, and
  - provide data to guide selection of locations for new overburden and bedrock monitoring wells.
- Installing 27 new wells to:
  - evaluate PFAS concentrations downgradient of source areas, and
  - provide data to guide selection of locations of additional wells to evaluate extent and migration of PFAS

3.2.3 Remedial Investigation Work Plan

This work plan was designed to evaluate the nature and distribution of PFAS in soil, groundwater, surface water, sediment, and fish tissue and address data gaps identified during previous investigations.

Proposed Field Investigation:

- Collecting up to 208 soil samples in source areas using direct push technology to:
  - evaluate the horizontal distribution of PFAS, and
  - inform the locations of lysimeter installations.
- Collecting up to 34 soil samples using sonic drilling technology with a split spoon sampler for soil samples collected deeper than 10 feet bgs.
- Sampling hydric soil and shallow groundwater at eight locations east and west of the Runway to evaluate potential human exposure areas.
- Installing and sampling pressure-vacuum lysimeter pairs at up to four locations to support evaluation of PFAS fate and transport.
- Sampling soil at up to four locations to conduct Leaching Environmental Assessment Framework (LEAF) testing.
- Conducting a groundwater investigation to:
  - evaluate the lateral and vertical distribution of PFAS groundwater contamination migrating from source areas,
  - guide selection of locations for newly installed bedrock and overburden wells,

  - assess the relationship between bedrock and overburden aquifers, and
  - provide data to support human health and ERAs.
- Updating the existing groundwater flow model (MODFLOW) with data from the PFAS RI.
- Conducting a synoptic round of water level measurements to:
  - use in updating the groundwater model,
  - evaluate groundwater flow direction, and
  - evaluate vertical gradients.
- Installing and sampling up to 84 overburden and bedrock monitoring wells.
- Testing hydraulic conductivity on newly installed monitoring wells to update the existing numerical groundwater model.
- Sampling up to 82 surface water locations and 71 sediment locations to further evaluate extent of PFAS.
- Collecting up to 22 fish tissue samples to evaluate potential risks to human health.
- Sampling the stormwater sewer system to evaluate:
  - potential impacts from groundwater infiltration, and
  - contaminants migrating in surface runoff.
- Collecting PFAS samples from 13 public and private supply wells within the PFAS plume flow path.

3.2.4 Soil Boring and Bedrock Well Step Out Recommendations Technical Memorandum

This memorandum provided recommendations for step out soil boring locations, installation of deep bedrock wells, and installation of lysimeters to further evaluate the extent of PFAS above RSLs in soil and groundwater.

Proposed Field Investigation:

- Advancing 75 soil borings within or near twelve source areas in locations that stepped out from confirmed exceedances of the USEPA RSL.
- Installing 3 deep bedrock nested well pairs to:
  - further evaluate the vertical extent of PFAS in groundwater, and
  - provide data to evaluate the potential for migration of PFAS-impacted groundwater.
- Installing four lysimeters to evaluate the fate and transport of porewater infiltrating to groundwater through the vadose zone.

3.2.5 Additional Hydric Soil and Shallow Groundwater Sampling Locations Technical Memorandum

This memorandum presented recommendations for sample collection of hydric soils to evaluate

- potential risk to human receptors via direct contact,
- the potential for plant uptake of PFAS, and
- consumption of plants contaminated with PFAS.

Proposed Field Investigation:

- Sampling hydric soils at five locations to:
  - assess plant soil conditions, and
  - evaluate the presence of hydric soil in areas on or near tribal land that support natural growth of blueberries, labrador tea, and fiddleheads.

3.2.6 Soil Sampling Round 3 Work Plan

This work plan proposed further step outs from previously collected soil samples to better evaluate PFAS in unsaturated soil that may be contributing to PFAS leaching to groundwater, stormwater, and surface water.

Proposed Field Investigation:

- Sampling soil at 58 locations in 11 potential source areas.

3.2.7 Groundwater Gauging and Sampling Work Plan

This work plan proposed sampling to evaluate the nature and extent of PFAS in groundwater and to provide data to augment the CSM.

Proposed Field Investigation:

- Conducting two additional rounds of groundwater and surface water sampling (spring and fall) occurring four to five months apart to evaluate temporal variability.
- Continuing to measure water levels of between 394 and 472 monitoring wells through Fall 2024.
- Continuing seasonal groundwater sampling of existing and newly installed monitoring wells proposed in the PFAS RI Work Plan (Wood, 2022c) through Fall 2024.
- Continuing stream gauging data collection through Fall 2024.
- Installing five additional stream gauges.
- Developing monitoring wells installed in 2024.
- Developing existing wells added to the program prior to sampling.
- Continuing lysimeter sampling through Fall 2024.

3.2.8 Supplemental Stormwater Sampling Work Plan

Follow-up storm sewer sampling was proposed in this work plan to evaluate the source of PFAS contamination entering the storm sewer system identified during sampling conducted in 2022.

Proposed Field Investigation:

- Sampling 42 storm sewer locations to evaluate migration of PFAS from 13 potential source areas.
- Providing data to guide future sampling activities (such as soil sampling and new well installations) for evaluating migration of contaminants.

3.2.9 Well Installation Mobilization Two and Aquifer Testing Plan

This work plan was an extension of groundwater and hydraulic conductivity testing to further evaluate the vertical and lateral boundaries of PFAS in groundwater evaluate hydraulic conditions of overburden and bedrock lithology in support of fate and transport modeling.

Proposed Field Investigation:

- Installing five overburden and seven bedrock monitoring wells in Flow Field #1 to:
  - evaluate the PFAS plume extending from the B-52 Crash Area, and
  - evaluate the boundary and hydraulic conditions of the PFAS plume to the east-southeast from the FTA toward Butterfield Brook.
- Installing one overburden and one bedrock monitoring well in Flow Field #2 to:
  - evaluate horizontal and vertical groundwater flow upgradient of FTF, and
  - evaluate the PFAS plume upgradient of FTF.
- Installing two overburden, one bedrock, and three deep bedrock monitoring wells in Flow Field #3 to:
  - evaluate horizontal and vertical groundwater flow downgradient from the NDA, and
  - evaluate the PFAS plume at FJETC.
- Installing five overburden, seven bedrock, and nine deep bedrock monitoring wells in Flow Field #4 to:
  - evaluate PFAS plumes extending downgradient of SFS, FTF, and the Burn House.
- Geophysical logging at deep bedrock wells to evaluate bedrock structure, water-bearing zones, and attitude of water-bearing zones to aid in the determination of sampling intervals at each well.
- Surveying each well for latitude, longitude, ground surface elevation, and measuring point elevation.

- Developing newly installed monitoring wells to improve hydraulic connection between the well screen and the geologic formation.
- Slug testing of 39 monitoring wells to:
  - evaluate hydraulic conductivity, and
  - inform the CSM and associated PFAS fate and transport modeling.

3.2.10 Supplemental Storm Sewer Sampling Plan

This sampling plan was an extension of storm sewer sampling activities conducted in 2022 and recommended further sample collection to evaluate:

- The source of PFAS contamination entering the storm sewer system, and
- Data gaps related to the nature of stormwater flow discharging from outfall structures into surface water bodies.

Proposed Field Investigation:

- Resampling of 25 storm sewer features sampled during 2022.
- Sampling of 26 new locations to evaluate potential groundwater infiltration into the storm sewer system within B-52 Crash Area, Aircraft Hardstands, Nose Docks 40, Nose Dock 44, Arch Hangar, Runway, and FTA.
- Collecting continuous flow monitoring data at seven outfalls which discharge water into the WBGB, EBGB, and Butterfield Brook drainage areas to:
  - evaluate groundwater infiltration and inflow (I&I) rates throughout seasonal and temporal variation, and
  - evaluate PFAS mass discharge into these drainage areas.

3.2.11 Supplemental Storm Sewer Sampling Plan

The objective of the activities proposed in this sampling plan was to evaluate PFAS loading to the storm sewer system during various stages of discharge, informed by flow monitoring data.

Proposed Field Investigation:

- Sampling storm sewers at six outfall locations during peak flow conditions.
- Sampling storm sewers at six outfall locations during mid-flow conditions.
- Sampling storm sewers at three outfall locations that discharge stormwater into the FLDD during base flow conditions.

3.2.12 Forage Sampling Plan

The objective of activities proposed in this sampling plan was to evaluate the migration pathway from hydric soils to species that may be foraged and enter the human food chain on Mi'kmaq Nation owned parcels.

Proposed Field Investigation:

- Spring sampling of up to 20 each of soil or hydric soil, shallow groundwater, and foraged plant samples in areas that were likely to contain target foraged species.
- Fall sampling of up to 20 each of soil or hydric soil, shallow groundwater, and foraged plants within the same three foraging areas.
- Sampling of up to 16 each of soil or hydric soil, shallow groundwater, and foraged plant samples located offsite.

3.2.13 Sampling Plan to Support the Baseline Ecological Risk Assessment

This sampling plan introduced conclusions of the *Screening Level Ecological Risk Assessment (SLERA)* and recommended sampling of additional locations and media to:

- further evaluate the nature and extent of PFAS releases in terrestrial and aquatic media,
- aid in validating bioaccumulation models, and
- evaluate PFAS dietary exposure concentrations in bird and mammal food chain models.

Proposed Field Investigation:

- Sampling of 28 soil locations to:
    - further evaluate nature and extent of PFAS, and
    - compare with co-located concentrations of terrestrial biotic media in wooded, grassland, and forest/wetland habitats.
- Collecting 24 plant tissue, 26 invertebrate tissue, and 23 rodent tissue samples to validate tissue bioaccumulation in areas with low, medium, and high soil concentrations in hydric soil.
- Collecting 45 abiotic surface water, sediment, and porewater samples to:
    - further evaluate nature and extent of PFAS, and
    - compare with co-located concentrations of aquatic biotic media in areas where contaminants of potential ecological concern were identified and in areas with lower PFAS concentrations.
    - Collecting 30 plant tissue, 37 invertebrate tissue, and 28 fish tissue samples to:
    - evaluate exposures in aquatic environments, and
    - validate tissue bioaccumulation models used to develop surface water screening benchmarks used in the ERA.

3.2.14 Soil Sampling Round 4 Plan

The objectives of activities proposed in this sampling plan were to:

- further evaluate the vertical and horizontal distribution of PFAS contamination in soils,
- evaluate the vertical assessment of PFAS leaching characteristics in soil to support fate and transport modeling, and

- evaluate data gaps in the CSM.

Proposed Field Investigation:

- Collecting 21 direct push soil samples.
- Collecting 11 surface soil samples.
- Collecting LEAF, total organic carbon, and grain size samples at four locations with relatively lower historical PFAS concentrations within the NDA, FTA, SFS, and CFS to support fate and transport modeling.

3.2.15 Additional Data Collection and Evaluation

This section provides information on additional data that was collected throughout the PFAS RI and not included in a work plan.

Private and Public Drinking Water Sampling

The objective of activities proposed in this sampling plan was to:

- evaluate risk to potential offsite private and public drinking water well receptors based on the distribution of PFAS in groundwater.

Field Investigation Included:

- Sampling of 11 private and public drinking water wells in 2021.
- Sampling of 36 private and public drinking water wells in 2022.
- Sampling of three private and public drinking water wells in 2023, with quarterly sampling conducted for one additional well.
- Sampling of 19 private and public drinking water wells in December 2024.

Additional sampling is planned in 2025, the results of which are not presented in this RI Site Characterization Summary Report but will be included in the PFAS RI Report. The proposed additional sampling includes the following:

- Quarterly sampling of four wells.
- Additional sampling in the area southeast of Loring to fully encompass offsite wells that might be impacted by base contamination.

Storm Sewer Evaluation

The objective of this evaluation was to:

- Evaluate the potential for infiltration of impacted groundwater to the storm sewer system attributed to historic releases at Loring.

This evaluation included:

- a review of historic Site utility maps,
- targeted sampling at manholes and outfalls throughout the storm sewer network,

- flow meter monitoring at select outfalls, and
- analysis of potential areas of infiltration.

These efforts allowed for the estimation of mass flux of PFAS from the storm sewer system to respective receiving water bodies.

Sanitary Sewer Evaluation

The objective of this evaluation was to

- review existing studies and evaluate the potential for I&I into the sanitary sewer system from impacted groundwater attributed to historic releases at Loring.

Existing studies incorporated into this evaluation included

- Analytical data provided by MEDEP,
- I&I reports and proposed repairs to the sanitary sewer completed on behalf of the LDA,
- collections of historical utility maps, and
- outputs of the groundwater model created for this PFAS RI.

3.3 STAKEHOLDER ENGAGEMENT

Meetings were held with stakeholders and members of the community throughout the PFAS RI process to provide updates on the investigation and inform future work. Meetings with the Mi'kmaq Nation were held on 9 September 2021, 8 June 2022, 31 March 2023, 21 February 2024, and 14 and 15 August 2024. The purpose of these meetings was to discuss the ongoing work associated with the PFAS RI, with a focus on the human health risk assessment and identifying potential exposure areas and pathways. Information obtained from these meetings was used to inform PFAS RI work plans.

Community Information Sessions open to the public were held on 03 June 2022 and 15 August 2024. The purpose of these meetings was to present the ongoing work associated with the PFAS RI and answer questions from the community.

A meeting with Loring property owners was held on 30 March 2023. The purpose of this meeting was to present the ongoing work associated with the PFAS RI and answer questions from stakeholders, specifically regarding base re-development.

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4.0 INVESTIGATION ACTIVITIES AND SAMPLING RESULTS

The PFAS RI field work was conducted in accordance with the work plans described in **Section 3.2.** A Photographic Log documenting PFAS RI field activities is included in **Appendix A.** Work plan deviations are presented in **Appendix B.**

This section presents the PFAS RI field data collected and analytical results by media. Tabulated analytical results are presented in **Table 4-1 through Table 4-15**, biota and ecological sample summaries are presented in **Table 4-16** and **Table 4-17**, and field quality check results are presented in **Table 4-18**. Sampling locations, analytical results, and additional field data collected are presented on **Figure 4-1 through Figure 4-35**. Field data records associated with field activities are presented in **Appendix C.** Non-analytical data collected are presented in **Appendices D through I.** Additional analytical data results and analyses completed in support of this PFAS RI are presented in **Appendices J through L.** Modeling efforts completed in support of this PFAS RI are presented in **Appendices M** and **N.** A statistical analysis of analytical results for each media type is included in **Appendix O.**

PFAS results are presented on figures and tables as outlined in **Table 4-19**.

Figures presenting analytical results for soil samples, stormwater samples, and biota for human consumption samples use summary boxes. Summary boxes are a tool used to convey results for multiple PFAS analytes in samples from a single location that are collected:

- at multiple depths,
- over multiple years, or
- from multiple media.

Further details such as concentrations, sample depth intervals, sample collection dates, and/or concentrations of additional PFAS analytes are included in the associated analytical results tables. The summary boxes present PFAS analytes (e.g., PFOS, PFOA) in columns and each cell is color coded to indicate the result compared to the applicable health-based or ecological benchmark SL. The color ramp is as follows:

- white (non-detect),
- green (detected below the RSL),
- orange (detected above the RSL),
- red (detected above 10 times the RSL),
- purple (detected above 100 times the RSL), or
- black (detected above 1000 times the RSL).

PFAS analytical results for other media including groundwater, surface water, sediment, porewater, hydric soil, shallow groundwater, and stormwater are summarized in dot plots. The dot plots depict a composite of PFAS compounds compared to their respective MCL or RSL, as appropriate. PFOS was the most frequently detected PFAS compound identified in these media with the most results exceeding its MCL or

RSL and was detected across the largest extent of the investigation area as compared to other PFAS with RSLs. Full analytical data for these media are shown in associated tables. The color ramp in dot plot figures is the same as the color ramp outlined above. Subsections below present the activities completed by location and/or type of activity, as applicable. PFAS results were compared to the PFAS RSLs, MCLs, or ecological benchmarks as presented in **Table 1-3**.

Appendix O presents a summary of the frequency of detections and exceedances of SLs, and the range of concentrations for each PFAS compound analyzed under USEPA Method 537M and USEPA Method 1633. Summary statistics for soil and groundwater are presented by source area. Summary statistics for surface water, sediment, porewater, hydric soil, and shallow groundwater are presented by drainage basin**.** Summary statistics for biota tissue for human consumption, including blueberries, cattail roots, cattail shoots, fiddleheads, labrador tea, and fish for human consumption are provided by drainage basin with comparisons to the lowest applicable screening values (SVs) that were calculated based on USEPA remedial action guidelines (RAGs) and the RSL calculator for food ingestion. Summary statistics for ecological tissue, including aquatic plants, aquatic invertebrates, and whole-body fish are presented by drainage basin while terrestrial plants, soil invertebrates, and rodents are presented sitewide. For the ecological tissue, there are no relevant SVs or SLs for comparison, so the summary tables report the number of samples, detections, and range in concentrations detected. Further details on the biota tissue for human consumption and ecological tissue sample results are provided in **Section 7**. For the summary tables when the MDL exceeded the applicable SL or SV, non-detect results were not counted as either detections or exceedances.

These include:

- Soil and hydric soil: The USEPA Residential Soil RSLs for PFDA and PFOA are below the reported MDLs for USEPA Method 537M and USEPA Method 1633. Soil and hydric soil samples analyzed with USEPA Method 537M had reported MDLs for PFOS above the USEPA Residential Soil RSLs.
- Groundwater and shallow groundwater: The USEPA Tapwater RSLs for PFDA, PFOS, and PFOA are below the reported MDLs for USEPA Method 537M and USEPA Method 1633. HFPO-DA was not analyzed for using Method 537M and had reported MDLs for HFPO-DA above the USEPA Tapwater RSL using Method 1633.
- Surface water and porewater: The Swimming SLs for PFDA and PFOA are below the reported MDLs for USEPA Method 537M and USEPA Method 1633. HFPO-DA was not analyzed for using Method 537M and had reported MDLs above the USEPA Tapwater RSL using Method 1633.
- Sediment: The Wading Sediment SL for PFDA and PFOA are below the reported MDLs for USEPA Method 537M and USEPA Method 1633. HFPO-DA was not analyzed for using Method 537M and had reported MDLs above the Wading Sediment SL using Method 1633.
- Biota for Human Consumption: The lowest applicable SVs for PFOA, PFDA, and PFOS are below the reported MDLs using USEPA Method 537M and USEPA Method 1633. The lowest applicable SV for PFNA is below the reported MDLs using USEPA Method 537M.

4.1 SOURCE AREA

Soil samples were collected in source areas to evaluate the distribution of contaminants exceeding RSLs, except in Landfill 2, Landfill 3, and Base Laundry, where groundwater was the only media sampled. Soil sample locations are shown on **Figure 4-1**. Soil results are presented on **Table 4-1** and are compared to:

- USEPA Residential Soil RSLs with a hazard quotient of 0.1,
- the lowest of four ecological benchmarks for soil, and
- the USEPA Industrial Soil RSLs with a hazard quotient of one or a cancer risk value of 10^{-6}.

Figures 4-2 through 4-5 present the soil sample results. Data is presented on these figures as follows:

- SLs used vary by depth:
  - The shallowest sample results were compared to the lower of the respective Residential Soil RSLs or ecological screening benchmarks.
  - Deeper samples were compared to only the USEPA Residential Soil RSL.
- Results are presented for seven PFAS compounds (PFHpA, PFBA, PFOS, PFOA, PFHxS, PFHxA, and PFNA) in summary boxes with colors representing concentrations compared to SLs. These summary boxes also show multiple samples where samples were collected at various depths at the same location. Compounds included in the figures are the most prevalent PFAS detected in source areas and/or represent the highest risk levels based on the SLs that can be detected with current analytical methods. PFBS and PFDA results are not depicted in the summary boxes because RSL exceedances of PFBS were not identified and exceedances of PFDA correspond with the extent of RSL exceedances of the other seven compounds.
- An interpreted extent of exceedances of the USEPA Industrial Soil RSLs for PFOS and PFOA with a hazard quotient of one or a cancer risk value of 10^{-4} are presented as an outline on the figures to discretize the distribution of PFAS in source areas in relation to RSLs and illustrate the extent of the highest levels of PFAS impacts to soils.

Field data records for soil samples are included in **Appendix C-2.**

Groundwater results for PFAS are presented in **Table 4-2** and are compared to applicable human health SLs including:

- the USEPA Tapwater RSL for nine PFAS with a hazard quotient of 0.1,
- the USEPA MCL for five PFAS, and
- Maine's Sum of Six PFAS MCL.

Figures 4-9 through 4-20 present the most recent groundwater results for each location compared to the USEPA MCL for either PFHxS, PFNA, PFOS, or PFOA depending on which compound has the highest concentration compared to its respective MCL. **Figures 4-9 through 4-20** present the most recent groundwater results for each location compared to the USEPA MCL for either PFHxS, PFNA, PFOS, or PFOA

depending on which compound has the highest concentration compared to its respective MCL. Results are presented for PFOS only because it is most representative of the PFAS plume extent.

4.1.1 Flow Field #1 Source Area PFAS Analytical Results

Soil samples were collected at locations in Flow Field #1 including the FTA, Runway, and B-52 Crash Area potential source areas. Flow Field #1 soil analytical results are presented in **Table 4-1**, shown on **Figure 4-2**, and summarized in **Table O-1** of **Appendix O**.

FTA

- A total of 116 soil samples were collected for PFAS analysis in the FTA. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFDA, PFHxS, PFOS, and PFOA.
    - PFDA was detected and exceeded USEPA Residential Soil RSLs in 13 soil samples.
    - PFHxS was detected in 73 soil samples, 1 sample exceeded the USEPA Residential Soil RSL.
    - PFOS was detected in 98 soil samples, 88 of which exceeded the USEPA Residential Soil RSL.
    - PFOA was detected and exceeded USEPA Residential Soil RSLs in 51 soil samples.
- PFAS compounds detected in the FTA below USEPA Residential Soil RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the FTA that do not have RSLs include: 1H,1H, 2H, 2H-Perfluorodecane sulfonic acid (8:2FTS), 1H,1H, 2H, 2H-Perfluorooctane sulfonic acid (6:2FTS), n-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA), n-ethyl perfluorooctanesulfonamidoethanol (NEtFOSE), n-methyl perfluorooctanesulfonamide (NMeFOSA), n-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA), perfluorodecanesulfonic acid (PFDS), perfluorododecanesulfonic acid (PFDoS), perfluorododecanoic acid (PFDoA), perfluoroheptanesulfonic acid (PFHpS), PFHpA, perfluorononanesulfonic acid (PFNS), perfluorooctane sulfonamide (PFOSA), perfluoropentanesulfonic acid (PFPeS), perfluoropentanoic acid (PFPeA), perfluorotetradecanoic acid (PFTeDA), perfluorotridecanoic acid (PFTrDA), and perfluoroundecanoic acid (PFUnA).

B-52 Crash Area

- A total of 39 soil samples were collected for PFAS analysis in the B-52 Crash Area. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFDA, PFOS, and PFOA.
    - PFDA was detected and exceeded USEPA Residential Soil RSLs in 1 soil sample.
    - PFOS was detected in 26 soil samples, 24 of those samples exceeded the USEPA Residential Soil RSL.
    - PFOA was detected and exceeded USEPA Residential Soil RSLs in 2 soil samples.
- PFAS compounds detected in the B-52 Crash Area below USEPA Residential Soil RSLs include: PFBS, PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the B-52 Crash Area that do not have RSLs include: PFDS, PFDoS, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, and PFUnA.

4.1.2 Flow Field #2 Source Area PFAS Analytical Results

Soil samples were collected in Flow Field #2 at portions of the Runway area and the Ready Area at the southeastern end of the Runway. Flow Field #2 soil analytical results are presented in **Table 4-1**, shown on **Figure 4-3**, and summarized in **Table O-1** of **Appendix O**.

Runway

- A total of 121 soil samples were collected for PFAS analysis in the Runway. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFDA, PFOS, and PFOA.
    - PFDA was detected and exceeded USEPA Residential Soil RSLs in 11 soil samples.
    - PFOS was detected in 50 soil samples, 34 of those samples exceeded the USEPA Residential Soil RSL.
    - PFOA was detected and exceeded USEPA Residential Soil RSLs in 16 soil samples.
- PFAS compounds detected in the Runway below USEPA Residential Soil RSLs include: PFBS, PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the Runway that do not have RSLs include: 8:2FTS, 6:2FTS, PFDS, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeA, PFTeDA, PFTrDA, and PFUnA.

4.1.3 Flow Field #3 Source Area PFAS Analytical Results

Soil samples were collected in Flow Field #3 at areas including: Nose Dock 11, Nose Dock 40, and Nose Dock 44, Aircraft Hardstands, Hardstand 19, Ramp #1, FDA, FJETC, and portions of the Runway. Flow Field #3 soil analytical results are presented in **Table 4-1**, shown on **Figure 4-4**, and summarized in **Table O-1** of **Appendix O**.

Nose Dock 11

- A total of 20 soil samples were collected for PFAS analysis in Nose Dock 11. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS, and PFOA.
    - PFOS was detected in 8 soil samples, each sample exceeded the USEPA Residential Soil RSL.
    - PFOA was detected and exceeded USEPA Residential Soil RSLs in 2 soil samples.
- PFAS compounds detected in Nose Dock 11 below USEPA Residential Soil RSLs include: PFHxS and PFNA.
- No detections of PFAS compounds that do not have RSLs were identified at Nose Dock 11.

Nose Dock 40

- A total of 10 soil samples were collected for PFAS analysis in Nose Dock 40. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS.
    - PFOS was detected in 3 soil samples, 2 of those samples exceeded the USEPA Residential Soil RSL.

- No PFAS compounds were detected in Nose Dock 40 below USEPA Residential Soil RSLs.
- No detections of PFAS compounds that do not have RSLs were identified at Nose Dock 40.

Nose Dock 44

- A total of 51 soil samples were collected for PFAS analysis in Nose Dock 44. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS and PFOA.
    - PFOS was detected in 37 soil samples, 35 of those samples exceeded the USEPA Residential Soil RSL.
    - PFOA was detected and exceeded USEPA Residential Soil RSLs in 5 soil samples.
- PFAS compounds detected in Nose Dock 44 below USEPA Residential Soil RSLs include: PFBS, PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in Nose Dock 44 that do not have RSLs include: 8:2FTS, 6:2FTS, PFDS, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, PFTeDA, PFTrDA, and PFUnA.

Aircraft Hardstands

- A total of 70 soil samples were collected for PFAS analysis in the Aircraft Hardstands. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS.
    - PFOS was detected in 37 soil samples, 34 of those samples exceeded the USEPA Residential Soil RSL.
- No other PFAS compounds with screening levels were detected in the Aircraft Hardstands.
- Other PFAS compounds detected in the Aircraft Hardstands that do not have RSLs include: PFDS and PFUnA.

Hardstand 19

- A total of 8 soil samples were collected for PFAS analysis in Hardstand 19. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS and PFOA.
    - PFOS was detected in 2 soil samples, both of those samples exceeded the USEPA Residential Soil RSL.
    - PFOA was detected and exceeded USEPA Residential Soil RSLs in 1 soil sample.
- PFAS compounds with screening levels detected in Hardstand 19 below the USEPA Residential Soil RSLs include: PFHxS and PFNA.
- No detections of PFAS compounds that do not have RSLs were identified at Hardstand 19.

FDA

- A total of 11 soil samples were collected for PFAS analysis in the FDA. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS, and PFOA.

- PFOS was detected in 6 soil samples, 5 of those samples exceeded the USEPA Residential Soil RSL.
- PFOA was detected and exceeded USEPA Residential Soil RSLs in 1 soil sample.

- No PFAS compounds were detected in the FDA below the USEPA Residential Soil RSLs.
- Other PFAS compounds detected in the FDA that do not have RSLs include: 8:2FTS, 6:2FTS, and PFHpA.

FJETC

- A total of 15 soil samples were collected for PFAS analysis in the FJETC. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS.
  - PFOS was detected and exceeded the USEPA Residential Soil RSL in 1 soil sample.
- No PFAS compounds were detected in the FJETC below the USEPA Residential Soil RSLs.
- No detections of PFAS compounds that do not have RSLs were identified at FJETC.

4.1.4 Flow Field #4 Source Area PFAS Analytical Results

Soil samples were collected in Flow Field #4 at areas including: SFS, Burn House, CFS, Arch Hangar, JEMS, FTF, KC-135 Crash Area, FLDD/SCF, WWTP, and portions of the Runway. Flow Field #4 soil analytical results are presented in **Table 4-1**, shown on **Figure 4-5**, and summarized in **Table O-1** of **Appendix O**.

SFS

- A total of 76 soil samples were collected in the SFS. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFDA, PFOS, and PFOA.
  - PFDA was detected and exceeded USEPA Residential Soil RSLs in 4 soil samples.
  - PFOS was detected in 66 soil samples, 62 of those samples exceeded the USEPA Residential Soil RSL.
  - PFOA was detected and exceeded USEPA Residential Soil RSLs in 28 soil samples.
- PFAS compounds detected in the SFS below USEPA Residential Soil RSLs include: PFBS, PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the SFS that do not have RSLs include: 8:2FTS, 6:2FTS, perfluoro-3-methoxypropanoic acid (PFMPA), PFDS, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, and PFUnA.

Burn House

- A total of 46 soil samples were collected in the Burn Hose. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFDA, PFOS, and PFOA.
  - PFDA was detected and exceeded USEPA Residential Soil RSLs in 5 soil samples.
  - PFOS was detected in 36 soil samples, 34 of those samples exceeded the USEPA Residential Soil RSL.

- PFOA was detected and exceeded USEPA Residential Soil RSLs in 13 soil samples.

- PFAS compounds detected in the Burn House below USEPA Residential Soil RSLs include: PFBS, PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the Burn House that do not have RSLs include: 8:2FTS, 6:2FTS, 2H,2H,3H,3H-Perfluorooctanoic acid (5:3FTCA), PFDS, PFDoS, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, and PFUnA.

CFS

- A total of 86 soil samples were collected in the CFS. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFDA, PFOS, and PFOA.
  - PFDA was detected and exceeded USEPA Residential Soil RSLs in 9 soil samples.
  - PFOS was detected in 59 soil samples, 55 of those samples exceeded the USEPA Residential Soil RSL.
  - PFOA was detected and exceeded USEPA Residential Soil RSLs in 39 soil samples.
- PFAS compounds detected in the CFS below USEPA Residential Soil RSLs include: PFBS, PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the CFS that do not have RSLs include: 8:2FTS, 6:2FTS, NMeFOSA, PFDS, PFDoS, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, and PFUnA.

Arch Hangar

- A total of 15 soil samples were collected in the Arch Hangar. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS and PFOA.
  - PFOS was detected and exceeded USEPA Residential Soil RSLs in 7 soil samples.
  - PFOA was detected and exceeded USEPA Residential Soil RSLs in 1 soil sample.
- No PFAS compounds were detected in the Arch Hangar below USEPA Residential Soil RSLs.
- No detections of PFAS compounds that do not have RSLs were identified at the Arch Hangar.

JEMS

- A total of 11 soil samples were collected in JEMS. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS.
  - PFOS was detected and exceeded USEPA Residential Soil RSLs in 3 soil samples.
- No PFAS compounds were detected in JEMS below USEPA Residential Soil RSLs.
- No detections of PFAS compounds that do not have RSLs were identified at JEMS.

FTF

- A total of 33 soil samples were collected in the FTF. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFDA, PFOS, and PFOA.

- PFDA was detected and exceeded USEPA Residential Soil RSLs in 1 soil sample.
- PFOS was detected in 16 soil samples, 13 of those samples exceeded the USEPA Residential Soil RSL.
- PFOA was detected and exceeded USEPA Residential Soil RSLs in 3 soil samples.

- PFAS compounds with detections in the FTF below the USEPA Residential Soil RSLs include: PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the FTF that do not have RSLs include: PFHpA, PFOSA, PFPeA, and PFUnA.

KC-135 Crash Area

- A total of 8 soil samples were collected in the KC-135 Crash Area. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS.
  - PFOS was detected and exceeded USEPA Residential Soil RSLs in 6 soil samples.
- No PFAS compounds were detected in the KC-135 Crash Area below USEPA Residential Soil RSLs.
- No detections of PFAS compounds that do not have RSLs were identified at the KC-135 Crash Area.

FLDD/SCF

- A total of 16 soil samples were collected in the FLDD/SCF. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFOS and PFOA.
  - PFOS was detected in 10 soil samples, 9 of those samples exceeded the USEPA Residential Soil RSL.
  - PFOA was detected and exceeded USEPA Residential Soil RSLs in 3 soil samples.
- PFAS compounds with detections in the FLDD/SCF below the USEPA Residential Soil RSLs include: PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the FLDD/SCF that do not have RSLs include: PFDS, PFHpS, PFHpA, PFOSA, PFPeA, PFUnA.

WWTP

- A total of 27 soil samples were collected in the WWTP. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFDA, PFOS, and PFOA.
  - PFDA was detected and exceeded USEPA Residential Soil RSLs in 1 soil sample.
  - PFOS was detected in 20 soil samples, 19 of those samples exceeded the USEPA Residential Soil RSL.
  - PFOA was detected and exceeded USEPA Residential Soil RSLs in 5 soil samples.

- PFAS compounds with detections in the WWTP below the USEPA Residential Soil RSLs include: PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the WWTP for which applicable RSLs have not been established include: 8:2FTS, NMeFOSAA, PFDS, PFDoA, PFHpS, PFHpA, and PFOSA.

Base Laundry

Groundwater samples were collected in Flow Field #4 at four monitoring wells located upgradient and downgradient of Base Laundry to evaluate the nature and extent of PFAS concentrations within this source area. This source area evaluation included bedrock monitoring wells JBW7215B, JMW3601, MMW0124, and JMW1981 and are shown on **Figure 4-16**. Analytical results are presented in **Table 4-2**.

- PFAS was detected in 4 out of 4 monitoring wells sampled as part of the Base Laundry source area evaluation.
    - 4 wells had PFOS concentrations exceeding the MCL.
    - 4 wells had concentrations exceeding Maine's MCL for Sum of Six PFAS.

4.1.5 Flow Field #5 Source Area PFAS Analytical Results

Groundwater samples were collected in Flow Field #5 at three monitoring wells within Landfill 2 to evaluate the nature and extent of PFAS concentrations within this source area. This source area evaluation included overburden monitoring well JMW0880 and bedrock monitoring wells JMW-0806 and JMW0882. The most recent overburden and bedrock results are shown on **Figure 4-17** and **Figure 4-18**, respectively. Analytical results are included in **Table 4-2** and summarized in **Table O-2** of **Appendix O**.

- PFAS were detected in 3 out of 3 monitoring wells sampled within Landfill 2.
    - 3 wells had PFOS concentrations that exceed the MCL.
    - 1 well had concentrations exceeding Maine's MCL for the Sum of Six PFAS.

4.1.6 Flow Field #6 Source Area PFAS Analytical Results

Groundwater samples were collected in Flow Field #6 at three monitoring wells within Landfill 3 to evaluate the nature and extent of PFAS concentrations within this source area. This source area evaluation included bedrock monitoring wells JMW0982, JMW0941, and JMW0980. Analytical results are shown on **Figure 4-20** and are included in **Table 4-2** and summarized in **Table O-2** of **Appendix O**.

- PFAS was detected in 2 out of 3 monitoring wells sampled within Landfill 3.
    - 2 wells had PFOS concentrations that exceed the MCL.
    - There were no wells sampled that exceeded Maine's MCL for the Sum of Six PFAS.

4.2 GROUNDWATER AND SHALLOW GROUNDWATER

Construction diagrams for overburden and bedrock wells installed during the PFAS RI are included in **Appendix C-5**. Wells installed include:

- 30 overburden wells, **Figure 4-7**, and

- 91 bedrock monitoring wells, **Figure 4-8**.
    - 32 shallow bedrock monitoring wells were installed up to 20 feet into bedrock.
    - 59 deep bedrock wells were installed more than 20 feet into bedrock.

A total of 291 existing and newly installed groundwater monitoring wells were sampled during the PFAS RI. Samples were collected over six sampling rounds, which occurred in the spring and fall of each year of the PFAS RI. Groundwater analytical results presented in figures reflect the most recent round of sampling for each well and display comparisons to the MCL for PFAS compounds with an applicable MCL. During the spring 2024 field season, 22 groundwater samples were collected at monitoring wells with historically low recovery using passive sampling methodology. Upon further examination of the results, this method was not used in fall of 2024 due to variability in the sample results. Field data records associated with groundwater sampling are included in **Appendix C-9.**

4.2.1 Groundwater Analytical Results

4.2.1.1 Flow Field #1 PFAS Groundwater Analytical Results

Flow Field #1 groundwater PFAS analytical results are presented in **Table 4-2.** The most recent overburden and bedrock groundwater analytical results are presented on **Figure 4-9** and **Figure 4-10**, respectively and summarized in **Table O-2** of **Appendix O**.

FTA

- A total of 134 groundwater samples were collected for PFAS analysis in the FTA. PFAS compounds with exceedances of USEPA Tapwater RSLs include: PFDA, PFHxS, PFNA, PFOS, and PFOA.
    - PFDA was detected and exceeded the USEPA Tapwater RSL in 43 groundwater samples.
    - PFHxS was detected in 133 groundwater samples, 117 of those samples exceeded the USEPA Tapwater RSL.
    - PFNA was detected in 109 groundwater samples, 53 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSL in 128 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 129 groundwater samples.
- PFAS compounds detected in the FTA below USEPA Tapwater RSLs include: PFBS, PFBA, and PFHxA.
- Other PFAS compounds detected in the FTA that do not have RSLs include: 8:2FTS, 1H,1H, 2H, 2H-Perfluorohexane sulfonic acid (4:2FTS), 6:2FTS, NEtFOSAA, NEtFOSE, NMeFOSAA, n-methyl perfluorooctanesulfonamidoethanol (NMeFOSE), PFDS, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

B-52 Crash Area

- A total of 80 groundwater samples were collected for PFAS analysis in the B-52 Crash Area. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFOS, and PFOA.
  - PFHxS was detected in 74 groundwater samples, 60 of those samples exceeded the USEPA Tapwater RSL.
  - PFOS was detected and exceeded the USEPA Tapwater RSL in 74 groundwater samples.
  - PFOA was detected and exceeded the USEPA Tapwater RSL in 67 groundwater samples.
- PFAS compounds detected in the B-52 Crash Area below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the B-52 Crash Area that do not have RSLs include: 8:2FTS, 6:2FTS, NEtFOSE, NMeFOSE, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

4.2.1.2 Flow Field #2 PFAS Groundwater Analytical Results

Flow Field #2 groundwater PFAS analytical results are presented in **Table 4-2.** The most recent overburden and bedrock groundwater analytical results are presented on **Figure 4-11** and **Figure 4-12,** respectively and summarized in **Table O-2** of **Appendix O**.

Runway

- A total of 108 groundwater samples were collected for PFAS analysis in the Runway. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFOS, and PFOA.
  - PFDA was detected and exceeded the USEPA Tapwater RSL in 2 groundwater samples.
  - PFHxS was detected in 92 groundwater samples, 50 of those samples exceeded the USEPA Tapwater RSL.
  - PFOS was detected and exceeded the USEPA Tapwater RSL in 91 groundwater samples.
  - PFOA was detected and exceeded the USEPA Tapwater RSL in 84 groundwater sampled.
- PFAS compounds detected in the Runway below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the Runway that do not have RSLs include: 6:2FTS, NEtFOSE, NMeFOSE, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

4.2.1.3 Flow Field #3 Groundwater PFAS Analytical Results

Flow Field #3 groundwater PFAS analytical results are presented on **Table 4-2.** The most recent overburden and bedrock groundwater analytical results are presented in **Figure 4-13** and **Figure 4-14,** respectively and summarized in **Table O-2** of **Appendix O**.

Nose Dock 11

- A total of 36 groundwater samples were collected for PFAS analysis in Nose Dock 11. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFOS, and PFOA.

- PFHxS was detected in 36 groundwater samples, 21 of those samples exceeded the USEPA Tapwater RSL.
- PFOS was detected and exceeded the USEPA Tapwater RSL in 36 groundwater samples.
- PFOA was detected and exceeded the USEPA Tapwater RSL in 35 groundwater samples..

- PFAS compounds detected in Nose Dock 11 below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in Nose Dock 11 that do not have RSLs include: 6:2FTS, NEtFOSE, NMeFOSE, PFHpS, PFHpA, PFOSA, PFPeS, and PFPeA.

Nose Dock 40

- A total of 45 groundwater samples were collected for PFAS analysis in Nose Dock 40. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFOS, and PFOA.
  - PFHxS was detected in 44 groundwater samples, 37 of those samples exceeded the USEPA Tapwater RSL.
  - PFOS was detected and exceeded the USEPA Tapwater RSL in 43 groundwater samples.
  - PFOA was detected and exceeded the USEPA Tapwater RSL in 41 groundwater samples.
- PFAS compounds detected in Nose Dock 40 below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in Nose Dock 40 that do not have RSLs include: 6:2FTS, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

Nose Dock 44

- A total of 28 groundwater samples were collected for PFAS analysis in Nose Dock 44. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFNA, PFOS, and PFOA.
  - PFDA was detected and exceeded the USEPA Tapwater RSL in 1 groundwater sample.
  - PFHxS was detected and exceeded the USEPA Tapwater RSL in 28 groundwater samples.
  - PFNA was detected in 25 groundwater samples, 1 of those samples exceeded the USEPA Tapwater RSL.
  - PFOS was detected and exceeded the USEPA Tapwater RSL in 28 groundwater samples.
  - PFOA was detected and exceeded the USEPA Tapwater RSL in 28 groundwater samples.
- PFAS compounds detected in Nose Dock 44 below USEPA Tapwater RSLs include: PFBS, PFBA, and PFHxA.
- Other PFAS compounds detected in Nose Dock 44 that do not have RSLs include: 8:2FTS, 4:2FTS, 6:2FTS, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

Aircraft Hardstands

- A total of 75 groundwater samples were collected for PFAS analysis in the Aircraft Hardstands. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFOS, and PFOA.
    - PFDA was detected and exceeded the USEPA Tapwater RSL in 3 groundwater samples.
    - PFHxS was detected in 75 groundwater samples, 49 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 72 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 70 groundwater samples.
- PFAS compounds detected in the Aircraft Hardstands below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the Aircraft Hardstands that do not have RSLs include: 6:2FTS, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, and PFUnA.

Hardstand 19

- A total of 86 groundwater samples were collected for PFAS analysis in Hardstand 19. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFNA, PFOS, and PFOA.
    - PFHxS was detected in 85 groundwater samples, 59 of those samples exceeded the USEPA Tapwater RSL.
    - PFNA was detected in 31 groundwater samples, 1 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 77 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 82 groundwater samples.
- PFAS compounds detected in Hardstand 19 below USEPA Tapwater RSLs include: PFBS, PFBA, and PFHxA.
- Other PFAS compounds detected in the Aircraft Hardstands that do not have RSLs include: 8:2FTS, 6:2FTS, NEtFOSAA, NEtFOSE, NMeFOSAA, NMeFOSE, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, and PFTeDA.

FDA

- A total of 39 groundwater samples were collected for PFAS analysis in the FDA. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFOS, and PFOA.
    - PFHxS was detected in 36 groundwater samples, 25 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 36 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 36 groundwater samples.

- PFAS compounds detected in the FDA below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the FDA that do not have RSLs include: 6:2FTS, NEtFOSE, NMeFOSE, PFHpS, PFHpA, PFOSA, PFPeS, and PFPeA.

FJETC

- A total of 59 groundwater samples were collected for PFAS analysis in the FJETC. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFOS, and PFOA.
  - PFHxS was detected in 54 groundwater samples, 41 of those samples exceeded the USEPA Tapwater RSL.
  - PFOS was detected and exceeded the USEPA Tapwater RSLs in 52 groundwater samples.
  - PFOA was detected and exceeded the USEPA Tapwater RSL in 52 groundwater samples.
- PFAS compounds detected in the FJETC below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the FJETC that do not have RSLs include: 6:2FTS, NEtFOSE, PFHpS, PFHpA, PFOSA, PFPeS, and PFPeA.

4.2.1.4 Flow Field #4 PFAS Groundwater Analytical Results

Flow Field #4 groundwater PFAS analytical results are presented on **Table 4-2.** The most recent overburden and bedrock groundwater analytical results are presented in **Figure 4-15** and **Figure 4-16,** respectively and summarized in **Table O-2** of **Appendix O**.

SFS

- A total of 89 groundwater samples were collected for PFAS analysis in the SFS. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFNA, PFOS, and PFOA.
  - PFDA was detected and exceeded the USEPA Tapwater RSL in 14 groundwater samples.
  - PFHxS was detected in 82 groundwater samples, 47 of those samples exceeded the USEPA Tapwater RSL.
  - PFNA was detected in 47 groundwater samples, 35 of those samples exceeded the USEPA Tapwater RSL.
  - PFOS was detected and exceeded the USEPA Tapwater RSLs in 82 groundwater samples.
  - PFOA was detected and exceeded the USEPA Tapwater RSL in 77 groundwater samples.
- PFAS compounds detected in the SFS below USEPA Tapwater RSLs include: PFBS, PFBA, and PFHxA.
- Other PFAS compounds detected in the SFS that do not have RSLs include: 8:2FTS, 4:2FTS, 6:2FTS, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

Burn House

- A total of 57 groundwater samples were collected for PFAS analysis in the Burn House. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFNA, PFOS, and PFOA.
    - PFDA was detected and exceeded the USEPA Tapwater RSL in 16 groundwater samples.
    - PFHxS was detected in 57 groundwater samples, 53 of those samples exceeded the USEPA Tapwater RSL.
    - PFNA was detected in 54 groundwater samples, 20 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 57 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 57 groundwater samples.
- PFAS compounds detected in the Burn House below USEPA Tapwater RSLs include: PFBS, PFBA, and PFHxA.
- Other PFAS compounds detected in the Burn House that do not have RSLs include: 8:2FTS, 4:2FTS, 6:2FTS, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

Crash Fire

- A total of 81 groundwater samples were collected for PFAS analysis in Crash Fire. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFHxA, PFNA, PFOS, and PFOA.
    - PFDA was detected and exceeded the USEPA Tapwater RSL in 28 groundwater samples.
    - PFHxS was detected and exceeded the USEPA Tapwater RSL in 81 groundwater samples.
    - PFHxA was detected in 81 groundwater samples, 6 of those samples exceeded the USEPA Tapwater RSL.
    - PFNA was detected in 73 groundwater samples, 47 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 81 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 81 groundwater samples.
- PFAS compounds detected in Crash Fire below USEPA Tapwater RSLs include: PFBS and PFBA.
- Other PFAS compounds detected in Crash Fire that do not have RSLs include: 8:2FTS, 4:2FTS, 6:2FTS, 3-Perfluoropropyl propanoic acid (3:3FTCA), NMeFOSAA, PFDS, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

Arch Hangar

- A total of 67 groundwater samples were collected for PFAS analysis in the Arch Hangar. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFNA, PFOS, and PFOA.

- PFDA was detected and exceeded the USEPA Tapwater RSL in 15 groundwater samples.
- PFHxS was detected in 67 groundwater samples, 63 of those samples exceeded the USEPA Tapwater RSL.
- PFNA was detected in 57 groundwater samples, 1 of those samples exceeded the USEPA Tapwater RSL.
- PFOS was detected and exceeded the USEPA Tapwater RSLs in 67 groundwater samples.
- PFOA was detected and exceeded the USEPA Tapwater RSL in 67 groundwater samples.

- PFAS compounds detected in the Arch Hangar below USEPA Tapwater RSLs include: PFBS, PFBA, and PFHxA.
- Other PFAS compounds detected in the Arch Hangar that do not have RSLs include: 8:2FTS, 4:2FTS, 6:2FTS, n-ethyl perfluorooctanesulfonamide (NEtFOSA), NEtFOSAA, NEtFOSE, NMeFOSE, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

JEMS

- A total of 108 groundwater samples were collected for PFAS analysis in JEMS. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFOS, and PFOA.
  - PFDA was detected and exceeded the USEPA Tapwater RSL in 2 groundwater samples.
  - PFHxS was detected in 108 groundwater samples, 105 of those samples exceeded the USEPA Tapwater RSL.
  - PFOS was detected and exceeded the USEPA Tapwater RSLs in 108 groundwater samples.
  - PFOA was detected and exceeded the USEPA Tapwater RSL in 108 groundwater samples.
- PFAS compounds detected in JEMS below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in JEMS that do not have RSLs include: 8:2FTS, 4:2FTS, 6:2FTS, NEtFOSE, NMeFOSAA, NMeFOSE, PFDoA, PFHpS, PFHpA, PFOSA, PFPeS, PFPeA, PFTeDA, and PFUnA.

Fuel Tank Farm

- A total of 89 groundwater samples were collected for PFAS analysis in the Fuel Tank Farm. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFOS, and PFOA.
  - PFDA was detected and exceeded the USEPA Tapwater RSL in 2 groundwater samples.
  - PFHxS was detected in 77 groundwater samples, 53 of those samples exceeded the USEPA Tapwater RSL.
  - PFOS was detected and exceeded the USEPA Tapwater RSLs in 73 groundwater samples.
  - PFOA was detected and exceeded the USEPA Tapwater RSL in 75 groundwater samples.

- PFAS compounds detected in the Fuel Tank Farm below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the Fuel Tank Farm that do not have RSLs include: 8:2FTS, 6:2FTS, NEtFOSAA, NEtFOSE, NMeFOSA, NMeFOSE, PFHpS, PFHpA, PFOSA, PFPeS, and PFPeA.

KC-135 Crash Area

- A total of 14 groundwater samples were collected for PFAS analysis in the KC-135 Crash Area. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFOS, and PFOA.
    - PFHxS was detected in 14 groundwater samples, 1 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 12 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 13 groundwater samples.
- PFAS compounds detected in the KC-135 Crash Area below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the KC-135 Crash Area that do not have RSLs include: 6:2FTS, PFHpA, PFPeS, and PFPeA.

FLDD/SCF

- A total of 44 groundwater samples were collected for PFAS analysis in the FLDD/SCF. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFNA, PFOS, and PFOA.
    - PFDA was detected and exceeded USEPA Tapwater RSLs in 3 groundwater samples.
    - PFHxS was detected in 41 groundwater samples, 34 of those samples exceeded the USEPA Tapwater RSL.
    - PFNA was detected in 30 groundwater samples, 2 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 38 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 43 groundwater samples.
- PFAS compounds detected in the FLDD/SCF below USEPA Tapwater RSLs include: PFBS, PFBA, and PFHxA.
- Other PFAS compounds detected in the FLDD/SCF that do not have RSLs include: 8:2FTS, 4:2FTS, 6:2FTS, NMeFOSE, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

WWTP

- A total of 18 groundwater samples were collected for PFAS analysis in the WWTP. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFOS, and PFOA.
    - PFHxS was detected in 18 groundwater samples, 11 of those samples exceeded the USEPA Tapwater RSL.

- PFOS was detected and exceeded the USEPA Tapwater RSLs in 17 groundwater samples.
- PFOA was detected and exceeded the USEPA Tapwater RSL in 15 groundwater samples.

- PFAS compounds detected in the WWTP below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the WWTP that do not have RSLs include: 6:2FTS, PFHpS, PFHpA, PFOSA, PFPeS, and PFPeA.

Base Laundry

- A total of 51 groundwater samples were collected for PFAS analysis in Base Laundry. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFOS, and PFOA.
  - PFDA was detected and exceeded the USEPA Tapwater RSL in 2 groundwater samples.
  - PFHxS was detected in 51 groundwater samples, 43 of those samples exceeded the USEPA Tapwater RSL.
  - PFOS was detected and exceeded the USEPA Tapwater RSLs in 51 groundwater samples.
  - PFOA was detected and exceeded the USEPA Tapwater RSL in 51 groundwater samples.
- PFAS compounds detected in Base Laundry below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in Base Laundry that do not have RSLs include: 8:2FTS, 6:2FTS, PFHpS, PFHpA, PFOSA, PFPeS, and PFPeA.

4.2.1.5 Flow Field #5 PFAS Groundwater Analytical Results

Flow Field #5 groundwater PFAS analytical results are presented on **Table 4-2.** The most recent overburden and bedrock groundwater analytical results are presented in **Figure 4-17** and **Figure 4-18,** respectively and summarized in **Table O-2** of **Appendix O**.

Landfill 2

- A total of 61 groundwater samples were collected for PFAS analysis in Landfill 2. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFOS, and PFOA.
  - PFDA was detected and exceeded the USEPA Tapwater RSL in 2 groundwater samples.
  - PFHxS was detected in 52 groundwater samples, 12 of those samples exceeded the USEPA Tapwater RSL.
  - PFOS was detected and exceeded the USEPA Tapwater RSLs in 51 groundwater samples.
  - PFOA was detected and exceeded the USEPA Tapwater RSL in 47 groundwater samples.
- PFAS compounds detected in Landfill 2 below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in Landfill 2 that do not have RSLs include: 8:2FTS, 6:2FTS, NEtFOSA, NEtFOSAA, NEtFOSE, NMeFOSA, NMeFOSAA, NMeFOSE, PFDS, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, PFTeDA, and PFUnA.

4.2.1.6 Flow Field #6 PFAS Groundwater Analytical Results

Flow Field #6 groundwater PFAS analytical results are presented on **Table 4-2.** The most recent overburden and bedrock groundwater analytical results are presented in **Figure 4-19** and **Figure 4-20,** respectively and summarized in **Table O-2** of **Appendix O**.

Landfill 3

- A total of 98 groundwater samples were collected for PFAS analysis in Landfill 3. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFOS, and PFOA.
    - PFDA was detected and exceeded the USEPA Tapwater RSL in 2 groundwater samples.
    - PFHxS was detected in 58 groundwater samples, 8 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 58 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 62 groundwater samples.
- PFAS compounds detected in Landfill 3 below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in Landfill 3 that do not have RSLs include: 6:2FTS, NEtFOSAA, NMeFOSAA, PFHpS, PFHpA, PFOSA, PFPeS, and PFPeA.

4.2.1.7 PFAS Groundwater Analytical Results Outside Flow Fields

Several wells are located outside of defined flow fields on the northern and southern extent of Loring and in between Flow Field #3 and Flow Field #6.

- 9 monitoring wells located outside of flow fields were installed during the PFAS RI.
- 9 existing wells were added to the sampling program.

The most recent sampling results for wells located outside of the flow fields can be found on **Table 4-2**. The figures depicting the closest flow field, including **Figure 4-9, Figure 4-10, Figure 4-11, Figure 4-14**, and **Figure 4-16** with results summarized in **Table O-2** of **Appendix O**.

Butterfield Brook

- A total of 28 groundwater samples were collected for PFAS analysis in the Butterfield Brook drainage basin. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFOS, and PFOA.
    - PFHxS was detected in 20 groundwater samples, 10 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 12 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 11 groundwater samples.
- PFAS compounds detected in the Butterfield Brook drainage basin below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.

- Other PFAS compounds detected in the Butterfield Brook drainage basin that do not have RSLs include: 6:2FTS, PFHpS, PFHpA, PFOSA, PFPeS, and PFPeA.

Greenlaw Brook

- A total of 139 groundwater samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFOS, and PFOA.
    - PFDA was detected and exceeded the USEPA Tapwater RSL in 1 groundwater sample.
    - PFHxS was detected in 107 groundwater samples, 38 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 105 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 104 groundwater samples.
- PFAS compounds detected in the Greenlaw Brook drainage basin below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have RSLs include: 6:2FTS, NEtFOSE, NMeFOSE, PFHpS, PFHpA, PFOSA, PFPeS, PFPeA, and PFUnA.

North Wherry

- A total of 20 groundwater samples were collected for PFAS analysis in North Wherry. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFOS, and PFOA.
    - PFHxS was detected in 16 groundwater samples, 2 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 17 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 14 groundwater samples.
- PFAS compounds detected in North Wherry below USEPA Tapwater RSLs include: PFBS, PFBA, PFHxA, and PFNA.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have RSLs include: 6:2FTS, PFHpS, PFHpA, PFOSA, PFPeS, and PFPeA.

Noyes Pond

- A total of 18 groundwater samples were collected for PFAS analysis in the Noyes Pond drainage. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFOS and PFOA.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 6 groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 1 groundwater samples.
- PFAS compounds detected in the Noyes Pond drainage below USEPA Tapwater RSLs include: PFHxS and PFHxA.

- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have RSLs include: 6:2FTS and PFPeA.

4.2.2 Shallow Groundwater

Shallow groundwater results for PFAS are presented in **Table 4-6** and are compared to applicable human health SLs including:

- the USEPA Tapwater RSL for nine PFAS with a hazard quotient of 0.1, and
- the USEPA MCL for five PFAS.

Figure 4-23 shows the locations of shallow groundwater sample collection. **Figures 4-24A through 4-24E** compare shallow groundwater results to the tapwater SL for PFAS compounds with an applicable SL. Summary statistics detailing the number of detections, exceedances, and range in concentrations are reported in **Table O-6** of **Appendix O**.

Field data records for shallow groundwater sampling are included in **Appendix C-13**.

4.2.2.1 Shallow Groundwater Analytical Results

Shallow groundwater analytical results are broken out by drainage basin, including Greenlaw Brook, Butterfield Brook, and the Reference Drainages that were sampled.

Greenlaw Brook

- A total of 17 shallow groundwater samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFDA, PFHxS, PFNA, PFOS, and PFOA.
    - PFDA was detected and exceeded the USEPA Tapwater RSLs in 2 shallow groundwater samples.
    - PFHxS was detected in 13 shallow groundwater samples, 7 of those samples exceeded the USEPA Tapwater RSL.
    - PFNA was detected in 15 shallow groundwater samples, 2 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 15 shallow groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSLs in 14 shallow groundwater samples.
- PFAS compounds detected in the Greenlaw Brook drainage basin below USEPA Tapwater RSLs include: PFBS, PFBA and PFHxA.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have applicable RSLs include: 6:2FTS, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

Butterfield Brook

- A total of 6 shallow groundwater samples were collected for PFAS analysis in the Butterfield Brook drainage basin. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFHxS, PFNA, PFOS and PFOA.
    - PFHxS was detected in 5 shallow groundwater samples, 2 of those samples exceeded the USEPA Tapwater RSL.
    - PFNA was detected in 4 shallow groundwater samples, 1 of those samples exceeded the USEPA Tapwater RSL.
    - PFOS was detected and exceeded the USEPA Tapwater RSLs in 5 shallow groundwater samples.
    - PFOA was detected and exceeded the USEPA Tapwater RSLs in 3 shallow groundwater samples.
- PFAS compounds detected in the Butterfield Brook drainage basin below USEPA Tapwater RSLs include: PFBS, PFBA, and PFHxA.
- Other PFAS compounds detected in the Butterfield Brook drainage that do not have applicable RSLs include: PFHpA, PFOSA, and PFPeA.

Reference Drainages

- A total of 1 shallow groundwater sample was collected for PFAS analysis in the Reference drainage basins. PFAS compounds with exceedances of USEPA Tapwater RSL include: PFOA.
    - PFOA was detected and exceeded the USEPA Tapwater RSL in 1 shallow groundwater sample.
- No PFAS compounds were detected in the Reference drainage basins below USEPA Tapwater RSLs.
- No other PFAS compounds were detected in the Reference drainage basins that do not have RSLs.

4.3 SURFACE WATER, SEDIMENT, HYDRIC SOIL, AND POREWATER

4.3.1 Surface Water

Surface water results for PFAS are presented in **Table 4-3** and are compared to applicable human health and ecological SLs including:

- the Swimming SL for nine PFAS with a hazard quotient of 0.1, and
- the lowest of three ecological benchmarks for eight PFAS.

Figure 4-23 shows the locations of surface water sample collection**. Figures 4-24A through 4-24E** compare surface water results to the Swimming SL for any PFAS compound with an applicable SL**.** Summary statistics detailing the number of detections, exceedances, and range in concentrations are reported in **Table O-3** of **Appendix O.**

Field data records for surface water sampling are included in **Appendix C-10** and **Appendix C-12**.

4.3.1.1 Surface Water Analytical Results

Surface water analytical results are presented by drainage basin, including Greenlaw Brook, Butterfield Brook, and the Reference Drainages that were sampled.

Greenlaw Brook

- A total of 100 surface water samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. PFAS compounds with exceedances of the Swimming SLs include: PFDA, PFOS, and PFOA.
    - PFDA was detected and exceeded Swimming SLs in 9 surface water samples.
    - PFOS was detected in 92 surface water samples, 82 of those samples exceeded the Swimming SL.
    - PFOA was detected and exceeded Swimming SLs in 91 surface water samples.
- PFAS compounds detected in the Greenlaw Brook drainage basin below the Swimming SLs include: PFBS, PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have applicable SLs include: 8:2FTS, 4:2FTS, 6:2FTS, PFDS, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, and PFUnA.

Butterfield Brook

- A total of 35 surface water samples were collected for PFAS analysis in the Butterfield Brook drainage basin. PFAS compounds with exceedances of the Swimming SLs include: PFDA, PFOS, and PFOA.
    - PFDA was detected and exceeded Swimming SLs in 1 surface water sample.
    - PFOS was detected in 33 surface water samples, 19 of those samples exceeded the Swimming SL.
    - PFOA was detected and exceeded Swimming SLs in 32 surface water samples.
- PFAS compounds detected in the Butterfield Brook drainage basin below the Swimming SLs include: PFBS, PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the Butterfield Brook drainage that do not have applicable SLs include: PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, and PFUnA.

Reference Drainages

- A total of 9 surface water samples were collected for PFAS analysis in the Reference drainage basins. PFAS compounds with exceedances of the Swimming SLs include: PFOS, and PFOA.
    - PFOS was detected in 5 surface water samples, 1 of those samples exceeded the Swimming SL.
    - PFOA was detected and exceeded Swimming SLs in 5 surface water samples.
- PFAS compounds detected in the Reference drainage basins below the Swimming SLs include: PFBS, PFBA, PFHxS, and PFHxA.
- Other PFAS compounds detected in the Reference drainage basins that do not have applicable SLs include: PFHpA and PFPeA.

4.3.2 Sediment

Sediment results for PFAS are presented in **Table 4-4** and are compared to applicable human health and ecological SLs including: the Wading Sediment SL for nine PFAS with a hazard quotient of 0.1 and the lowest of two ecological benchmarks for six PFAS**. Figure 4-23** shows the locations of sediment sample collection. **Figures 4-24A through 4-24E** compare sediment sample results to the wading sediment SL for PFAS compounds with an applicable SL. Summary statistics detailing the number of detections, exceedances, and range in concentrations are reported in **Table O-4** of **Appendix O.**

Field data records for sediment sampling are included in **Appendix C-10**.

4.3.2.1 Sediment Analytical Results

Sediment analytical results are presented by drainage basin, including Greenlaw Brook, Butterfield Brook, and the Reference Drainages that were sampled.

Greenlaw Brook

- A total of 103 sediment samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. PFAS compounds with exceedances of the Wading Sediment SLs include: PFDA, PFOS, and PFOA.
    - PFDA was detected and exceeded the Wading Sediment SLs in 2 sediment samples.
    - PFOS was detected in 83 sediment samples, 46 of those samples exceeded the Wading Sediment SL.
    - PFOA was detected and exceeded the Wading Sediment SLs in 9 sediment samples.
- PFAS compounds detected in the Greenlaw Brook drainage basin below the Wading Sediment SLs include: PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have applicable SLs include: 8:2FTS, PFDS, PFDoS, PFHpS, PFHpA, PFNS, PFOSA, and PFPeA.

Butterfield Brook

- A total of 35 sediment samples were collected for PFAS analysis in the Butterfield Brook drainage basin. PFAS compounds with exceedances of the Wading Sediment SLs include: PFOS.
    - PFOS was detected in 21 sediment samples, 9 of those samples exceeded the Wading Sediment SL.
- PFAS compounds detected in the Butterfield Brook drainage basin below the Wading Sediment SLs include: PFHxS.
- Other PFAS compounds detected in the Butterfield Brook drainage basin that do not have applicable SLs include: PFDS, PFDoS, and PFNS.

Reference Drainages

- A total of 7 sediment samples were collected for PFAS analysis in the Reference drainage basins. No PFAS compounds exceeded the Wading Sediment SL.
- PFAS compounds detected in the Reference drainage basins below the Wading Sediment SLs include: PFOS.
- No other PFAS compounds were detected in the Reference drainage basins that do not have Wading SLs.

4.3.3 Hydric Soils

Hydric soil results for PFAS are presented in **Table 4-5** and are compared to applicable human health and ecological SLs including:

- the USEPA Residential Soil RSL with a hazard quotient of 0.1, and
- the lowest of four ecological benchmarks for soil.

Figure 4-23 shows the locations of hydric soil sample collection. **Figures 4-24A through 4-24E** compare hydric soil results to the USEPA Residential Soil RSL for PFAS compounds with an applicable RSL. Summary statistics detailing the number of detections, exceedances, and range in concentrations are reported in **Table O-5** of **Appendix O**.

Field data records for hydric soil sampling are included in **Appendix C-13**.

4.3.3.1 Hydric Soil Analytical Results

Hydric Soil analytical results are broken out by drainage basin, including Greenlaw Brook, Butterfield Brook, and the Reference Drainages that were sampled.

Greenlaw Brook

- A total of 35 hydric soil samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFDA, PFOS, and PFOA.
    - PFDA was detected and exceeded the Residential Soil RSLs in 3 hydric soil samples.
    - PFOS was detected in 29 hydric soil samples, 24 of those samples exceeded the USEPA Residential Soil RSL.
    - PFOA was detected and exceeded the Residential Soil RSLs in 15 hydric soil samples.
- PFAS compounds detected in the Greenlaw Brook drainage basin below USEPA Residential Soil RSLs include: PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have applicable RSLs include: PFDS, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeA, PFTrDA, and PFUnA.

Butterfield Brook

- A total of 10 hydric soil samples were collected for PFAS analysis in the Butterfield Brook drainage basin. PFAS compounds with exceedances of USEPA Residential Soil RSLs include: PFDA, PFOS, and PFOA.
    - PFDA was detected and exceeded the Residential Soil RSLs in 1 hydric soil sample.
    - PFOS was detected in 8 hydric soil samples, 5 of those samples exceeded the USEPA Residential Soil RSL.
    - PFOA was detected and exceeded the Residential Soil RSLs in 2 hydric soil samples.
- PFAS compounds detected in the Butterfield Brook drainage basin below USEPA Residential Soil RSLs include: PFHxS and PFNA.
- Other PFAS compounds detected in the Butterfield Brook drainage basin that do not have applicable RSLs include: PFUnA.

Reference Drainages

- A total of 1 hydric soil sample was collected for PFAS analysis in the Reference drainage basins. No PFAS compounds were detected.

4.3.4 Porewater

Porewater results for PFAS are presented in **Table 4-7** and are compared to human health and ecological SLs including:

- the lowest of three surface water and porewater ecological benchmarks for eight PFAS**,** and
- the Swimming SL since porewater can be used as a conservative surrogate for surface water. There are no directly applicable human health SLs for porewater.

Figure 4-23 shows the locations of porewater sample collection. **Figures 4-24A through 4-24E** compare results to the lowest ecological surface water/porewater benchmark for any PFAS with an applicable SL. Summary statistics detailing the number of detections, exceedances, and range in concentrations are reported in **Table O-7** of **Appendix O**.

Field data records for porewater sampling are included in **Appendix C-17**.

4.3.4.1 Porewater Analytical Results

Porewater analytical results are broken out by drainage basin, including Greenlaw Brook, Butterfield Brook, and the Reference Drainages that were sampled.

Greenlaw Brook

- A total of 32 porewater samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. PFAS compounds with exceedances of the lowest ecological porewater benchmark include: PFOS.
    - PFOS was detected in 30 porewater samples, 23 of which exceeded the lowest ecological porewater benchmark.
- PFAS compounds detected in the Greenlaw Brook drainage basin below the lowest ecological porewater benchmark include: PFBS, PFBA, PFDA, PFHxS, PFHxA, PFNA and PFOA.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have ecological porewater benchmarks include: 6:2FTS, NEtFOSAA, NMeFOSAA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, and PFPeA.

Butterfield Brook

- A total of 10 porewater samples were collected for PFAS analysis in the Butterfield Brook drainage basin. PFAS compounds with exceedances of the lowest ecological porewater benchmark include: PFOS.
    - PFOS was detected in 9 porewater samples, 6 of which exceeded the lowest ecological porewater benchmark.
- PFAS compounds detected in the Butterfield Brook drainage basin below the lowest ecological porewater benchmarks include: PFBS, PFBA, PFDA, PFHxS, PFHxA, PFNA, and PFOA.
- Other PFAS compounds detected in the Butterfield Brook drainage basin that do not have ecological porewater benchmarks include: PFHpS, PFHpA, PFNS, PFPeS, and PFPeA.

Reference Drainages

- A total of 2 porewater samples were collected for PFAS analysis in the Reference drainage basins. PFAS compounds with exceedances of the lowest ecological porewater benchmark include: PFOA.

  - PFOA was detected and exceeded the lowest ecological porewater benchmark in 1 porewater sample.

- PFAS compounds detected in the Reference drainage basins below the lowest ecological porewater benchmarks include: PFBA and PFOS.
- Other PFAS compounds detected in the Reference drainage basins that do not have ecological porewater benchmarks include: PFPeA.

4.3.5 Additional Field Data Records

Field data records for foraging samples to support the Baseline Human Health Risk Assessment (BHHRA) combine biotic and abiotic media sampled at each location. Field data records for foraging samples that include biota, hydric soil, shallow groundwater, surface water, and sediment are provided in **Appendix C-15**.

Field data records for ecological samples to support the Baseline Ecological Risk Assessment (BERA) combine biotic and abiotic media sampled within each area of the terrestrial and aquatic sampling programs. Field data records for aquatic samples that include biota, surface water, sediment, and porewater are provided in **Appendix C-17**.

4.4 STORM SEWER

Stormwater sampling results for PFAS are presented in **Table 4-8.** There are no applicable human health RSLs or ecological benchmarks for stormwater, however, since the water discharges to surface water bodies, results are compared to human health and ecological screening values including:

- the Swimming SL for nine PFAS with a hazard quotient of 0.1, and
- the lowest of three ecological benchmarks for eight PFAS.

Locations of the storm sewers sampled are shown on **Figure 4-25**. **Figure 4-26** presents the stormwater sampling results by year. **Figure 4-27** presents the results of the targeted base, mid, and peak flow sampling around a precipitation event, as discussed in **Section 3.2.11.** Data is presented on these figures as follows:

- Results are presented for eight PFAS compounds (PFBS, PFBA, PFOS, PFOA, PFHxS, PFHxA, PFNA, and PFDA) in summary boxes with colors representing concentrations compared to SLs. These summary boxes also show multiple samples where samples were collected for various years at the same location. Compounds with RSLs or benchmark values were included in the figures because they are the most prevalent PFAS detected in source areas. HFPO-DA is not included in the figures because no exceedances of this compound were identified.

Field data records for the stormwater sampling are included in **Appendix C-18**. Additional details regarding the storm sewer evaluation are included in **Appendix I**. Summary statistics detailing the number of detections, exceedances, and range in concentrations are reported in **Table O-8** of **Appendix O**.

4.4.1 Analytical Results

- A total of 142 stormwater samples were collected for PFAS analysis. PFAS compounds with exceedances of the Swimming SL include: PFDA, PFOS, and PFOA.
    - PFDA was detected and exceeded the Swimming SL in 33 storm sewer samples.
    - PFOS was detected in 140 storm sewer samples, 122 of which exceeded the Swimming SL.
    - PFOA was detected and exceeded the Swimming SL in 140 storm sewer samples.
- PFAS compounds that were detected below the Swimming SL include: PFBS, PFBA, PFHxS, PFHxA, and PFNA.
- Other PFAS compounds detected in the storm sewer that do not have Swimming SLs include: 8:2FTS, 4:2FTS, 6:2FTS, NetFOSE, NMeFOSE, PFDS, PFDoS, PFDoA, PFHpS, PFHpA, PFNS, PFOSA, PFPeS, PFPeA, and PFUnA.

4.5 SANITARY SEWER

Figure 4-29 shows the results of the sanitary sewer evaluation and outlines the locations where the sanitary sewer piping is interpreted below the water table. The sanitary sewer evaluation included an assessment of data from samples collected throughout the sanitary sewer system provided by MEDEP. PFAS compounds were detected in each sample. Concentrations of PFOS from samples collected through the sanitary sewer system range between 9.22 ng/L and 79.4 ng/L while PFOA ranges between 0.642 ng/L and 19.8 ng/L. Concentrations of PFOS from samples collected at the outfall of the CUD WWTP range between 47.5 ng/L and 118 ng/L and PFOA ranges between 7.97 ng/L and 15.6 ng/L. Concentration of PFAS compounds detected in surface water show an increase of PFOS from 0.818 ng/L to 3.52 ng/L, PFOA is shown to increase in concentration from 0.642 ng/L to 2.92 ng/L when comparing samples collected upstream compared to downstream of the sanitary sewer outfall. Additional details of the sanitary sewer evaluation are included in **Appendix J**.

4.6 DRINKING WATER

Drinking water PFAS sampling results through the end of 2024 are presented in **Table 4-9** and are compared to applicable human health SLs including:

- the USEPA MCL for five PFAS, and
- Maine's Sum of Six PFAS MCL.

Figure 4-30 shows the locations of drinking water sample collection. **Figure 4-31** compares the most recent sampling results through the end of 2024 to the USEPA MCL for PFOS.

Tables and figures are redacted where permission to share sampling locations was not given by the property owner.

Field data records associated with the drinking water well sampling are provided in **Appendix C-19**.

4.6.1 Private and Public Drinking Water Analytical Results

16 of 46 private and public drinking water wells sampled during the PFAS RI between 2021 and 2024 exceeded the lowest applicable SL.

Of the private and public drinking water wells sampled during the PFAS RI, five had samples that exceeded the DoD actionable levels as outlined in the September 2024 policy memorandum, discussed in **Section 1.3**. The status of these wells is as follows:

- RES07 has a point-of-entry treatment (POET) system installed by the MEDEP.
- RES09 was placed on a quarterly monitoring program to better understand seasonal distribution.
- RES11 has a POET system installed by the MEDEP.
- ANWR02 was decommissioned and the well pump removed.
- USFW01 was placed on a quarterly monitoring program to better understand seasonal distribution.

4.7 BIOTA TISSUE FOR HUMAN CONSUMPTION

Biota tissue for human consumption sampling results for PFAS are presented in **Table 4-10** and are compared to the applicable human health SLs where SLs exist for the following media:

- Fish (filleted with skin on)
- fiddleheads
- labrador tea
- cattail shoots
- blueberries, and
- cattail roots.

Figure 4-32 shows the locations of biota for human consumption sample collection. **Figures 4-33** and **4-34** compare biota for human consumption results to screening values for PFAS with the highest frequency of detection in summary boxes. Data is presented on these figures as follows:

- Results are presented for four PFAS compounds for fish tissue samples and associated abiotic media (PFDA, PFOS, PFNA, PFHxS).
- Results are presented for three PFAS compounds for plant tissue samples and associated abiotic media (PFDA, PFOS, and PFOA).
- Colors represent concentrations compared to SLs.
- Summary boxes show multiple samples where samples were collected for different media at the same location. **Table 4-16** presents which species were collected from each sample location and the abiotic sample associations.

Field data records associated with the fish tissue sampling are provided in **Appendix C-14**. Field data records associated with the foraging plant sample collection are provided in **Appendix C-15**. Summary statistics detailing the number of detections, exceedances, and range in concentrations are reported in **Tables O-9 through O-14** of **Appendix O**.

4.7.1 Biota Tissue for Human Consumption Analytical Results

Biota tissue for human consumption analytical results are presented by drainage basin, including Greenlaw Brook, Butterfield Brook, and the Reference Drainages that were sampled.

4.7.1.1 Blueberries

Greenlaw Brook

- A total of 3 blueberry tissue samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. No PFAS compounds exceeded the Foraging Biota for Human Consumption Screening Values.
- PFAS compounds detected in the Greenlaw Brook drainage basin below the Foraging Biota for Human Consumption Screening Values include: PFBA.
- No other PFAS compounds were detected in the Greenlaw Brook drainage basin that do not have Foraging Biota for Human Consumption Screening Values.

Butterfield Brook

- A total of 1 blueberry tissue sample was collected for PFAS analysis in the Butterfield Brook drainage basin. No PFAS compounds were detected.

4.7.1.2 Cattail Roots

Greenlaw Brook

- A total of 7 cattail root tissue samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. PFAS compounds with exceedances of the Foraging Biota for Human Consumption Screening Values include: PFDA, PFOS, and PFOA.
- PFDA was detected and exceeded the Foraging Biota for Human Consumption Screening Values in 1 cattail root tissue sample.
- PFOS was detected in 5 cattail root tissue samples, 1 of those samples exceeded the Foraging Biota for Human Consumption Screening Values.
- PFOA was detected and exceeded Foraging Biota for Human Consumption Screening Values in 7 cattail root tissue samples.
- PFAS compounds detected in the Greenlaw Brook drainage basin below the Foraging Biota for Human Consumption Screening Values include: PFHxS and PFHxA.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have Foraging Biota for Human Consumption Screening Values include: PFDS, PFDoA, PFOSA, PFPeA, PFTrDA, and PFUnA.

Butterfield Book

- A total of 1 cattail root tissue samples were collected for PFAS analysis in the Butterfield Brook drainage basin. No PFAS compounds were detected.

Reference Drainages

- A total of 1 cattail root tissue sample was collected for PFAS analysis in the Reference drainage basins. PFAS compounds with exceedances of the Foraging Biota for Human Consumption Screening Values include: PFOA.
- PFOA was detected and exceeded Foraging Biota for Human Consumption Screening Values in 1 cattail root tissue sample.
- No PFAS compounds were detected in the Reference drainage basins below the Foraging Biota for Human Consumption Screening Values.
- Other PFAS compounds detected in the Reference drainage basins that do not have Foraging Biota for Human Consumption Screening Values include: PFOSA and PFPeA.

4.7.1.3 Cattail Shoots

Greenlaw Brook

- A total of 4 cattail shoot tissue samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. PFAS compounds with exceedances of the Foraging Biota for Human Consumption Screening Values include: PFDA and PFOA.
- PFDA was detected and exceeded the Foraging Biota for Human Consumption Screening Values in 1 cattail shoot tissue sample.
- PFOA was detected and exceeded Foraging Biota for Human Consumption Screening Values in 1 cattail shoot tissue samples.
- PFAS compounds detected in the Greenlaw Brook drainage basin below the Foraging Biota for Human Consumption Screening Values include: PFHxS, PFNA, and PFOS.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have Foraging Biota for Human Consumption Screening Values include: 6:2FTS, PFDoA, PFHpA, PFPeA, PFTrDA, and PFUnA.

Butterfield Brook

- A total of 1 cattail shoot tissue samples were collected for PFAS analysis in the Butterfield Brook drainage basin. No PFAS compounds exceeded the Foraging Biota for Human Consumption Screening Values.
- No PFAS compounds were detected in the Butterfield Brook drainage basin below the Foraging Biota for Human Consumption Screening Values.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have Foraging Biota for Human Consumption Screening Values include: PFPeA.

Reference Drainages

- A total of 1 cattail shoot tissue samples were collected for PFAS analysis in the Reference drainage basins. No PFAS compounds exceeded the Foraging Biota for Human Consumption Screening Values.
- No PFAS compounds were detected in the Reference drainage basins below the Foraging Biota for Human Consumption Screening Values.
- Other PFAS compounds detected in the Reference drainage basins that do not have Foraging Biota for Human Consumption Screening Values include: PFPeA.

4.7.1.4 Fiddleheads

Greenlaw Brook

- A total of 3 cattail root tissue samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. No PFAS compounds were detected.

Reference Drainages

- A total of 1 cattail root tissue sample was collected for PFAS analysis in the Reference drainage basins. No PFAS compounds were detected.

4.7.1.5 Labrador Tea

Greenlaw Brook

- A total of 7 labrador tea tissue samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. No PFAS compounds exceeded the Foraging Biota for Human Consumption Screening Values.
- No PFAS compounds detected in the Greenlaw Brook drainage basin below the Foraging Biota for Human Consumption Screening Values.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have Foraging Biota for Human Consumption Screening Values include: PFBA.

Butterfield Book

- A total of 2 labrador tea tissue samples were collected for PFAS analysis in the Butterfield Brook drainage basin. No PFAS compounds exceeded the Foraging Biota for Human Consumption Screening Values.
- PFAS compounds were detected in the Butterfield Brook drainage basin below the Foraging Biota for Human Consumption Screening Values include: PFBA.
- No other PFAS compounds were detected in the Greenlaw Brook drainage basin that do not have Foraging Biota for Human Consumption Screening Values.

4.7.1.6 Fish for Human Consumption

Greenlaw Brook

- A total of 15 fish tissue for human consumption samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. PFAS compounds with exceedances of the Foraging Biota for Human Consumption Screening Values include: PFDA, PFHxS, PFNA, and PFOS.
- PFDA was detected and exceeded the Foraging Biota for Human Consumption Screening Values in 4 fish tissue samples.
- PFHxS was detected 8 fish tissue samples, 2 of those samples exceeded the Foraging Biota for Human Consumption Screening Values.
- PFNA was detected in 3 fish tissue samples, 2 of those samples exceeded the Foraging Biota for Human Consumption Screening Values.
- PFOS was detected and exceeded Foraging Biota for Human Consumption Screening Values in 15 fish tissue samples.
- No PFAS compounds were detected in the Greenlaw Brook drainage basin below the Foraging Biota for Human Consumption Screening Values.
- Other PFAS compounds detected in the Greenlaw Brook drainage basin that do not have Foraging Biota for Human Consumption Screening Values include: PFDoA, PFHpS, PFHpA, PFNS, and PFUnA.

Butterfield Book

- A total of 10 fish tissue for human consumption samples were collected for PFAS analysis in the Butterfield Brook drainage basin. PFAS compounds with exceedances of the Foraging Biota for Human Consumption Screening Values include: PFOS.
- PFOS was detected and exceeded Foraging Biota for Human Consumption Screening Values in 10 fish tissue samples.
- PFAS compounds detected in the Butterfield Brook drainage basin below the Foraging Biota for Human Consumption Screening Values include: PFHxS and PFNA.
- Other PFAS compounds detected in the Butterfield Brook drainage basin that do not have Foraging Biota for Human Consumption Screening Values include: PFUnA.

Reference Drainages

- A total of 3 fish tissue for human consumption samples were collected for PFAS analysis in the Reference drainage basins. PFAS compounds with exceedances of the Foraging Biota for Human Consumption Screening Values include: PFOS.
- PFOS was detected and exceeded Foraging Biota for Human Consumption Screening Values in 3 fish tissue samples.
- No PFAS compounds were detected in the Reference drainage basins below the Foraging Biota for Human Consumption Screening Values.

- No other PFAS compounds were detected in the Reference drainage basins that do not have Foraging Biota for Human Consumption Screening Values.

4.8 ECOLOGICAL TISSUE

Ecological tissue sampling results are presented in **Table 4-11.** There are no applicable SLs for ecological tissue.

Figure 4-35 shows the locations of ERA tissue sampling.

Table 4-17 provides a description of the abiotic and biotic media collected for each sampling location.

Field data records associated with the terrestrial ecological sampling are provided in **Appendix C-16**. Field data records associated with the aquatic ecological sampling are provided in **Appendix C-17**. Summary statistics detailing the number of detections and range in concentrations are reported in **Tables O-15 through O-20** of **Appendix O**. There are no applicable SLs to compare ecological tissue against.

4.8.1 Ecological Tissue Analytical Results

Aquatic ecological tissue sampling analytical results are presented by drainage basin, including Greenlaw Brook, Butterfield Brook, and the Reference Drainages that were sampled. Terrestrial ecological tissue sampling analytical results are presented as sitewide summaries.

4.8.1.1 Aquatic Plant

Greenlaw Brook

- A total of 22 aquatic plant tissue samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. Detected PFAS compounds include: 8:2FTS, 6:2FTS, 3-Perfluoroheptyl propanoic acid (7:3FTCA), NMeFOSAA, NMeFOSE, Perfluoro-4-methoxybutanoic acid (PFMBA), PFBA, PFDS, PFDA, PFDoS, PFDoA, PFHpS, PFHpA, PFHxS, PFHxA, PFNS, PFNA, PFOSA, PFOS, PFOA, PFPeS, PFPeA, PFTrDA, and PFUnA.

Butterfield Brook

- A total of 8 aquatic plant tissue samples were collected for PFAS analysis in the Butterfield Brook drainage basin. Detected PFAS compounds include: PFMBA, PFBA, PFDA, PFHxS, PFNA, PFOSA, PFOS, and PFOA.

Reference Drainages

- A total of 2 aquatic plant tissue samples were collected for PFAS analysis in the Reference drainage basins. Detected PFAS compounds include: PFBA and PFPeA.

4.8.1.2 Aquatic Invertebrate

Greenlaw Brook

- A total of 25 aquatic invertebrate samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. Detected PFAS compounds include: 8:2FTS, 6:2FTS, 5:3FTCA, 7:3FTCA, HFPO-DA, NEtFOSAA, PFMBA, PFBS, PFBA, PFDS, PFDA, PFDoS, PFDoA, PFHpS, PFHpA, PFHxS, PFHxA, PFNS, PFNA, PFOSA, PFOS, PFOA, PFPeS, PFPeA, PFTeDA, PFTrDA, and PFUnA.

Butterfield Brook

- A total of 9 aquatic invertebrate samples were collected for PFAS analysis in the Butterfield Brook drainage basin. Detected PFAS compounds include: 7:3FTCA, PFDS, PFDA, PFDoS, PFDoA, PFHpA, PFHxS, PFNS, PFNA, PFOSA, PFOS, PFOA, PFTeDA, PFTrDA, and PFUnA.

Reference Drainages

- A total of 2 aquatic invertebrate samples were collected for PFAS analysis in the Reference drainage basin. Detected PFAS compounds include: PFOS, PFOA, and PFTrDA.

4.8.1.3 Whole Body Fish

Greenlaw Brook

- A total of 18 whole body fish samples were collected for PFAS analysis in the Greenlaw Brook drainage basin. Detected PFAS compounds include: 8:2FTS, 5:3FTCA, 7:3FTCA, NEtFOSAA, PFBS, PFDS, PFDA, PFDoS, PFDoA, PFHpS, PFHxS, PFNS, PFNA, PFOSA, PFOS, PFOA, PFPeS, PFTeDA, PFTrDA, and PFUnA.

Butterfield Brook

- A total of 8 whole body fish samples were collected for PFAS analysis in the Butterfield Brook drainage basin. Detected PFAS compounds include: PFDS, PFDA, PFDoS, PFDoA, PFHpS, PFHxS, PFNS, PFNA, PFOSA, PFOS, PFOA, PFTeDA, PFTrDA, and PFUnA.

Reference Drainages

- A total of 2 whole body fish samples were collected for PFAS analysis in the Reference drainage basin. Detected PFAS compounds include: PFMBA, PFDA, PFDoA, PFNA, PFOS, PFTeDA, PFTrDA, and PFUnA.

4.8.1.4 Terrestrial Plant

- A total of 21 terrestrial plant samples were collected for PFAS analysis sitewide. Detected PFAS compounds include: 8:2FTS, 6:2FTS, NEtFOSE, PFBS, PFBA, PFDA, PFDoS, PFHpS, PFHpA, PFHxS, PFHxA, PFNS, PFNA, PFOSA, PFOS, PFOA, PFPeS, and PFPeA.

4.8.1.5 Terrestrial Invertebrate

- A total of 23 terrestrial invertebrate samples were collected for PFAS analysis sitewide. Detected PFAS compounds include: 8:2FTS, 6:2FTS, 5:3FTCA, 7:3FTCA, 3:3FTCA, NEtFOSA, NEtFOSAA, NEtFOSE, NMeFOSA, NMeFOSAA, NMeFOSE, PFMBA, PFBS, PFBA, PFDS, PFDA, PFDoS, PFDoA, PFHpS, PFHpA, PFHxS, PFHxA, PFNS, PFNA, PFOSA, PFOS, PFOA, PFPeS, PFPeA, PFTeDA, PFTrDA, and PFUnA.

4.8.1.6 Rodent

- A total of 12 rodent samples were collected for PFAS analysis sitewide. Detected PFAS compounds include: 8:2FTS, 6:2FTS, 5:3FTCA, 7:3FTCA, PFBS, PFBA, PFDS, PFDA, PFDoS, PFDoA, PFHpS, PFHpA, PFHxS, PFHxA, PFNS, PFNA, PFOSA, PFOS, PFOA, PFPeS, PFPeA, PFTeDA, PFTrDA, and PFUnA.

4.9 NON-PFAS ANALYTICAL DATA

Non-PFAS Soil Data

- Non-PFAS soil samples were collected to supplement non-PFAS soil data from previous investigations and confirm sufficient data exists to evaluate potential risks to human health. Non-PFAS analytical results for soil samples are presented in **Table 4-12**.
- Non-PFAS soil samples were collected to support fate and transport modeling. Non-PFAS results for solid fate and transport samples are included in **Table 4-12**, and aqueous PFAS results from LEAF testing are provided in **Table 4-13**.

Non-PFAS Groundwater Data

- Fifty groundwater samples were collected throughout Loring in 2022 to supplement non-PFAS groundwater data from previous investigations and provide sufficient data for evaluation of potential risks to human health from non-PFAS compounds. These samples were analyzed for VOCs, SVOCs, PCBs, pesticides, metals, and/or perchlorate. Results for non-PFAS compounds in groundwater can be found in **Table 4-15**.

4.10 NON-ANALYTICAL DATA

4.10.1 Non-Analytical Groundwater Data

Well Installation

PFAS RI monitoring wells were drilled, constructed, and developed in accordance with applicable work plans and standard operating procedures (SOPs). Field data records for the development of existing monitoring wells and monitoring wells installed during the PFAS RI are provided in **Appendix C-6** and **C-7**, respectively. Field data records for groundwater sampling are provided in **Appendix C-9**.

Location Data

Sample location coordinates were recorded with handheld global positioning system (GPS) devices to collect latitude and longitude. New monitoring well installations were surveyed by a licensed professional surveyor that recorded latitude, longitude, ground surface elevation, measuring point elevation, and top of casing elevation. Elevations were recorded using the North American Vertical Datum of 1988 (NAVD88). Well survey reports of monitoring wells installed during the PFAS RI can be found in **Appendix G**.

Overburden Thickness

Field observations recorded during PFAS RI well installation and soil boring activities were used to interpolate overburden thickness over the investigation area, presented in **Figure 4-6**. Overburden thickness across Loring ranges from approximately one foot to 95 feet and is generally thinner near discharge areas. Overburden is generally thicker near the WWTP, northeast of Malabeam Lake, FJETC, and to the north and northwest of the Loring boundary.

Hydraulic Conductivity Testing

Hydraulic conductivity testing was performed at 35 monitoring wells. Field data records for hydraulic conductivity testing can be found in **Appendix C-8**. These data were analyzed by AQTESolv® software to estimate hydraulic conductivity and were used to inform the CSM and the fate and transport model. These analyses are provided in **Appendix H**.

Borehole Geophysics

Borehole geophysics was completed in accordance with applicable work plans at 18 deep bedrock wells prior to their installation to identify water-bearing fractures and inform the decision-making process for bedrock well construction. In addition to identifying water-bearing fractures, the borehole geophysics was used to identify bedrock structure and the attitude of water-bearing fracture zones.

Geophysical logs are provided in **Appendix D**, and bedrock structural features identified from the geophysical logging efforts from the PFAS RI and previous investigations are shown on **Figure 2-8.**

Water Level Gauging

Water level gauging of between 394 and 472 monitoring wells was conducted during each of the six groundwater sampling events, with results provided in **Appendix E-1**. Monitoring wells were selected at locations and depths that were optimal to serve as hydraulic control informational points to aid in hydrogeologic modeling of groundwater contours, **Appendix M**. Overburden and bedrock groundwater potentiometric surface contours are shown on **Figure 4-7** and **Figure 4-8** respectively. Groundwater potentiometric surface contours are shown on figures marked with their respective water level elevations compared to NAVD88. Water level measurements were also used as inputs to develop the vertical hydraulic gradients provided in **Appendix E-4** and shown on **Figure 4-22**. Total depths of monitoring wells were measured in September 2022 and April 2024 to confirm the correct depth measurements were being used in hydrogeologic models.

Pressure Transducers

Pressure transducers were installed in 12 monitoring wells in November 2023 and remained deployed until November 2024 to observe how water levels varied seasonally over the course of one year. Transducers were installed at depths to ensure the probe was submerged for the entirety of data collection. Data was collected continuously at two-hour intervals and was downloaded monthly during the spring, summer, and fall to confirm the transducers were operating normally. Hydrographs of transducer data are provided in **Appendix E-3**. The locations of the monitoring wells with pressure transducers are shown on **Figure 4-21**. In May 2024, it was determined that two transducers were no longer functioning at wells AA20MW-01 and SB/OW12001. After attempting to troubleshoot the probe and data cable in the field, these transducers were sent to the manufacturer for repair and redeployed in August 2024.

4.10.2 Non-Analytical Surface Water Data

Stream Gauges

At each of the 17 stream gauges installed to measure the water level and discharge of Greenlaw Brook and Butterfield Brook, the channel was discretized into a series of representative sections at predefined intervals. Water levels and flow velocity were measured at each of these sections to calculate the cross-sectional area and velocity associated with each section. The total discharge of each section was summed to calculate the discharge at that portion of the stream. These measurements were collected concurrently with water level gauging of monitoring wells during each of the six groundwater sampling rounds. Stream gauge locations at some of these monitoring points were altered during the field program based on accessibility or field conditions, including locations for LSG-01 and LSG-06. LSG-15 was found to be inaccessible after the 2022 field season. Field data records for stream gauging are provided in **Appendix C-11**, and a data summary table is provided in **Appendix E-2**. The locations of the stream gauges are shown on **Figure 4-21**.

4.10.3 Non-Analytical Lysimeter Data

Pressure-vacuum lysimeters were installed in 2022 in accordance with applicable work plans and SOPs in the FTA, SFS, and CFS source areas to aid in development of the fate and transport model.

Locations of lysimeters are shown on **Figure 4-23.** Visual soil characteristics were logged during drilling and soil samples were collected and analyzed for characteristics to support LEAF testing. Boring logs and construction diagrams of lysimeter installations are provided in **Appendix C-3**. Lysimeter analytical results are presented in **Table 4-14**.

4.11 GROUNDWATER MODELING

Data collected as part of this PFAS RI were used to assess the leaching of PFAS from identified source areas and the transport of PFAS in groundwater using a three-dimensional numerical groundwater model. This model also incorporates PFAS transport through surface water and storm drain interaction with groundwater. The fate and transport assessment provides insight into potential PFAS concentrations

temporally and spatially across Loring and identifies areas at risk of exceeding or remaining above regulatory limits.

The PFAS compounds retained in the soils or sediment continue to serve as a source of PFAS to groundwater and surface water, including flow in storm sewers, since their release to the environment. The PFAS within the hydrologic system can be transported away from the source areas and currently identified areas of known PFAS impacts via groundwater and surface water transport. The goal of the fate and transport assessment is to identify the potential nature and extent of PFAS in groundwater and surface water bodies downstream of source areas in the future and to support development of remedial actions to reduce risk to downgradient receptors. The following sections summarize the findings of this PFAS RI study in terms of PFAS contributions from source areas and the predicted potential future transport through groundwater and surface water bodies from source areas and currently identified areas of impact. Additional analysis details are provided in **Appendix N**.

4.11.1 Source Area Vadose Zone Soil Leaching

The leaching of PFAS from soils to groundwater at four primary identified source areas (FTA, SFS, CFS, and Nose Dock 44) was assessed using a combination of data including soil PFAS concentrations, lysimeter porewater PFAS concentrations, PFAS leaching concentrations from column testing (LEAF method 1314 analysis), recharge rates, water levels, and soil physical properties such as hydraulic conductivity, bulk density, total porosity, effective porosity, and soil moisture content. Additionally, data reported in literature was used to support calculations where Site-specific information was not available. The PFAS assessed include only PFOA and PFOS as they have an assigned USEPA MCL value of 4 ng/L. The combined data was used to define the source term input for the numerical model transport simulations, leaching to groundwater mass flux calculations, and USEPA soil screening level (SSL) calculations including calculation of a revised SSL (SSL^{Rev}) that incorporates air-water interfacial interactions. The approach used is consistent with aspects of the AFCEC Environmental Restoration Technical Support Branch (CZTE) guide on lysimeter sampling and analysis (AFCEC/CZTE 2025). However, the AFCEC/CZTE (2025) guide was first reported in January 2025 after the lysimeters were installed and the lysimeter data was collected at Loring (between 2022 and 2024). The AFCEC/CZTE (2025) guide could not be followed due to a lack ofdata to do so, including, but not limited to, the number of lysimeters required to perform the assessment presented in the guide. The guide is based on no less thanthree (3) lysimeter locations near the water table for each source area where only one lysimeter near the water was available at each Loring source area for evaluation. The approach, calculations, and data used in the soil leaching assessment is provided in **Appendix N** with a summary of results presented in the following sections.

4.11.1.1 Source Area Soil Leaching Areal Extent

The four source areas (FTA, SFS, CFS, and Nose Dock 44) were assessed for their individual areal extent of PFAS in soils using ArcGIS and soil PFAS data from this PFAS RI to support fate and transport modelling and risk assessment. A convex hull polygon that encompasses PFAS detections at each source area was created to define the source areas, **Appendix N, Figures N-20** and **N-21**. The resulting calculated source

areas range in size from 4.8 acres for PFOS at Nose Dock 44 and up to 74 acres for PFOS at the FTA, **Appendix N**, **Table N-1**.

4.11.1.2 Source Area Soil Leaching Lysimeter Assessment

The PFAS results from six semi-annual sampling events were reported for porewater suction-lysimeter sampling that occurred in the summer and fall of 2022, 2023, and 2024 for three of the four source areas (FTA, CFS, and SFS). An attempt was made to install a lysimeter at Nose Dock 44 however the lysimeter was not installed due to the presence of perched water and difficulty drilling through the glacial till.

The lysimeter PFAS concentration distributions for the two primary PFAS of interest in lysimeter porewater samples show that the leaching to groundwater is dominated by PFOS and followed by PFOA at approximately an order of magnitude lower concentrations. The highest concentrations are observed at the CFS source area with relatively similar ranges for the other two source areas.

The PFAS average mass flux rate for current conditions was calculated for each of the two PFAS compounds at each lysimeter for the three source areas that have lysimeters installed. The average PFAS mass flux rate leaching to groundwater was calculated using the combined deep lysimeter median concentrations for each source area for the three-year interval in combination with the recharge rates of 12.5 to 22.7 inches per year (in/yr) and assuming a unit area of one square foot, **Appendix N, Table N-2**. Components of recharge are based on Site-specific data and the rates are calculated using methods described in detain in **Appendix N**.

4.11.1.3 SSL Assessment

The USEPA Soil Screening Guidance (U.S. EPA, 1996) was used in combination with the revised screening method reported by Brusseau and Guo (2023) as an initial assessment in the determination of soil PFAS concentrations that will result in groundwater PFAS values below the regulatory values **Appendix N, Tables N-3 through N-6**.

This soil screening assessment is used to estimate contaminant release to groundwater at a source are based on a linear equilibrium soil/water partition equation referred to as the SSL. The SSL is a linear equilibrium soil/water partition equation. The SSL^{Rev} takes into account the air water interface based on the work by Brusseau and Guo (2023) and is provided for comparison to the traditional SSL, with both equations incorporating a combination of a water-balance and dilution attenuation factor to account for reduction of soil leachate concentration from mixing in an aquifer. The development of the SSL and SSL^{Rev} input parameters for the Loring source areas, including inputs to the dilution attenuation factor and d_m equations, are discussed in detail in **Appendix N**.

The resulting calculated soil PFAS concentrations are referred to as the SSLs. The USEPA Soil Screening Guidance on developing SSLs is conservative in that the results likely indicate biased low residual soil concentrations to meet groundwater regulatory values but serves as a basis for further evaluation. In part the evaluation is conservative in that the vadose zone calculated distribution coefficient (K_d) values are the only mechanism used to account for attenuation of PFAS. The USEPA methodology does not capture

or consider other potential mechanisms such as those occurring at the air water interface that can lead to increased retention in the vadose zone. Thus, the revised method by Brusseau and Guo (2023) is used to calculate the $SSLs^{Rev}$ to consider the increased attenuation by soils due to air water interface interactions and provide more realistic PFAS soil concentrations that will result in meeting groundwater PFAS concentration regulatory criteria. The SSLs and $SSLs^{Rev}$ are both calculated and summarized for comparison, **Appendix N, Table N-7**.

Results are provided for estimates of soil concentrations needed to meet groundwater regulatory criteria, and should be taken as a low-end estimate that requires additional assessment. This could include vadose zone numerical modeling that provides a more robust assessment, during subsequent efforts.

4.11.2 Numerical Transport Model

There are several additional parameter inputs required for setting up the three-dimensional numerical model in addition to what is already included in the numerical flow model. The additional parameters characterize the current distribution of PFAS concentrations in groundwater, continuing source inputs to groundwater, and how the PFAS compounds interact with the aquifer media and therefore how quickly the PFAS compounds transport through the aquifer. The additional parameters required for transport simulations include effective porosity, bulk density, saturated K_d, dispersivity, recharge concentrations associated with each of the four source areas, and an initial concentration condition. The additional parameters were developed from Site-specific data collected during this PFAS RI. Derivation of the additional transport modeling parameters and their input values for the three-dimensional numerical groundwater transport model are provided.

The predictive transport modeling includes the continued leaching of PFAS from the vadose zone to groundwater at each of the three source zones that have lysimeters based on the median deep lysimeter porewater concentrations, the source zone depletion rate from LEAF testing results fitted using power functions, and the recharge rates. The details of the approach, calculations, and results are provided in **Appendix N**. The results provide temporal PFAS leaching to groundwater concentrations in the numerical groundwater model for predictive simulations.

The predictive modeling of PFAS transport in groundwater also requires the input of an initial concentration for each PFAS compound simulated to represent current conditions. The model predictions of future concentrations are strongly dependent on the initial concentrations assigned in the model. The initial concentrations of each PFAS were developed using Earth Volumetric Studio (EVS) and PFAS data collected as part of this PFAS RI from across Loring. The resulting interpolated plumes were imported directly into the groundwater transport model as an initial current condition for predictive modeling. Additional information about EVS modeling is included in **Appendix M.**

4.11.3 Contaminant Migration

Contaminant migration was assessed using the three-dimensional numerical groundwater fate and transport model incorporating a combination of the Site-specific and literature-based data described in previous sections. The transport of PFOA and PFOS was predicted using the numerical model with a steady state flow field employing sorption and dispersion, but not degradation, and with a constant rate of leaching, assigned to recharge, for each of the four source areas, for up to 50 years into the future. The initial conditions, PFAS interpolated plume using EVS, is considered representative of PFAS concentrations at Loring as of the development of this report. Therefore, the numerical model times referenced will be with respect to the end of 2025 simulated predictions moving forward 50 years.

4.11.3.1 Contaminant Fate/Persistence

The persistence of PFAS in the environment is well documented and is present in both soil and groundwater at Loring. In areas where groundwater is shallow, it readily interacts with surface water features. PFAS compounds have been measured in surface water at the Site above MCLs. This indicates that surface water is a vector for contaminant transport and allows migration far faster than groundwater flow alone.

The transport of PFOA and PFOS is relatively limited in the groundwater over the simulated duration of 50 years. However, transport is increased where the plumes intersect surface water features in gaining reaches of streams. Greenlaw Brook and, to a lesser extent the FLDD, both receive contaminated groundwater and transport it downstream to a point that it reinfiltrates. Concentrations are predicted in groundwater along Greenlaw Brook after 10 years and Little Madawaska River after 25 years, earlier than would be expected with groundwater transport alone. There is little to no reduction in the size of the PFOA or PFOS plumes at Loring over the 50-year simulation period.

4.12 DATA QUALITY

The primary objectives of the PFAS RI were presented in **Section 1.1**. The types of data needed to meet the data quality objectives (DQOs) as required by CERCLA are detailed in the QPP (Wood, 2022a; WSP, 2025a). The quality of the data needed to achieve the DQO's includes the following data quality indicators (DQI):

- ***Method Selectivity/Specificity*** is defined as the compound type or class that can be detected by the instrument or detector.
- ***Method Sensitivity***, the effectiveness of the reporting limits compared to the action levels for the Site.
- ***Precision*** addresses analytical variability (field duplicates).
- ***Accuracy*** compares measured values to the true value (percent recoveries).
- ***Representativeness*** evaluates how well the samples represent the system under study.
- ***Comparability*** evaluates how well data from one study compares to data from previous studies.

- ***Completeness*** evaluates the percentage of usable data.
- ***Evaluations*** of the DQIs are presented in each data validation report associated with soil sampling, sediment sampling, groundwater sampling, and biological sampling.

Data validation was conducted manually by the WSP project chemist or by a third-party validator with final review by the WSP project chemist following the guidelines referenced in the QPP (Wood, 2022a; WSP, 2025a). Data validation reports are included in **Appendix K**. Data presented in this RI Site Characterization Summary Report is considered usable and defensible.

A portion of the samples collected through the PFAS RI investigation process are not reported to their applicable screening levels for PFOS, PFDA, HFO-PDA, and PFOA. This includes samples collected during the 2022 field season, which were analyzed using USEPA Method 537M. Samples collected between 2023 and 2024 were analyzed using USEPA Method 1633. These samples were reported to lower detection limits than the samples analyzed using USEPA Method 537M, however the pooled MDLs for USEPA Method 1633 are still higher than current screening levels for PFOA and PFDA.

Equipment and field blank PFAS analytical results are provided in **Table 4-18.**

4.13 INVESTIGATION DERIVED WASTE MANAGEMENT

Liquid Investigation Derived Waste

A mobile water treatment system was deployed in 2022 and 2024 to treat investigation derived waste (IDW) water generated from monitoring well installation, development, and sampling activities. Untreated water was transported from the investigation location and pumped into two sets of weir tanks, allowing sediment to collect at the bottom of the tanks. Water was then pumped through bag filters which further removed sediment larger than 5 micrometers before reaching vessels containing granular activated carbon (GAC) and then pumped into holding tanks to store clean water. Once each tank was full, a sample was collected and analyzed to ensure no PFAS were at detectable levels before discharging the treated water into the storm sewer system.

In 2022, the treatment system was located at the Arch Hangar and consisted of six 5-micron bag filters and two 4,000-pound GAC vessels. Approximately, 52,080 gallons of water were treated and discharged into a catch basin adjacent to the staging area which flows out of the C3 outfall and into the FLDD.

Due to fewer planned well installations during the 2024 field season, a smaller treatment system was deployed at the parking lot outside of the old library which consisted of two 5-micron bag filters and two 1000-pound GAC vessels. Much higher volumes of water were generated at each drilling location, with some boreholes producing volumes of water estimated at over 300 gallons per minute. This resulted in four additional 20,000-gallon frac tanks being deployed to hold untreated water at each drilling location, and two additional frac tanks being deployed to hold untreated water at the treatment system. Approximately, 526,500 gallons were treated during 2024 and discharged into the catch basin in the corner of the parking lot which flows into the FLDD.

Liquid IDW sampling results are provided in **Appendix L-4**, and IDW field data records are provided in **Appendix L-5**.

Solid IDW

Solid waste included sediment, soil, and rock generated during drilling activities, contaminated personal protective equipment, debris from storage containers holding contaminated material, and spent GAC. Solid IDW was held in Department of Transportation-approved 55-gallon drums at each drilling site and was transferred into 25-cubic yard roll-off containers at the staging area. Roll-off containers were then transported to a RCRA Subtitle C landfill after investigation activities were completed. Non-hazardous waste manifests for each roll-off transported offsite are provided in **Appendix L-1.**

Solid IDW waste characterization samples were collected in 2022 and analyzed for PCBs and toxicity characteristic leaching procedure of VOCs, SVOCs, PCBs, pesticides, herbicides, and the RCRA 8 metals. Samples were also analyzed for characterization of pH, corrosivity, ignitability, and reactivity with cyanide and sulfide. Waste characterization analytical results are presented in **Appendix L-3.** To support the characterization of solid IDW, PFAS samples were also collected in 2022 and 2024 with results provided in **Appendix L-2**.

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5.0 NATURE AND EXTENT OF CONTAMINATION

The RI Site Characterization Summary Report includes an evaluation of the nature and extent of source area PFAS in soils and sediment and the resulting impacts to the hydrologic system. CSMs were presented in various work plans developed for this PFAS investigation and the collection of physical and chemical data at the locations described through this report were selected to test and refine the CSM. The CSM was revised throughout the PFAS investigation as data generated provided additional information. These updates were used to guide subsequent investigation activities and analysis. Analytical results of PFAS samples in soil, groundwater, surface water, sediment, porewater, and hydric soils at locations informed by this CSM have been compared to SLs detailed in **Table 1-3.**

The following sub-sections include **Section 5.1**, which provides a summary of the Site-wide CSM and details regarding the mechanisms that control PFAS fate and transport through the environment at Loring. **Sections 5.2 through 5.7** provide additional details to support the Site-wide CSM as well as the characteristics of each source area by flow field. These discussions address how the mechanisms detailed in **Section 5.1** apply at each of these source areas, and how those source areas fit within the larger system and provide support for the statements made in **Section 5.1**. For each source area there is a discussion of the nature of the source material stored in soils or sediment, source area specific migration pathways including groundwater and surface water transport away from the source area, and identification of potential exposure pathways for relevant receptors to be further evaluated in the human health and ERAs. **Section 5.8** details the impacts identified through the local drainage basins, providing more context regarding the extent of PFAS impacts to surface waters. As outlined in **Section 4.0**, PFOS drives the overall extent of PFAS detections and exceedances in groundwater at Loring, and therefore is the primary compound referenced throughout the CSM, however, additional compounds are referenced where relevant to the CSM.

The datasets collected and analyses performed, as described in **Sections 3** and **4**, have been compiled into a series of figures which illustrate the core components of the CSM. These figures compile the results of the independent datasets and evaluations which have been collected and developed through the PFAS RI.

- **Figure 5-1** illustrates PFAS migration pathways, displaying the pathway from source area soils through groundwater to discharge to surface water bodies. This figure combines the extents of soils with the greatest impacts, the modeled groundwater contours, a groundwater plume map for PFOS interpreted groundwater discharge zones, and the extent of local watershed contamination distribution. The groundwater contours represent the modeled water table derived from the MODFLOW, **Appendix N**. The interpreted groundwater discharge zones are shown where the modeled groundwater table intersects the land surface. Soil polygons that outline the extent of confirmed exceedances of residential and industrial SLs have been carried through from **Figures 4-2** to **4-5**. The extent of local watershed contamination is displayed as an outline of water bodies that are impacted above SLs for surface water or sediment. These extents are displayed within two polygons that show the extent of impacts which exceed SLs as well as the extent of impacts which exceed SLs by an order of magnitude. The extent of the PFOS plume

was developed using PFOS concentrations identified in on-Site monitoring wells from the most comprehensive groundwater sampling program, completed in the fall of 2024, detailed in **Appendix M**.

- **Figure 5-2** shows the extents of PFAS MCL exceedances. This figure includes two outlines. The solid black line represents a composite of the extent of impacts identified above the MCL for regulated PFAS compounds based on data collected from the existing monitoring well network. A second, dashed outline incorporates the composite extent of MCL exceedances of PFAS compounds based on the existing monitoring well network as well as results from the residential monitoring program with assumptions regarding private well construction, **Appendix M**. Within the outlines of the composite plume exceedances based on the monitoring well network, the interpolated distribution of the PFAS compounds with MCLs above screening levels is shown. These include PFOS, PFOA, PFNA, PFHxS, and the Maine Sum of 6 PFAS compounds. PFOS is shown to be the most extensive PFAS compound found in groundwater above MCLs across the majority of Loring and responsible for the majority of the areal extent of exceedances.
- **Figure 5-3** shows the locations of geological cross sections.
- **Figures 5-4 through 5-7** provide interpreted cross sections which illustrate Site features, lithologic relationships, hydrologic relationships, and modeled plume extents. These cross sections are oriented to bisect the mapped groundwater plume cores for PFOS at the primary source areas across Loring and illustrate the hydrogeologic conditions in the subsurface. The groundwater plume cores are defined as the zone of highest contaminant concentration within a delineated groundwater plume (EPA, 2014). The interpolated plume cores are discretized on these figures by an order of magnitude difference in PFOS concentrations above the USEPA MCL. The monitoring wells which define the plume cores by consistently exhibiting the highest concentrations at the primary source areas were used to trace the pathway of these cross sections. Further details on the specific concentrations of PFAS compounds identified in groundwater at these wells are included in **Table 4-2**. Lithologic boundaries, the interpolated plume extent, and modeled water levels are derived from outputs of the 3-dimensional block model created in EVS, **Appendix M**. Lithologic boundaries reflect subsurface investigation results incorporating information from existing wells and wells that were installed as part of this PFAS RI.

5.1 SITE WIDE CONCEPTUAL SITE MODEL

The PFAS RI activities at Loring resulted in the characterization of source areas and migration pathways, evaluation of potential impacts to receptors, and refinement of the CSM. These findings are consistent with the underlying mechanisms controlling contaminant fate and transport of PFAS presented in this section**.** The PFAS RI confirmed 22 source areas exhibited exceedances of residential soil RSLs and/or contribute to exceedances of the groundwater MCLs. The PFAS RI identified two additional source areas, Malabeam Lake and Chapman Pit, which were found to have impacted sediment which contributes to local groundwater and surface water impacts. Five of those 24 source areas, including the Burn House, the FTA, the CFS, Nose Dock 44, and the SFS were identified to contain greater PFAS mass in soils and groundwater and have the greatest

potential to impact receptors. These primary source areas are highlighted on **Figure 5-1,** where concentrations of PFAS in soil exceed industrial soil RSLs with associated groundwater plumes up to three orders of magnitude above drinking water MCLs. The historic releases of AFFF and ongoing transport of PFAS from these sources impact surface water bodies and groundwater within and beyond Loring, above their respective MCLs and SLs.

Releases at the identified source areas have impacted local surface water bodies. Impacts to surface water, sediment, and porewater above their respective SLs extend along Greenlaw Brook and Butterfield Brook, including their tributaries and impoundments where they are downstream or downgradient of source areas, **Figure 5-1**. Impacts to surface water bodies are attributed to the retention and back diffusion of PFAS mass from historic releases within sediment and/or the ongoing discharge of impacted groundwater. The PFAS data suggests impacted groundwater can discharge directly to surface water or be captured by the stormwater system collection for subsequent discharge to their respective receiving water bodies.

Historic releases at Nose Dock 44 and the SFS are responsible for the majority of impacts identified along the WBGB. A pair of stormwater infiltration basins, directly west of the Nose Docks, have retained PFAS mass from the historic release of AFFF at Nose Dock 44. The retained PFAS mass at these infiltration basins contribute to groundwater impacts, which are then transported downgradient and discharged downstream along the WBGB. The downstream transport of PFAS from Nose Dock 44 and the SFS have resulted in the retention of PFAS within the sediments of Malabeam Lake and Chapman Pit. The PFAS mass in the sediment of these impoundments act as source areas, impacting surface water and shallow groundwater above SLs and MCLs downgradient and downstream of these water bodies.

Historic releases at the CFS, the SFS, and the Burn House are responsible for the majority of impacts identified along the FLDD and the EBGB. Ongoing discharge of impacted groundwater is identified through either direct groundwater discharge along gaining sections of the brook, or discharge of impacted groundwater through the storm sewer system. The transfer of PFAS from these source areas impacts surface water, sediment, and porewater above their respective SLs. Historic releases at the Burn House, and to a lesser extent, the KC-135 Crash Site and FTF, have impacted surface water, sediment, and porewater above their respective SLs along Tributary 5 of the EBGB which drains through land managed by the Mi'kmaq Nation.

Exceedances of SLs for surface water and sediment along Greenlaw Brook after the confluence of the EBGB and the WBGB extend past the Loring boundary and contribute to exceedances of these criteria along the Little Madawaska River.

The ongoing discharge of impacted groundwater from the FTA and, to a lesser extent the historic release at the B-52 Crash Site, result in impacts to surface water, sediment, and porewater above their respective SLs along Butterfield Brook, the Durepo Reservoir, and Limestone Stream outside the Loring boundary. The impacts to Butterfield Brook are less extensive than those identified along Greenlaw Brook. Concentrations of PFAS in the Butterfield Brook drainage, which are further from the FTA, exhibit more variable concentrations and are often below SLs. Surface water concentrations are controlled largely by the relative contribution of impacted groundwater discharged from the FTA source area compared to the contribution of

flow from relatively cleaner sources from the larger watershed. The relative contribution of streamflow from the discharge of impacted groundwater will decrease during wetter periods with higher surface water discharge.

The PFAS RI has resulted in the identification of the potential for impacts to groundwater used as drinking water. The extent of PFAS exceedances above the MCL extend beyond the Loring boundary, **Figure 5-2**. Potential sources for off-site impacts include agricultural land use, however the location of farm fields with confirmed spreading of potentially impacted PFAS sludge are south of the identified impacts, **Figure 2-2**. Further analysis of the potential impacts will be included in the BHHRA which will be incorporated into the full PFAS RI Report.

Investigation activities confirmed the physical aspects of the Loring CSM, including the underlying mechanisms controlling the geologic and hydrologic systems. The physical controls of these systems are detailed in **Sections 5.1.3 through 5.1.6.** These physical controls were initially developed during RIs completed throughout the 1990's through the 2000's to address legacy contaminants and have been refined through this PFAS investigation. The underlying understanding of the physical conditions at the site have been applied to the identified PFAS source areas and understanding of the chemical behavior of PFAS in the environment, detailed in **Sections 5.1.1** and **5.1.2**.

5.1.1 Contaminant Fate and Transport Characteristics for PFAS

Once released to the environment, the PFAS compounds will interact with environmental media based on their chemistry, and the chemical and physical conditions of the environment. Key mechanisms that control these transport properties are defined and summarized below.

- "Retention" of contaminant mass is a general term that encompasses several physical and chemical processes that result in a particular compound to resist transport from where it currently exists.
- The amount of PFAS mass that will be retained in a source area is controlled by the tendency of PFAS to "partition" to relatively immobile surface of soil particles or into porewater held within the unsaturated zone.
    - Partitioning is a term that refers to the general tendency of a compound to exist in the dissolved, solid, liquid, or gas phase is impacted by chemical characteristics of the compound and the environment it exists in.
- "Partition Coefficients" are ratios that quantify the tendency of these molecules to exist in a particular phase.
- "Sorption" is a form of partitioning where a dissolved compound can transfer out of the dissolved phase to adhere to the surface of a solid, which is "adsorption", or from the surface of a solid, to the dissolved phase, which is "desorption" (Freeze and Cherry, 1979).

- "Leaching" of contaminant mass is a general term that encompasses several physical and chemical processes that result in the transfer of contaminant mass from soils or sediment and into groundwater or surface water.
- Leaching can occur as precipitation infiltrates through the soil column and recharges groundwater. This can result in the transfer of mass retained in the soil through desorption.
- This infiltration can also result in the transfer of contaminant mass held in porewater within the unsaturated zone through the soil column and into groundwater (Freeze and Cherry, 1979; Drever, 1997).

5.1.1.1 PFAS Chemical Characteristics

PFAS are a class of organic compounds that include thousands of anthropogenic chemicals. Each PFAS compound is comprised of carbon-fluorine (C-F) chain with at least one bond and a "functional head". Each combination of C-F chains of different lengths with different functional heads have their own physical and chemical properties which control its fate and transport in the environment (NGWA, 2021).

The focus of this investigation is centered on two sub-groups of PFAS which include perfluoroalkyl carboxylates (PFCAs) and perfluoroalkane sulfonates (PFSAs). Other sub-groups of PFAS compounds exist, however, the majority of PFAS that are included in laboratory analyte lists and within federal and state health-based guidance values are either PFCAs or PFSAs. PFCAs include compounds with a "carboxylate" functional head such as PFOA while PFSAs include compounds with a "sulfonic" functional head, such as PFOS or PFHxS (ITRC, 2026). An analysis of 37 military AFFF sites has identified that PFOA, PFOS, and PFHxS contribute 99% of the magnitude of exceedances in groundwater compared to USEPA MCLs (Kulkarni et al, 2025). As detailed in **Section 4.2**, PFOS consistently has the most detections and exceedances of regulatory criteria in groundwater at Loring.

PFAS compounds used in AFFF are "surfactants", which are substances that lower the surface tension of a liquid. This behavior is a result of the relative charge of PFAS molecules, where the functional head has a charge, while the C-F chains do not have a charge. This results in the functional head preferring to exist dissolved in water compared to the C-F chains, which prefer not to dissolve in water. The charge within the functional head also contributes to the capacity of PFAS compounds to adsorb to the surfaces of solids.

- This balance between the charged head and non-charged tail results in an affinity for PFAS to partition to the "air-water interface" (AWI) (ITRC, 2026).
    - Partitioning of PFAS to the AWI can slow its leaching from soil and can contribute roughly 50% of the retention of PFAS in source areas, depending on site specific parameters (ITRC, 2026).
    - PFAS with longer C-F chains, including PFOA and PFOS, have a relatively higher affinity for the AWI compared to other, shorter chain PFAS compounds (NGWA, 2021).
- Longer C-F chain PFAS, such as PFOA and PFOS, have relatively higher capacity to adsorb to soil particles compared to shorter chain PFAS.

- Compared to other common volatile organic contaminants, PFOS has been found to have similar partition coefficients as naphthalene while PFOA has slightly lower partition coefficients, between published values for tetrachloroethene or benzene. PFHxS has partition coefficients between PFOS and PFOA (NGWA, 2021).

- PFAS can partition to the interface between LNAPLs and groundwater. The retention of PFAS at this interface relative to the AWI or sorption sites will vary based on site-specific conditions, however, studies suggest partitioning to the LNAPL-water interface will be less than the AWI (ITRC, 2026).

The relative differences in partitioning coefficients for various PFAS compounds mean that they will behave differently in the environment.

- Shorter C-F chain PFAS are more soluble and mobile in groundwater while longer chain PFAS are less soluble and less mobile (NGWA, 2021). This dynamic can change the relative proportions of PFAS compounds as they are transported away from the source area (ITRC, 2026).

PFAS compounds can be categorized as either terminal transformation products or precursors.

- PFAS terminal transformation products are the most resistant to degradation in the environment. Degradation is a general term referring to the transformation of a chemical to other constituent(s) regardless of the actual chemical or biochemical process involved (ITRC, 2026).
  - Terminal transformation compounds that have been detected at Loring include PFOA, PFOS, and PFHxS. This resistance to degradation plays an important role in the accumulation and persistence of these terminal products in the environment (NGWA, 2021).
- PFAS precursors are compounds that are less stable in the environment and have greater potential to transform into other PFAS precursors or terminal transformation products. Relatively weaker bonds within the chemical structure, primarily within the functional head, can be broken. This results in the transformation of the precursor to a PFAS compound which can have different properties (ITRC, 2026). PFAS precursor compounds that have been detected in samples from Loring include 8:2 FTS, 6:2 FTS, and PFOSA, among others.
  - The mechanisms that control these transformations and the timeframes within which these reactions occur are subject to ongoing research, but the degradation is relatively slow compared to other common organic pollutants such as chlorinated solvents or petroleum compounds (NGWA, 2021; ITRC, 2026).
  - Due to the relatively slow degradation process, PFAS precursors can act as a long-term source of continued production of terminal PFAS compounds (Dasu et al, 2022).

5.1.1.2 Environmental Media Fate and Transport

Hydrologic conditions, including precipitation and infiltration rates, depth to saturated groundwater, groundwater and surface water chemistry, the volume of groundwater or surface water flow, and the presence of other co-contaminants impact the fate of PFAS molecules in the environment (ITRC, 2026).

Soil chemistry controls the relative amount of sorption sites available for contaminant mass to be retained.

- Organic matter will have the highest adsorption capacity while coarser soil particles such as sand and gravel will have the lowest adsorption capacity. Fine particles such as clay or silt will have moderate adsorption capacity. The surfaces of bedrock fractures generally have low adsorption capacity (Freeze and Cherry, 1979; Drever, 1997).
- When present, soil organic carbon is a dominant adsorption site for PFAS due to the amount of sorption sites available (ITRC, 2026).

Groundwater and surface chemistry at source areas will impact PFAS fate and transport.

- When a solution has more dissolved compounds than available sorption sites, the compounds with higher partition coefficients will preferentially fill those sites. Compounds with lower partition coefficients can remain in solution while compounds with higher values will adhere to the surface of the solids (Drever, 1997).

Precipitation, infiltration rates, and depth to saturated groundwater will impact the leaching of mass from source area soils, to groundwater systems.

- Lower precipitation and infiltration rates will result in less opportunity for mass to be leached from soils or porewater in the unsaturated zone, to groundwater.
- Deeper groundwater means that there will be greater retention capacity for contaminant mass within the unsaturated zone (ITRC, 2026).

Once PFAS mass is transferred from source zone to groundwater, contaminant fate and transport is further controlled by the nature and the volume of groundwater flowing through the system.

- Groundwater flow will be greater through aquifer material with a higher hydraulic conductivity or a steeper hydraulic gradient (Freeze and Cherry, 1979), where:
    - Hydraulic conductivity is a measure of how easily water will flow through the pore spaces of the aquifer material.
    - Hydraulic gradient is a measure of the change in groundwater levels over the distance between groundwater monitoring wells or observation points.
- More groundwater flow under a source area can result in a larger transfer of mass downgradient from those source areas.
    - Concentrations of PFAS may be reduced through dilution, where groundwater with PFAS leached from source areas mixes with groundwater that infiltrated outside of source areas.

- Concentrations of PFAS are also reduced by a greater spread of impacts associated with greater heterogeneity, or amount of dissimilarity between sub-surface materials increases the spread of impacts. This results in lower concentration impacts being spread over a wider area (Freeze and Cherry, 1979; Drever, 1997).

- Less groundwater flow under a source area can result in greater retention of PFAS mass at that source area and more localized, but higher concentrations in groundwater.
  - The partitioning mechanisms described above can result in the further retention of contaminant mass in soils or bedrock below the water table, predominantly in lower permeability material.
    - This can result in ongoing diffusion of PFAS out of these low permeability materials, even when the ongoing mass transfer from those source areas is eliminated through remediation, in a process called “back-diffusion”.
  - Since terminal PFCAs and PFSAs are resistant to degradation and the retained mass can include precursors which will slowly become terminal PFAS, back-diffusion can result in the long-term persistence of PFAS in groundwater even after source removal and remediation (ITRC, 2026).

PFAS can be transported through surface water, either dissolved as a solute or partitioned onto suspended particles.

- PFAS identified in the sediments of surface water bodies can be a result of partitioning out of the dissolved phase from the water or through the deposition of suspended solids via erosion of source area soils into surface water bodies (ITRC, 2026).
  - Partitioning of PFAS from surface water to sediments is expected to behave in a similar manner as partitioning to soils, where high organic content will provide abundant adsorption sites and can provide the majority of mass retention. This behavior can result in the transfer of PFAS mass from sediment to surface water or vice versa, depending on chemical gradients (ITRC, 2026).
  - The transfer of PFAS from source area soil to sediment in surface water bodies can occur through the erosion of source area soil and subsequent deposition of those sediments in water bodies that receive that runoff (ITRC, 2026).

- PFAS concentrations are typically higher in surface water bodies nearer source areas, at the upper reaches, and during dry conditions, though PFAS concentrations in surface waters near source areas may initially increase with precipitation due to mobilization of PFAS from sources (ITRC, 2026).

  - PFAS concentrations in surface water samples can be impacted by various factors, particularly for samples collected during rain events. Dilution can occur during rainfall if areas upstream of the sample contains lower PFAS concentrations. Conversely, PFAS concentrations or the mass of PFAS-sorbed particulates in surface water can increase when there is an upstream source area or source of runoff (ITRC, 2026).
  - PFAS concentrations in surface water downstream of point sources tend to be highest during dry periods when stormwater runoff is low. Conversely, when PFAS sources are nonpoint sources, such as biosolids application areas, peak concentrations will occur during precipitation events due to mobilization of PFAS from those nonpoint source areas and subsequent discharge to surface water (ITRC, 2026).

- PFAS can be transported through air, particularly when they partition onto aerosols. Aerosols are small particles or water droplets that are suspended in air that will be carried by wind away from the release area. This can result in atmosphere deposition of PFAS via aerosols released from industrial smokestacks (ITRC, 2026).
- During initial release of AFFF foam, the potential for transport through the air can occur, as a portion of the released foam may be carried from the release area by localized wind patterns (Hannan et al, 2025).

PFAS are widespread in the environment because of multiple release mechanisms and migration pathways that affect their distribution. These include, but are not limited to:

- aerial dispersion and deposition,
- incorporation into WWTPs and their biosolids, which can be subsequently used as agricultural fertilizer, and
- the potential for transport and redistribution through infrastructure including stormwater or sanitary sewer systems (ITRC, 2026; NGWA, 2021).

In summary, PFAS compounds released to the environment at source areas can be retained in soil or sediment. PFAS stored in soil and sediment can then gradually leach out of these media and into groundwater, stormwater, and/or surface water systems. When PFAS is incorporated into the hydrologic system, the mass can be transported away from these source areas and creates the potential to impact receptors over a larger area.

5.1.2 Source Areas

The distribution of PFAS compounds at Loring are reflective of historic activities resulting in either intentional or unintentional releases of these compounds to the environment. Analytical results at 22 source areas (excluding the Base Laundry) indicate there are exceedances of residential soil RSLs or exceedances of the groundwater MCLs. Five of these source areas, including the Burn House, the FTA, the CFS, Nose Dock 44, and the SFS, exhibit a greater mass of PFAS in soil and groundwater and are largely responsible for groundwater and surface water impacts identified at Loring. Through this investigation, two additional source areas were identified, at Malabeam Lake and Chapman Pit, bringing the total to 24 source areas.

The five primary source areas (the Burn House, the FTA, the CFS, Nose Dock 44, and the SFS) have exceedances of the industrial RSLs and contribute to groundwater plumes with concentrations greater than 400 ng/L. Polygons that outline exceedances of industrial RSLs at these primary source areas are co-located with the core of the groundwater plumes, where groundwater concentrations are greater than 400 ng/L, shown on **Figure 5-1**. The greater magnitude of soil and groundwater impacts identified at these primary source areas is a major contributor to the spread of PFAS across Loring and increases the potential for impacts to receptors.

One of the five primary source areas, the Burn House, was not identified to be a primary source area until the completion of additional investigations in 2024. With additional monitoring well installation as well as groundwater, soil, and sediment sampling, higher concentrations and more widespread impacts were identified at the Burn House than were initially identified, particularly in the wetland sediment north of the Burn House. Those results elevate the Burn House to be one of the primary source areas in this report. This means that the Burn House was not included in the source area vadose zone leaching assessment as described in **Section 4.11.1** because this source area lacks the LEAF testing and lysimeter results used to support this assessment.

The remaining source areas are considered secondary sources where there are identified impacts above SLs in soil or groundwater, but the impacts are distributed over a smaller area and concentrations are identified at up to several orders of magnitude lower than in the primary source areas. Potential impacts from releases at secondary source areas may comingle with the impacts from the primary source areas.

5.1.3 Overburden Groundwater

Surficial deposits are variable across Loring. Sand and gravel deposits have been identified along the western and northeastern portion of Loring. These sand and gravel deposits are identified as glaciofluvial deposits or stagnation moraine deposits. Till is the predominant native overburden material encountered at Loring, except beneath the western portion of the Site where glaciofluvial deposits are mapped, the northeastern portion of the Site where stagnation moraine deposits are mapped, and along surface water bodies where swamp or wetland deposits are present, **Figure 2-5**.

The till deposits are a heterogenous mix of silt, sand, and gravel, with minor components of clay, which has a lower permeability compared to the glaciofluvial deposits. Fill has been identified at numerous locations across Loring. The fill is generally reworked till and therefore has the same textural and density characteristics as the undisturbed till. Most areas where development of Loring occurred are associated with the installation of sub-surface storm sewer and sanitary sewer infrastructure. These utility corridors tend to have greater hydraulic conductivity and effective permeability, meaning water moves through it with greater ease, **Appendix H**. These utility corridors are displayed on **Figure 2-3** and are located through or near each identified source areas except for the FTA. In soil borings completed near these utility conduits, a relatively coarser material is often noted, likely sourced from historic sand and gravel mining operations. When present, this material overlies the finer grained native glacial till, **Appendices C-2** and **C-4**. The average hydraulic conductivity of overburden wells in sand or gravel deposits or utility corridors is 211 feet per day, or $7x10^{-2}$

centimeters per second. The average hydraulic conductivity of overburden wells in glacial till is 11.5 feet per day, or $4x10^{-3}$ centimeters per second, **Appendix H**.

The overburden groundwater generally occurs under unconfined conditions; however artesian conditions have been noted in a few wells located in Flow Field 4, **Appendix E**.

Overburden groundwater is typically present in low areas or valleys in the bedrock surface, which often correspond to the surface location of stream channels. In areas where the bedrock surface is relatively high, overburden groundwater is generally discontinuous or perched, **Figures 2-8** and **4-6**. Hydraulic gradients in overburden groundwater adjacent to surface water bodies indicate discharge to surface waters, **Figures 4-22** and **5-1**.

The hydraulic gradients that result in groundwater discharge to surface water are evidenced by water level monitoring results from several monitoring well clusters across Loring. These include JPZ0348 and JPZ0349, which are a pair of overburden and bedrock monitoring wells adjacent to the FLDD, as well as paired overburden and bedrock wells, OW05002 and BW05007 at the SFS. These wells show groundwater levels are highest in bedrock, lower in overburden, but water levels in groundwater are higher than in nearby drainages. Water levels in overburden along the FLDD range between 654 and 660 ft NAVD88, while the nearby drainage is at elevation 650 ft NAVD88. Water levels at the SFS range between 658 and 667 ft NAVD 88 while land surface at the surface water body north of the SFS is at 662 ft NAVD88. Water levels at BW12006 and SB/OW12001 at Nose Dock 44 indicate that groundwater levels are lower in the monitoring wells than the nearby surface water bodies, which act as stormwater infiltration basins. Water levels range between elevation 704 and 714 ft NAVD88 in overburden, but land surface at these basins is reported between 714 and 718 ft NAVD88. The locations of these wells are shown on **Figure 4-21** with hydrographs showing the water levels included in **Appendix E-3**.

5.1.4 Site Infrastructure

The storm sewer and sanitary sewer system at Loring, either by design or by degradation, permit I&I, **Figures 4-28** and **4-29**. An extensive underdrain system, which is designed to capture shallow groundwater and discharge it to the storm sewer system is present underlying the Runway, the NDA, and other developed portions of Loring, **Figure 2-3.** Portions of the storm sewer network are installed below the water table, resulting in the potential for infiltration into this infrastructure where this piping is degraded, **Figure 4-28**.

In addition to the storm sewer system, a sanitary sewer system exists which served Loring Air Force Base and continues to serve the currently used buildings at Loring. Portions of this system have degraded, allowing I&I. Portions of this system have been repaired to mitigate I&I, while other portions of the sanitary system that are not in use have been rerouted to discharge to the storm sewer system, **Appendix J** and **Figure 4-29**. This infrastructure provides a means for infiltrating contaminated groundwater and surface water runoff to translocate across Loring and directly discharge to local water bodies.

The primary receiving waters of storm sewer system discharge at Loring include the WBGB west of the NDA and the FLDD located south of the NDA. The FLDD is a channelized perennial stream that discharges to the EBGB. To a lesser extent, the storm sewer also drains eastward along the flightline, the FTA, and the northern portion of the NDA where it discharges to small tributaries that lead to ELL, Butterfield Brook and eventually Durepo Reservoir, **Figure 2-3**.

Baseflow conditions, where there is a constant discharge of water from the outfalls associated with groundwater infiltration to the storm sewer system, have been observed at culverts C1, C2 and C3, located at the headwaters of the FLDD, **Figure 4-28** and **Appendix I**. These culverts drain the areas associated with the NDA, CFS, the Runway, and the Arch Hangar. A portion of this underdrain system was installed within the footprint of wetlands which were present prior to base development, **Figure 2-12**. The storm drain networks and associated underdrains that discharge at outfalls C1, C2, and C3 are within the extents of these former wetlands. The movement of overburden groundwater along the east side of the NDA is, in part, controlled by the storm sewer system. Overburden groundwater east of the NDA and underlying the Runway is captured by the stormwater system for discharge to the FLDD. Tributaries of Butterfield Brook receive runoff from storm sewers on the eastern side of the Runway and the FTA, as well as a portion of the north side of the NDA.

After large storm events, discharge of water from the storm sewer system at the head of the FLDD results in a temporary increase in surface water levels and overburden groundwater elevation in the FLDD. The increase in surface water and overburden groundwater elevations impacts vertical gradients between these hydrologic units, reducing the discharge of bedrock groundwater to overburden or surface waters, **Appendices E** and **I**.

Historic releases of AFFF to impermeable surfaces would have been washed into nearby drainage swales and a portion of the mass would have been discharged to the local storm sewer network. These releases would have resulted in the discharge of AFFF at the outfalls which serve those areas, and transfer to local surface water bodies.

The sanitary sewer system drains to the WWTP at the southwest corner of Loring where it is combined with the sanitary sewer system discharge from the town of Limestone. After treatment to remove solids and reduce nutrient load, the sanitary sewer water is pumped to the Caribou WWTP on Grimes Road in Caribou and discharged to the Aroostook River, **Appendix J**.

5.1.5 Bedrock Groundwater

The bedrock underlying Loring is mapped as the Carys Mill Formation, a fine grained, thinly bedded limestone sequence, referred to as ribbon limestone, with varying components of fine-grained clastic sediment (Pavlides, 1968).

Groundwater movement in the bedrock is limited by the presence of open and interconnected fractures and the location of discharge areas. The nature of these fractures is related to the structure of deposit beneath Loring. The structural deformation including faulting and folding has led to a fracture pattern that is generally consistent across Loring. An anticline passes beneath Loring, roughly bisecting the Site from southwest to northeast. Another anticline and a parallel syncline are present at the southern end of the flightline. Smaller

folds have been interpreted east of ELL, just south of the Arch Hangar, at the Quarry, and beneath Landfill 2 along the western portion of Loring, **Figure 2-8**. The structural trends in bedrock underlying Loring are consistent with regional structural trends, **Figure 2-6** and **2-7**. Bedrock groundwater flow is influenced by faults that crosscut the axial directions of these bedrock folds.

Fracture frequency is relatively uniform with depth. However, analysis of specific capacity data and other information suggest that the upper 45 feet of bedrock (i.e., shallow bedrock) has greater water-bearing capacity than deeper rock (greater than 100 feet into bedrock). This increase in the transmissivity in the upper bedrock groundwater system is likely the result of weathering of existing fractures and bedding planes (i.e., fracture aperture decreases with depth). Core logs, acoustic televiewer-enhanced processed data, and limited available bedrock exposures show steeply dipping bedding, axial plane, and cross-cutting fractures to be the principal porosity features that transmit water in bedrock (ABB, 1997b).

Hydraulic conductivity measurements for bedrock wells are presented in **Appendix H.** The average hydraulic conductivity of bedrock wells is 8.6 feet per day, or $3x10^{-3}$ centimeters per second.

Numerical modeling (using MODFLOW) of the measured potentiometric surface across Loring conducted during the OU12 RI and subsequently during the PFAS RI showed good agreement within the model domain suggesting that the bedrock aquifer can, at the Site-wide scale, be approximated by an equivalent porous media (EPM) model. The EPM model for bedrock groundwater asserts that while localized groundwater flow through bedrock is influenced by heterogeneities in the fracture network, groundwater flow through the larger fractured bedrock system behaves in a predictable manner consistent with a porous media. EPM models do not account for preferential pathways dictated by the orientation of individual fractures but can represent the overall conductivity of the fracture network. The ability of the EPM approach to model groundwater flow accurately is a function of scale, where accuracy increases for larger models (ITRC, 2017).

Evaluation of the deep bedrock groundwater potentiometric surface compared to the water table potentiometric surface indicates that most flow is toward local drainages, including Butterfield and Greenlaw Brook. Comparison of the water table and bedrock groundwater potentiometric surfaces along the major drainage systems indicates that bedrock groundwater discharges to the overburden system, which in turn discharges to the surface water system (streams, ponds, and lakes). The direction of groundwater flow generally coincides with the strike direction of the principal water-bearing fractures and is driven by the location of surface water drainage systems. These conditions are consistent with behavior expected of a porous medium flow regime.

Bedrock groundwater recharge zones, characterized by downward vertical hydraulic gradients from overburden to bedrock, are identified across much of Loring, **Figure 4-22**. Bedrock groundwater discharge zones, characterized by upward vertical gradients from bedrock to overburden, are generally identified in topographic lows, particularly along the FLDD, EBGB, WBGB, and their tributaries, **Figure 4-22** and **Figure 5-1**. Bedrock groundwater is generally unconfined across the flow fields. **Appendix E-4** details the bedrock wells that demonstrated artesian (confined) conditions, most of which are in Flow Field #4.

A deeper component of bedrock groundwater flow may be controlled by the regional groundwater system represented by the Aroostook and the St. Johns River. This regional control on deeper bedrock groundwater flow imparted by these larger drainage systems can result in flow to the south and southeast of Loring which is not captured by the local drainages.

5.1.6 Surface Water

The behavior of surface water is driven by its relationship with the local groundwater system and precipitation patterns. The interaction of surface water and groundwater is important to understanding how contaminants migrate through the hydrogeologic system and the variability in concentrations of Site COCs in surface water bodies.

Groundwater can discharge to surface water or surface water can recharge groundwater depending on hydraulic gradients and the presence or absence of material that will impede the connection between these units. If water levels are higher in groundwater than in nearby surface water bodies, then groundwater can discharge to surface water, resulting in what is called a “gaining stream”. If water levels are lower in groundwater than in nearby surface water bodies, then surface water can recharge groundwater, resulting in what is called, a “losing stream”. The magnitude of the hydraulic gradient and hydraulic conductivity of the aquifer material or surface water sediment will control the rate of discharge between these units (Freeze and Cherry, 1979). PFAS mass dissolved in groundwater can transfer from groundwater to surface water. Once in surface water, PFAS can either stay in solution to be transported further downstream or partition onto sediments within that surface water body (ITRC, 2026).

Variations in precipitation patterns will impact PFAS concentrations in the surface water bodies. Groundwater discharge provides baseflow during periods without precipitation. During a precipitation event, and for a period after, overland flow increases discharge. For a period after precipitation events, freshly infiltrated precipitation raises the water table and maintains an increased discharge compared to baseflow conditions. Freshly infiltrated precipitation is the portion of rainfall that is absorbed by soils which then flows through the unsaturated soil column, to recharge groundwater. Surface water bodies which receive a greater proportion of their flow from groundwater impacted by upgradient source areas will exhibit higher concentrations of PFAS during dry periods (ITRC, 2026). Water bodies that receive discharge from groundwater impacted by PFAS are shown on **Figure 5-1**. These include the ELL, Butterfield Brook just downstream of the ELL, the WBGB to the southwest of Nose Dock 44, the FLDD, the majority of the EBGB, Greenlaw Brook after the confluence of the EBGB and WBGB, and several smaller tributaries and wetlands onsite.

Variations in substrate material can impact sediment and porewater concentrations of PFAS. Surface water bodies which were historically subject to the release of PFAS, or the ongoing discharge of impacted groundwater, have the potential to retain these compounds in their sediment and porewater. Finer grained and more organic rich sediment will have a relatively greater ability to retain PFAS due to its higher adsorption capacity while coarser grained sediment will have lower adsorption capacity and less ability to retain PFAS mass. Water bodies which have lower discharge rates will have less ability to reduce PFAS mass in the sediment and porewater and may retain PFAS for longer at higher concentrations, **Section 5.1.1**.

In areas where the surface water substrate stores PFAS and is in a groundwater discharge zone, the substrate can contribute PFAS mass from the sediment to surface water. These areas overlap with the groundwater discharge zones. In areas where this substrate is in a groundwater recharge zone, PFAS mass in the sediment and porewater can contribute PFAS to groundwater. As shown on **Figure 5-1,** this scenario may be present at the south sides of Malabeam Lake and Chapman Pit, as well as at the two stormwater infiltration basins to the west of Nose Dock 44; however, these conditions likely vary seasonally.

The local and regional surface water features detailed in **Section 2.7** fit into a larger drainage basin system, **Figure 1-1**. The St. Johns River receives discharge from the Aroostook River to the south of Loring. The Aroostook receives surface water from the Little Madawaska River and Limestone Stream. These tributaries of the Aroostook receive surface water flow from Loring from Butterfield Brook and Greenlaw Brook, **Figure 2-9.** The location and orientation of streams and brooks in this regional system often reflect underlying bedrock structural features and are often coincident with faults or fault zones, described in **Section 2.5.3** and shown on **Figure 2-8**.

5.1.7 Receptors

The theoretical human and environmental populations that may be exposed to PFAS in environmental media at the Site are represented by selected receptors. The selected receptor groups consider site-specific conditions and conform to USEPA guidance.

5.1.7.1 Human Health

Receptors are identified based on the current and foreseeable future land uses, as well as hypothetical future land uses (not necessarily foreseeable, but considered for evaluating the need for institutional controls). Receptors are chosen to cover the foreseeable range of potential exposures (exposure media and exposure routes). Exposure parameters for each receptor are identified to represent a theoretical maximally exposed individual in the receptor group. Each receptor may be evaluated for one or more media and exposure areas. Primary human receptors include:

- Current and future outdoor worker (e.g. landscape workers).
- Current and future utility worker.
- Future construction worker.
- Current and future recreator (child and adult) (e.g. hikers, waders, swimmers).
- Current and future resident (child and adult).
- Hypothetical future resident (child and adult).
- Current and future unauthorized forager.
- Hypothetical future Aroostook Band of Mi'kmaq resident (child and adult):

An exposure pathway describes the course a compound takes from the source to the impacted media to the exposed receptor. Receptors may be exposed to media at the site through the following exposure pathways and routes of exposure:

- Direct contact with soil (ingestion and dermal contact);

- Ingestion of groundwater during potable use;
- Direct contact with groundwater during showering or excavation (incidental ingestion and dermal contact);
- Direct contact with surface water (incidental ingestion and dermal contact);
- Direct contact with sediment (ingestion and dermal contact);and,
- Ingestion of plant or animal tissue through fishing, hunting, farming, and/or foraging as applicable (if impacted).

The human health risk assessment will evaluate potential exposure pathways, potentially complete exposure scenarios will be carried through the forthcoming BHHRA.

5.1.7.2 Ecological

An exposure pathway may exist for PFAS in permanent surface water bodies, and in ephemeral surface water bodies when standing water is present, via several major biological exposure mechanisms:

- Direct contact with chemicals in surface water (aquatic plants, aquatic invertebrates, fish, amphibians);
- Dietary ingestion of chemicals in forage and prey items (aquatic invertebrates, fish, amphibians, water-dependent birds, water-dependent mammals); and
- Incidental ingestion of chemicals in surface water (aquatic invertebrates, water-dependent mammals, water-dependent birds).

An exposure pathway may exist for PFAS in sediment through several major biological exposure mechanisms:

- Uptake from interstitial water between sediment particles (porewater) into tissue (aquatic plants, benthic invertebrates);
- Dietary ingestion of chemicals in forage and prey items (invertebrates, fish, amphibians, water-dependent birds, water-dependent mammals); and
- Incidental ingestion of chemicals bound to sediment (benthic invertebrates, fish, amphibians, water-dependent birds, water-dependent mammals).

An exposure pathway may exist for PFAS discharged to surface soil. Also, PFAS discharged into surface water bodies may be transported to adjacent floodplains and deposited onto the soil surface during storm events or other periods of high water. PFAS may move from surface soil into terrestrial plant and animal tissue through several major biological exposure mechanisms:

- Uptake of chemicals from soil through roots (vegetation);
- Incidental ingestion of chemicals bound to soil (terrestrial invertebrates, birds, mammals); and
- Dietary ingestion of chemicals in forage and prey items (terrestrial invertebrates, birds, mammals).

Where groundwater intersects the land surface, it is also typically expressed as surface water. In these cases, PFAS exposure will be assessed as a surface water or sediment porewater exposure, or as soil where it is expressed in vegetated wetlands in hydric soil.

Receptors and uptake mechanisms are discussed further in the forthcoming BERA.

5.2 FLOW FIELD #1 NATURE AND EXTENT

Flow Field #1 contains three identified source areas including the FTA, the B-52 Crash Area, and the northeast portion of the Runway, as shown on **Figure 3-1**. The FTA is one of the five primary source areas which has a greater mass of PFAS in soil and groundwater and therefore greater potential to impact receptors. As detailed in **Section 3.2** and **Section 4** and illustrated in **Figures 4-1 through 4-35** and **Appendices C through J**, nature and extent PFAS RI investigations include soil, groundwater, surface water, porewater, and sediment sampling, as well as monitoring well installation, borehole geophysics, stormwater discharge monitoring, aquifer testing, and long-term monitoring of water levels.

5.2.1 Source Material

B-52 Crash Area

Soil sampling identified exceedances of PFAS residential soil RSLs in surface soils across the investigated area. Exceedances of PFOS SLs are identified through the unsaturated soil column, with a water table that ranges from 15 to 30 feet bgs, **Appendix E-1**, at the crash site and immediately downslope. The highest concentration of PFOS in soils in this source area is immediately northeast of the northern extent of the Runway, where soils exceed the PFOS SL by an order of magnitude and extend through the unsaturated soil column. Overburden in this area is roughly 20 to 30 feet thick, **Figure 4-6.**

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - B-52 Crash Area

Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFBS	39	1	0	0.000041	0.0025
PFBA	39	2	0	0.00018	0.005
PFDA	39	1	1	0.000089	0.0025
PFHxS	39	15	0	0.000043	0.0025
PFHxA	39	4	0	0.000089	0.0025
PFNA	39	2	0	0.00011	0.0025
PFOS	39	26	24	0.00012	0.0274
PFOA	39	2	2	0.000089	0.0025

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-2**, and detailed on **Table 4-1**:

- PFOS in surface soils is not delineated to the residential soil RSL but has been confirmed to extend at least 800 feet in the east/west direction (from soil boring SB20005 to SB20018) and at least 325 feet in the north/south direction (from soil boring E-T-SO02A to SB20014).
- PFOS is delineated horizontally in sub-surface samples above the residential soil RSL across an area approximately 275 feet in the east/west direction (from soil boring SB20007 to SB20016) and approximately 150 feet in the north/south direction (from soil boring SB20007 to SB20013). PFOS extends through the soil column to the water table or bedrock in this area.
- PFOA is identified in surface soils above the residential soil RSL at two soil borings, SB20016 and SB20015.
- PFDA is identified in one surface soil sample above the residential soil RSL at boring, SB20015, which also exceeds residential soil RSLs for PFOS and PFOA.
- No other PFAS were detected in soils above residential soil RSLs.

To the south of the B-52 Crash Area, the storm sewer network discharges to Tributary 1 of Butterfield Brook. Sediment and porewater sampling at this outfall identified exceedances of the wading SLs or swimming SLs by an order of magnitude for PFOS, with decreased concentrations to below SLs further downstream, **Figures 4-24A** and **5-1**. No other PFAS compounds were detected above SLs for sediment in the Butterfield Brook Drainage. Impacted sediment at this area is treated as an extension of the source area, where mass discharged during the initial release or partitioned from ongoing discharge is retained at the outfall. The impacts to the nearby drainage are attributed to the historic release at the B-52 Crash Area. Additional discussion of the nature and extent of PFAS in sediment in this area is provided in **Section 5.8.1**.

Fire Training Area

Soil sampling identified exceedances of PFAS residential soil RSLs in soils across the investigation area of the FTA. Exceedances of these SLs are identified through the unsaturated soil column which ranges from 15 to 20 feet bgs, **Appendix E-1**, with the highest concentrations mostly in shallow surficial soils. Overburden in this area is roughly 15 to 25 feet thick, **Figure 4-6.** The primary mass of PFAS in soils has been identified at the training area, along the access road to the FTA, and along drainage swales that run next to the access road and are topographically downhill of the FTA. In these areas, PFOS exceedances extend down to bedrock or the water table at concentrations that are up to several orders of magnitude above residential RSLs.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Fire Training Area					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFBS	116	18	0	0.000027	0.0031
PFBA	116	26	0	0.000086	0.0063
PFDA	116	13	13	0.000044	0.0045

Excerpt from Table O-1: Soil Summary Statistics - Fire Training Area					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFHxS	116	73	1	0.000023	0.607
PFHxA	116	41	0	0.000032	0.0082
PFNA	116	34	0	0.000043	0.0086
PFOS	116	98	88	0.000083	7
PFOA	116	51	51	0.000054	0.0249

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-2**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend at least 2,400 feet in the east/west direction (from soil boring SB01026 to SB01016) to at least 2,000 feet in the north/south direction (from soil boring SB01016 to E-T-SO02Q). Additionally, surface soil samples collected to evaluate the Main Runway that are directly west of the FTA exceed PFOS residential SLs. These include samples from soil borings SB18011, SB18012, and SB18027 and are up to 1,000 feet west of SB01026. The analytical results from these borings indicate higher concentrations of PFOS are present as compared to other samples to the north and south that were collected to evaluate the Runway source area. Those detections may be attributed to releases at the FTA.
- PFOS has been delineated to residential RSLs in sub-surface samples to the west but is not delineated in sub-surface samples to the north, south, or east. PFOS has been confirmed in sub-surface samples across an area of at least 1,800 feet in the east/west direction (from soil boring SB01009 to SB01049) to at least 1,100 feet in the north/south direction (from soil boring SB01051 to SB01032). PFOS extends through the soil column to the water table or bedrock across much of this area.
- PFOA has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend over an area of approximately 1,400 feet in the east/west direction (from soil boring SB01042 to SB01055) to at least 1,900 feet in the north/south direction (from soil boring SB01051 to E-T-SO02Q).
- PFOA has been confirmed to exceed residential RSLs in sub-surface samples across an area of approximately 750 feet in the east/west direction (from soil boring SB01009 to SB01032) to at least 1,100 feet in the north/south direction (from soil boring SB01051 to SB01032). PFOA extends through the soil column to the water table or bedrock across much of this area.
- PFOA and PFOS are delineated in surface soils to industrial RSLs with a hazard quotient of 1 and a Total Cancer Risk at 1x10-4 across an area of at least 300 feet east/west (from soil boring SB01028 to SB01013) to 450 feet north/south (from soil boring SB01013 to SB01007).
- PFDA has been confirmed to exceed residential soil RSLs in 13 samples, within the extent of the PFOS or PFOA industrial RSL exceedances.

- PFHxS was detected above the residential RSL in one surface sample, from soil boring SB01006, within the extent of the PFOS or PFOA industrial RSL exceedances.
- One of the soil borings, SB01010, advanced in an area that was excavated and replaced with clean fill exhibited non-detect results for analyzed PFAS compounds.
- No other PFAS compounds were detected in soils above residential soil RSLs.

Runway – Northeast Portion

Soil borings were completed along the perimeter of the Runway. Soil borings along the Runway were reported with no detections of PFAS except for surface soil samples from soil borings SB18027 and SB18012. These samples are directly west of the FTA and may be attributable to PFAS releases at the FTA, **Figure 4-2**.

Summary statistics for the soil samples collected to evaluate the Runway are included **Section 5.2**.

5.2.2 Migration Pathways

The migration pathways from the source zones identified in Flow Field #1 are largely controlled by the surface water drainages. Tributaries 1, 2, and 3 provide an outlet for the storm sewer system on the eastern side of the Runway. The Butterfield Brook drainage captures overburden and bedrock groundwater that is impacted by PFAS attributed to the source areas in Flow Field #1.

B-52 Crash Area

PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Transport of this mass in overburden and bedrock groundwater at the B-52 Crash Area is to the east, towards ELL and Butterfield Brook, **Figures 4-9** and **4-10**. Downward vertical gradients result in bedrock recharge from overburden in the source area, **Figure 4-22**. Groundwater flow continues towards ELL, which is a discharge zone for groundwater, **Figure 5-1**. The downgradient groundwater plume comingles with the larger magnitude plume emanating from the FTA, **Figures 5-1**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - B-52 Crash Area					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	80	72	0	0.56	130
PFBA	80	70	0	1.1	17
PFHxS	80	74	60	1.8	1200
PFHxA	80	69	0	0.31	110
PFNA	80	41	0	0.16	3
PFOS	80	74	74	1.8	2300
PFOA	80	67	67	0.34	49

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-9** and **4-10**, with interpolated plume maps shown on **Figure 5-2:**

- PFOS is not identified in upgradient wells. The interpolated plume above the MCL extends approximately 3,000 feet downgradient of the source area at which point the plume is interpreted to comingle with impacts attributed to the FTA.
- PFOA is not identified in upgradient wells. The interpolated plume above the MCL extends approximately 1,000 feet downgradient of the source area.
- PFHxS is not identified in upgradient wells. The interpolated plume above the MCL extends approximately 3,000 feet downgradient of the source area at which point the plume is interpreted to comingle with impacts attributed to the FTA.
- PFNA is not identified above MCLs at this source area.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

The local storm sewer system near the B-52 Crash Area discharges to Tributary 1 of Butterfield Brook. Discharge readings from the outfall at this location, ST20001, were monitored with a flow meter from June 2024 through September 2024. Discharge from this location was intermittent, with measured discharge only during rain events, **Appendix I**. Comparisons of the stormwater invert elevations to the modeled water table, **Figure 4-28**, indicate the storm sewer network is above the water table. The underdrain system is present in this area, which may result in the discharge of shallow groundwater to the storm sewer system. This portion of the stream is subject to beaver activity, identified during field reconnaissance, resulting in poor drainage and standing water at the outfall. The beaver impoundment can slow the flow of surface water, reducing migration and increasing retention of PFAS mass at the storm sewer outfall. The majority of PFAS mass in Tributary 1 is retained proximal to this storm sewer outfall. Concentrations of PFAS in the storm sewer system were identified through the network and at the outfall above human health swimming SLs, **Figures 4-26** and **5-1**. Discharge of PFAS impacted stormwater from this storm sewer represents an ongoing migration pathway. Additional discussion of the nature and extent of PFAS in surface water in this area is provided in **Section 5.8.1**.

Fire Training Area

The FTA is to the east of the Runway in the Butterfield Brook watershed. The primary control on groundwater flow in this area is Butterfield Brook, which captures overburden and bedrock groundwater, **Figures 5-4** and **5-1**. The FTA contributes to one of the most extensive groundwater plumes of the PFAS source areas at Loring.

PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Transport of this mass in bedrock groundwater from the FTA is to the northeast, towards ELL and Butterfield Brook. ELL is a discharge zone for groundwater, **Figure 5-1**. Overburden groundwater is not present within the FTA but is present to the northeast. When present, overburden groundwater flow is to the east towards ELL and Butterfield Brook, **Figure 4-9** and **5-4**. Concentrations of PFAS in groundwater are up to several orders of magnitude greater than USEPA drinking water criteria, with impacts extending into bedrock. As shown on **Figure 4-22** and **Figure 5-4**, downward vertical gradients drive the groundwater plume core into the bedrock immediately downgradient of the source area. The plume core ultimately rises for discharge to surface water in the vicinity of where the bedrock water table intersects land surface, downstream of the outlet of ELL. The

extent of vertical impacts attributed to the FTA is not delineated vertically, allowing for the potential that regional flow pathways could impact the transport of PFAS in deep bedrock.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Fire Training Area					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	134	121	0	0.23	100
PFBA	134	120	0	0.9	170
PFDA	134	43	43	0.35	19
PFHxS	134	133	117	0.91	9500
PFHxA	134	123	0	0.18	980
PFNA	134	109	53	0.45	100
PFOS	134	128	128	0.81	11000
PFOA	134	129	129	0.23	920

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-9** and **4-10**, with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of the source area, however concentrations increase by three orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 5,300 feet downgradient of the source area.
- PFOA is identified above MCLs upgradient of the source area, however concentrations increase by two orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 4,500 feet downgradient of the source area.
- PFHxS is identified above MCLs upgradient of the source area, however concentrations increase by two orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 5,000 feet downgradient of the source area.
- PFNA is not identified upgradient of the source area and increases by two orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 2,200 feet downgradient of the source area.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.
- Shallow groundwater samples, which were not collected from monitoring wells, exceed MCLs and have been incorporated into the interpolated plume maps for this area and are shown on **Figure 4-24A**.

5.2.3 Receptors

B-52 Crash Area

PFOS and PFOA exceed residential RSLs in shallow soils, **Figure 4-2**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

Tributary 1 in the Butterfield Brook watershed begins at the outlet of the local storm sewer system, where it flows east to Butterfield Brook, **Figure 2-3**. Exceedances of SLs for surface water, sediment, and porewater extend at least 200 feet downstream from the storm sewer outfall discharge. The concentrations of PFAS identified in porewater at E-A-PW01A and E-A-PW02A are an order of magnitude greater than the concentrations identified in collocated surface water samples, E-A-SW01A and E-A-SW02A, just downstream of the storm sewer outfall. This relationship indicates that ongoing loading of PFAS from the storm sewer system is minimal compared to the mass stored in the sediment. It is possible that the PFAS mass in sediment and porewater is sourced from the release and initial washing of PFAS through the storm sewer system during historic base activities. Concentrations of PFAS further downstream of the storm sewer outfall discharge location are below SLs for sediment, indicating that the majority of PFAS mass in the stream system is retained proximal to the outfall, **Figure 4-24A** and **5-1**.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Fire Training Area

PFOS and PFOA exceed the USEPA Residential RSL in shallow soils. If the area were to be redeveloped for residential purposes, potential receptors would include future residents. Exceedances of industrial RSLs for soils are identified on **Figure 4-2**.

Butterfield Brook receives discharge of the groundwater plume, resulting in downstream transport of PFAS from the FTA, **Figures 5-1** and **5-4**. This discharge results in dilution of the concentrations identified in groundwater, resulting in surface water concentrations being much lower than those identified in the groundwater plume, **Figures 4-9, 4-10,** and **4-24A**. This dilution is attributed to the contribution of freshwater to ELL from the larger watershed, including groundwater discharge and surface flow from tributaries of ELL.

Exceedances of SLs for surface water, sediment, and porewater are identified intermittently along the length of Butterfield Brook, into Durepo Reservoir and until discharge to Limestone Stream, **Figure 5-1**. Exceedances of surface water exhibit a temporal relationship due to variations in hydrologic conditions explained in **Section 5.1.1** and **5.1.6**. This condition results in certain segments of the stream exhibiting concentrations below SLs, with downstream samples that exhibit exceedances of the same criteria, **Figure 4-24A**.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

5.3 FLOW FIELD #2 NATURE AND EXTENT

Flow Field #2 contains one identified source area: the southeast portion of the Runway, as shown on **Figure 3-1**. As detailed in **Sections 3.2** and **Section 4,**and illustrated in **Figures 4-1 through 4-35** and **Appendices C**

through J, PFAS RI nature and extent investigations include soil, groundwater, surface water, porewater, sediment sampling, and monitoring well installation.

5.3.1 Source Material

Runway – Southeast Portion

Soil sampling has identified exceedances of PFOS, PFOA, and PFDA residential soil RSLs in soils near the perimeter of the ready area at the southeast side of the Runway. Overburden in this area is roughly 20 to 30 feet thick, **Figure 4-6**, and the water table ranges between 25 to 35 feet bgs, **Appendix E-1**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1 through 4.1.4** are provided below. This summary includes soil samples associated with the Runway source area and includes samples from multiple flow fields.

Excerpt from Table O-1: Soil Summary Statistics – Main Runway Foaming Area					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFBS	121	2	0	0.000027	0.0026
PFBA	121	9	0	0.00011	0.0052
PFDA	121	11	11	0.000052	0.0038
PFHxS	121	15	0	0.00008	0.0024
PFHxA	121	13	0	0.000027	0.0026
PFNA	121	13	0	0.000081	0.0026
PFOS	121	50	34	0.000082	0.0924
PFOA	121	16	16	0.000057	0.004

The distribution of PFAS above soil RSLs at the southeast side of the Runway is described below, displayed on **Figure 4-3**, and detailed on **Table 4-1**. This does not include samples detailed in the excerpt of the summary statistics detailed above.

- PFOS has not been delineated to residential RSLs in surface soils horizontally but has been confirmed to extend at least 1,600 feet in the east/west direction (from soil boring SB18024 to SB18037) to at least 1,100 feet in the north/south direction (from soil boring SB18037 to SB18029).
- PFOS was identified in one sub-surface sample collected from 7-9 feet bgs at soil boring SB18033 above residential soil RSLs. This sub-surface exceedance is not delineated vertically but is delineated horizontally.
- PFOA has been confirmed to exceed residential RSLs in surface soils over an area of approximately 1,000 feet in the east/west direction (from soil boring SB18041 to SB18036) to approximately 750 feet in the north/south direction (from soil boring SB18036 to SB18029).
- PFOA has been confirmed to exceed the residential soil RSL in one sample collected from 7-9 feet bgs from soil boring SB18033. This sub-surface exceedance is not delineated vertically but is delineated horizontally.

- PFDA has been confirmed to exceed residential soil RSLs in four samples, including the surface sample at SB18040 and in samples that also exhibit exceedances of PFOA or PFOS.

No other PFAS were detected in soils above residential soil RSLs in the southeast portion of the Runway

5.3.2 Migration Pathways

The southeast portion of the Runway is in the Butterfield Brook watershed. The primary control on groundwater flow in this area is Butterfield Brook, which captures overburden and bedrock groundwater, **Figures 4-22** and **5-1**.

Runway – Southeast Portion

PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Transport of this mass in bedrock groundwater from the southeast portion of the Runway is to the east, towards Tributary 4, Noyes Pond, and ultimately, Limestone Stream. Overburden groundwater is not present at the Runway but is present along the drainages of the Tributary 4 to the east and southeast. Concentrations of PFAS in one bedrock groundwater monitoring well, BW18008, is greater than USEPA drinking water MCLs. This well is directly adjacent to the identified exceedances in soil samples at the southeast ready area. Shallow groundwater samples collected in this area also exceed PFAS MCLs. Downgradient wells exhibit non-detect concentrations of PFAS, **Figure 4-11** and **4-12**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2 through 4.1.4** is provided below. This summary includes groundwater samples associated with the Runway source area and includes samples from multiple flow fields.

Excerpt from Table O-2: Groundwater Summary Statistics – Main Runway Foaming Area					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	108	68	0	0.2	23.2
PFBA	108	78	0	0.6	33
PFDA	108	2	2	0.48	17
PFHxS	108	92	50	0.18	425
PFHxA	108	92	0	0.15	80.2
PFNA	108	39	0	0.16	17
PFOS	108	91	91	0.28	408
PFOA	108	84	84	0.15	114

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-11** and **4-12**, with interpolated plume maps shown on **Figure 5-2**. This does not include samples detailed in the excerpt of the summary statistics detailed above.

- PFOS is identified above MCLs upgradient of the source area, however concentrations increase by an order of magnitude at the ready area, identified in BW18008. The interpolated plume above the MCL extends approximately 1,800 feet downgradient of BW18008.

- PFOA was identified just above the MCL from one sampling event at BW18008, otherwise concentrations were below the MCL. The interpolated plume does not show PFOA extending over the ready area.
- PFHxS is identified above MCLs upgradient of the source area, however concentrations increase by an order of magnitude at the ready area, identified in BW18008. The interpolated plume above the MCL extends approximately 800 feet downgradient of BW18008.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.
- Shallow groundwater samples, which were not collected from monitoring wells, exceed MCLs and have been incorporated into the interpolated plume maps for this area and are displayed on **Figure 4-24A**.

5.3.3 Receptors

Runway – Southeast Portion

PFOS and PFOA exceed residential soil RSLs in shallow soils, **Figure 4-3**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

Receptors include potential users of drinking water wells with the forest service buildings serving ANWR. Potential receptors include public and private drinking water supplies in the town of Limestone as well as potential ecological receptors in Butterfield Brook.

Further discussion of the potential risk to human health and the environment are detailed in **Section 7**.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

5.4 FLOW FIELD #3 NATURE AND EXTENT

Flow Field #3 contains eight identified source areas including the FJETC, the FDA, Nose Docks 11, 40, and 44, the Aircraft Hardstands, Hardstand 19, and Ramp #1, as shown on **Figure 3-1**. Most of the source areas in Flow Field #3 are encompassed in the NDA, located west of the Runway. These include Nose Dock 11, the Aircraft Hardstands, Hardstand 19, Ramp #1, Nose Dock 40, Nose Dock 44, and the FDA. Two additional source areas identified in Flow Field #3 are the FJETC and the northwest side of the Runway. Nose Dock 44 is one of the five primary source areas which has been identified as having a greater mass of PFAS in soil and groundwater and therefore greater potential to impact receptors compared to the other source areas.

As detailed in **Section 3.2** and **Section 4** and illustrated in **Figures 4-1 through 4-35** and **Appendices C through J**, PFAS RI nature and extent investigations include soil, groundwater, surface water, porewater, and sediment

sampling as well as monitoring well installation, borehole geophysics, stormwater discharge monitoring, aquifer testing, and long-term monitoring of water levels.

5.4.1 Source Material

Former Jet Engine Test Cell

Soil sampling identified shallow surface exceedances of PFAS residential soil RSLs in two samples collected near the FJETC. Overburden in this area is roughly 25 to 35 feet thick, **Figure 4-6**, and the water table ranges between 7 to 15 feet bgs, **Appendix E-1**. PFAS impacts to soil are delineated to below SLs to the north, east, and southeast, **Figure 4-4**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Former Jet Engine Test Cell (FJETC)					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFOS	15	1	1	0.00055	0.0045

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-4**, and detailed on **Table 4-1**:

- PFOS was identified at concentrations that exceed the residential RSL in the surface sample at one boring, SB24004, which is not delineated horizontally to the west or south but is delineated to the east and north and vertically by a deeper sample in the same boring.
- PFOA was identified at concentrations that exceed the residential soil RSL in the surface sample in one boring, E-T-SO01B.
- No other PFAS were detected in soils above the residential soil RSLs.

Fuel Dump Area

Soil sampling identified exceedances of PFAS residential soil RSLs in shallow surface soil samples completed in or adjacent to the drainage swale. Overburden in this area is roughly 25 to 35 feet thick, **Figure 4-6**, and the water table ranges between 14 to 22 feet bgs, **Appendix E-1**. PFAS impacts above SLs are not identified in deeper soil samples, **Figure 4-4**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Fuel Dump Area					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFOS	11	6	5	0.00055	0.0034
PFOA	11	1	1	0.00084	0.0013

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-4**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential soil RSL in surface samples horizontally but is delineated vertically. Horizontal surface soil impacts have been confirmed to extend at least 900 feet in the east/west direction (from soil boring SB17008 to SB17004) to at least 750 feet in the north/south direction (from soil boring SB17004 to SB17008).
- PFOA was identified above the residential soil RSL in the surface sample from SB17006.
- No other PFAS were detected in soils above the residential soil RSLs.

Nose Dock 11

Soil sampling identified exceedances of PFAS residential soil RSLs in shallow surface soil samples over a wide area on the eastern side of the NDA in the vicinity of Nose Dock 11. These samples are distributed in the vicinity of soil samples that did not exhibit measurable concentrations of PFAS. Overburden in this area is roughly 35 to 40 feet thick, **Figure 4-6**, and the water table ranges between 5 to 7 feet bgs, **Appendix E-1**. PFAS impacts above SLs in surface soils are identified in the drainage swales to the east of the flightline, **Figure 4-4**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Nose Dock No. 11					
Analyte	**Number of Samples**	**Number of Detections**	**Number of USEPA Residential Soil RSL Exceedances**	**Minimum (mg/kg)**	**Maximum (mg/kg)**
PFHxS	20	2	0	0.00078	0.0013
PFNA	20	1	0	0.00087	0.0013
PFOS	20	8	8	0.0008	0.0284
PFOA	20	2	2	0.00069	0.0013

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-4**, and detailed on **Table 4-1**:

- PFOS in surface soils is not delineated horizontally to the residential soil RSL but is delineated vertically.
- PFOS exceedances of the residential soil RSL in surface samples have been confirmed to extend at least 900 feet in the east/west direction (from soil boring SB10009 to SB10006) and approximately 700 feet in the north/south direction (from soil boring SB10005 to SB10011).
- PFOA was detected in surface soils above the residential soil RSL at two soil borings, SB10008 and SB10011, which are approximately 125 feet apart and within the extent of PFOS exceedances.
- No other PFAS were detected in soils above the residential soil RSLs.

Aircraft Hardstands

Soil sampling identified exceedances of PFAS residential soil RSLs in shallow surface soil samples over a wide area of the Nose Docks and Aircraft Hardstands. These samples are distributed between and around soil samples that did not exhibit measurable concentrations of PFAS. Overburden over this relatively large area ranges between 5 to 35 feet thick, **Figure 4-6**, and the water table ranges between 13 to 20 feet bgs, **Appendix E-1**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Aircraft Hardstands					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFOS	70	37	34	0.00056	0.0168

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-4**, and detailed on **Table 4-1**:

- PFOS exceedances of the residential soil RSL have been confirmed in surface soils to extend across a disconnected area approximately 2,600 feet in the east/west direction (from soil boring SB13009 to SB13020) and approximately 3,700 feet in the north/south direction (from soil boring SB13004 to SB13020). Soil borings within this extent are shown to exhibit variable concentrations of PFOS, including borings that do not have detections of PFOS.
- PFOS exceedances were identified in the sub-surface sample at one boring, SB13017.
- No other PFAS were detected in soils above the residential soil RSLs.

Hardstand 19

Soil sampling identified exceedances of PFAS residential soil RSLs in shallow surface soil samples on the northeast side of the NDA and Aircraft Hardstands. These samples are distributed around other soil samples collected within the hardstands and nose docks that did not exhibit measurable concentrations of PFAS. Overburden over this relatively large area ranges between 35 to 40 feet thick, **Figure 4-6**, and the water table ranges between 13 to 20 feet bgs, **Appendix E-1**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Hardstand 19					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFHxS	8	1	0	0.001	0.0016
PFNA	8	1	0	0.001	0.0015
PFOS	8	2	2	0.001	0.0452
PFOA	8	1	1	0.001	0.0015

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-4**, and detailed on **Table 4-1**:

- PFOS exceedances of the residential soil RSL have been confirmed in two surface soil samples, from soil borings SB14005 and SB14007, which are approximately 200 feet apart in the east/west direction.
- PFOS is delineated vertically as it is not identified in sub-surface samples.
- PFOA was detected in surface soils above the residential soil RSL at one soil boring, SB14005.
- No other PFAS were detected in soils above residential soil RSLs.

Ramp #1

Soil sampling identified exceedances of PFAS residential soil RSLs in shallow surface soil samples on the southeastern side of the NDA. Overburden over this relatively large area ranges between 30 to 45 feet thick, **Figure 4-6**, and the water table ranges between 8 to 12 feet bgs, **Appendix E-1**. Exceedances of PFAS SLs are identified in surface soil samples in drainage swales and topographic lows, **Figure 4-4**. Samples that evaluate soil quality in the vicinity of Ramp #1, which is on the southeast side of the Aircraft Hardstands, are reported with the Aircraft Hardstand samples.

Nose Dock 44

Soil sampling identified exceedances of PFAS residential soil RSLs in soil samples in the vicinity of Nose Dock 44. Concentrations of PFAS compounds are highest to the west of Nose Dock 44, particularly in borings advanced along drainage swales that run parallel to Quarry Road. To the west of the NDA, soil samples exhibit exceedances that are orders of magnitude greater than the residential soil RSL and extend through the soil column. A portion of the soil in this area exceeds the industrial soil RSL. Concentrations of PFAS compounds are lower to the east of Nose Dock 44 and decrease to below SLs to the north and east of Nose Dock 44, **Figure 4-4**. Overburden in this area ranges between 10 to 20 feet thick, **Figure 4-6**, and the water table ranges between 10 to 15 feet bgs, **Appendix E-1**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Nose Dock No. 44					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFBS	51	3	0	0.000024	0.0023

Excerpt from Table O-1: Soil Summary Statistics - Nose Dock No. 44					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFBA	51	3	0	0.000094	0.0045
PFHxS	51	15	0	0.000077	0.0054
PFHxA	51	7	0	0.000049	0.0023
PFNA	51	2	0	0.000073	0.0023
PFOS	51	37	35	0.00058	0.191
PFOA	51	5	5	0.000095	0.0023

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-4**, and detailed on **Table 4-1**:

- PFOS has not been delineated to residential RSLs in surface soils horizontally but has been confirmed to extend at least 650 feet in the east/west direction (from soil boring SB12024 to SB12005) to at least 625 feet in the north/south direction (from soil boring OW12002 to SB12021).
- PFOS has not been delineated to residential RSLs vertically based on sub-surface samples and extends across an area of at least 500 feet in the east/west direction (from soil boring SB12013 to SB12008) to approximately 500 feet in the north/south direction (from soil boring SB12007 to SB12021).
- PFOA has been confirmed to extend at least 200 feet in the east/west direction (from soil boring SB12024 to SB12020) to at least 300 feet in the north/south direction (from soil boring SB12024 to SB12020).
- PFOA has been confirmed to exceed residential RSLs in the sub-surface sample in one boring, SB12020.
- PFOS has been confirmed to exceed industrial RSLs to a hazard quotient of 1 and a Total Cancer Risk at 1x10-4 in two borings, SB12013 to SB12010, which are approximately 75 feet from each other, roughly east to west.
- No other PFAS compounds were detected in soils above residential soil RSLs.

To the west of Nose Dock 44, there are two separate storm sewer networks that discharge to two separate drainage swales which discharge to the WBGB, **Figure 2-3**. PFAS impacts to sediment, see results for SW/SD12007, SW/S12010, E-A-SD01K, E-A-SD01M, are identified in these drainage swales at higher concentrations than in the soils to the west of Nose Dock 44, **Figure 4-24B**. Sediment sampling downstream in WBGB exhibit lower concentrations than are identified in the drainage swales, but concentrations of PFAS exceeding the human health wading in sediment SLs persist along the remainder of the reach of the WBGB until it discharges to Malabeam Lake roughly 6,000 feet downstream. Sediment samples north of the discharge location of the drainage swales are either non-detect for PFAS compounds or exhibit detections below screening levels, **Figure 4-24B** and **5-1**. Additional discussion of the nature and extent of PFAS in sediment in this area is provided in **Section 5.8.2**.

Nose Dock 40

Soil sampling did not identify PFAS impacts above residential soil RSLs to the west of Nose Dock 40. PFAS concentrations in soils are above SLs to the east of Nose Dock 40. PFAS identified in sediment samples in the drainage swale to the west of Nose Dock 40 is likely attributed to the repeated releases at Nose Dock 44, which resulted in the transport of PFAS and discharge to the drainage swale through the storm sewer system, **Figure 4-4**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Nose Dock No. 40 Area					
Analyte	**Number of Samples**	**Number of Detections**	**Number of USEPA Residential Soil RSL Exceedances**	**Minimum (mg/kg)**	**Maximum (mg/kg)**
PFOS	10	3	2	0.00062	0.0103

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-4**, and detailed on **Table 4-1**:

- PFOS in surface soils is not delineated horizontally to the residential soil RSL but is delineated vertically.
- PFOS exceedances of the residential soil RSL have been confirmed in two surface soil samples from soil borings SB11002 and SB11001, which are approximately 400 feet apart in the east/west direction.
- No other PFAS were detected in soils above residential RSLs.

Runway – Northwest Portion

Soil sampling was completed along the west side of the Runway and in drainage swales between the Runway and taxiways. Several of the soil borings along the Runway and drainage swales reported no detections of PFAS. However, several of the samples exhibit exceedances of residential soil RSLs in the shallow surface soil samples, **Figure 4-4**.

Summary statistics for the soil samples collected to evaluate the Runway are included **Section 5.2**. The distribution of impacts identified in the Runway in Flow Field 4 are described below.

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-4**, and detailed on **Table 4-1**:

- PFOS has not been delineated to residential RSLs in surface soils horizontally but has been confirmed to extend over a disconnected area at least 300 feet in the east/west direction (from soil boring SS18003 to SS18004) to at least 2,900 feet in the north/south direction (from soil boring SS18001 to SS18005). These borings were completed as surface soil samples and lack vertical delineation.

- PFOA has been confirmed to exceed the residential soil RSL in the surface sample at soil boring, SB18011.
- No other PFAS compounds were detected in soils above the residential soil RSL.

5.4.2 Migration Pathways.

Former Jet Engine Test Cell

PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. The FJETC is along the axis of the approximate east/west drainage divide between Butterfield Brook and Greenlaw Brook. Groundwater flow that can transport this leached mass from the FJETC is to either the west, east, or south. Overburden groundwater is present; however, it is interpreted to be in a perched condition. This condition results in primarily horizontal flow in overburden, to the west towards the WBGB or to the south towards the Nose Docks, **Figures 4-13, 4-14,** and **4-22**. Flow to the south results in the comingling of PFAS that is leached from the soils into the larger groundwater plume under the NDA. Groundwater flow to the west results in gradual attenuation of PFAS impacts through dilution prior to discharge to the WBGB. Storm sewer and sanitary sewer infrastructure is not present at the FJETC.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Former Jet Engine Test Cell (FJETC)					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	54	45	0	0.23	4.4
PFBA	54	48	0	0.64	23.2
PFHxS	54	49	39	0.27	63
PFHxA	54	46	0	0.5	35.3
PFNA	54	32	0	0.2	2.4
PFOS	54	47	47	0.47	85
PFOA	54	47	47	0.25	19

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-13** and **4-14**, with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of the source area at concentrations consistent with concentrations at wells downgradient of the source area. The interpolated plume above the MCL extends approximately 3,000 feet downgradient, to the west of the source area.
- PFOA is identified above MCLs upgradient of the source area at concentrations consistent with concentrations at wells downgradient of the source area. The interpolated plume above the MCL extends approximately 1,000 feet downgradient, to the west of the source area.
- PFHxS is identified above MCLs upgradient of the source area at concentrations consistent with concentrations at wells downgradient of the source area. The interpolated plume above the MCL extends approximately 1,400 feet downgradient, to the west of the source area.

- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

Fuel Dump Area

PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. The FDA is along the axis of the approximate east/west drainage divide between Butterfield Brook and Greenlaw Brook. Groundwater flow that can transport this leached mass from the FDA is to either the south or east. Flow to the east is driven by a relative groundwater high at the northwest side of the NDA. Overburden groundwater is present with slight downward vertical gradients, **Figures 4-13** and **4-22**. Bedrock groundwater flows towards the east or the south, **Figure 4-14.** PFAS leached from soils comingles with the groundwater plume underlying the NDA or the Runway.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Fuel Dump Area					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	39	30	0	0.25	6.5
PFBA	39	35	0	1.98	60.6
PFHxS	39	36	25	1.3	32.9
PFHxA	39	38	0	1.1	51.4
PFNA	39	15	0	0.23	2.1
PFOS	39	36	36	0.48	42.5
PFOA	39	36	36	0.57	12.6

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-13** and **4-14**, with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of the source area at concentrations consistent with concentrations at wells downgradient of the source area. The interpolated plume above the MCL extends approximately 2,500 feet west and 1,500 feet southeast of the source area.
- PFOA is identified above MCLs upgradient of the source area at concentrations consistent with concentrations at wells downgradient of the source area. The interpolated plume above the MCL extends approximately 1,000 feet west and 600 feet southeast of the source area.
- PFHxS is identified above MCLs upgradient of the source area at concentrations consistent with concentrations at wells downgradient of the source area. The interpolated plume above the MCL extends approximately 2,500 feet west and 700 feet southeast of the source area.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

The storm sewer system near the FDA drains overland flow to a discharge point on the east side of the Runway, at outfall ST18003, to Tributary 2 of Butterfield Brook, **Figure 2-3**. Sewer system piping is interpreted to be above the water table, **Figure 4-28**, however an underdrain system is present, which could drain infiltrating precipitation or discontinuous shallow groundwater in a perched condition. A portion of the historic release could have been washed into the storm sewer network for discharge at the outfall east of the Runway, **Figure 5-1**. Additional discussion of the nature and extent of PFAS in surface water in this area is provided in **Section 5.8.1**.

Nose Dock 11

PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Nose Dock 11 is just west of the axis of the approximate east/west drainage divide between Butterfield Brook and Greenlaw Brook. Groundwater flow that can transport this leached mass from Nose Dock 11 is to the south/southeast. Overburden groundwater is present with downward vertical gradients to bedrock, **Figures 4-13** and **4-22**. Bedrock groundwater flows to the south/southeast, **Figure 4-14**. PFAS leached from soils will ultimately comingle with the groundwater plume underlying the NDA.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Nose Dock No. 11					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	36	27	0	0.25	5.5
PFBA	36	32	0	0.54	28
PFHxS	36	36	21	1.6	42
PFHxA	36	34	0	0.13	14
PFNA	36	12	0	0.32	3.5
PFOS	36	36	36	0.89	38.4
PFOA	36	35	35	0.24	13

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-13** and **4-14**, with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of the source area and decreases in monitoring wells downgradient to the southeast. The interpolated plume above the MCL extends approximately 800 feet downgradient to the southeast of the source area.
- PFOA is identified above MCLs upgradient of the source and decreases in monitoring wells downgradient to the southeast. The source area lies on the eastern edge of the interpolated plume above the MCL.
- PFHxS is identified above MCLs upgradient of the source area and decreases in monitoring wells downgradient to the southeast. The interpolated plume above the MCL extends approximately 300 feet southeast of the source area.

- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

The storm sewer system at Nose Dock 11 drains to the C2 storm sewer outfall which discharges to the FLDD, **Figure 2-3**. Sewer system piping is interpreted to be above the water table, **Figure 4-28**, however an underdrain system is present, which could drain infiltrating precipitation or discontinuous shallow groundwater in a perched condition. A portion of the historic release could have been washed into the storm sewer network for discharge to the FLDD. The sanitary sewer present in this area has been diverted to discharge to the storm sewer system (Wright-Pierce, 2011), **Figure 4-29**. Additional discussion of the nature and extent of PFAS in surface water in this area is provided in **Section 5.8.2**.

Aircraft Hardstands/Hardstand 19

PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. The Aircraft Hardstands, including Hardstand 19, are to the east of the nose docks and to the west of the axis of the approximate east/west drainage divide between Butterfield Brook and Greenlaw Brook. Groundwater flow that can transport this leached mass from the Aircraft Hardstands is to the south/southwest. Overburden groundwater is present and flows to the south with downward vertical gradients to bedrock, **Figures 4-13** and **4-22**. Bedrock groundwater flows to the south/southwest, **Figure 4-14**. PFAS leached from soils will ultimately comingle with the groundwater plume underlying the NDA.

The summary statistics for PFAS compounds that have screening levels for the Aircraft Hardstands and Hardstand 19 as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Aircraft Hardstands					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	69	55	0	0.24	9.4
PFBA	69	65	0	1.6	145
PFDA	69	3	3	0.44	2
PFHxS	69	69	49	0.82	110
PFHxA	69	69	0	0.84	27.6
PFNA	69	32	0	0.2	5.1
PFOS	69	69	69	0.8	243
PFOA	69	67	67	0.52	43.3

Excerpt from Table O-2: Groundwater Summary Statistics - Hardstand 19					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	96	76	0	0.16	22.7
PFBA	96	73	0	0.77	68.7
PFHxS	96	95	61	0.73	220
PFHxA	96	80	0	0.13	70.6
PFNA	96	33	1	0.17	7.2
PFOS	96	84	84	0.42	1030

Excerpt from Table O-2: Groundwater Summary Statistics - Hardstand 19					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFOA	96	89	89	0.13	74

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-13** and **4-14**, with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of these source areas at concentrations that are generally consistent with concentrations identified in the Hardstands. PFOS has been identified at just above or just below the MCL in monitoring well JMW-0416B at the southeastern end of the Hardstands. The interpolated plume above the MCL extends approximately 1,500 feet downgradient of these source areas until it comingles with impacts attributed to the CFS.
- PFOA is identified above MCLs upgradient of these source areas at concentrations that are generally consistent with concentrations identified in the Hardstands. PFOA has been identified at just above or just below the MCL in monitoring well JMW-0416B at the southeastern end of the Hardstands. The interpolated PFOA plume is not present at the southern end of the Hardstands.
- PFHxS is identified above MCLs upgradient of these source areas at concentrations that are generally consistent with concentrations identified in the Hardstands. The interpolated plume above the MCL extends approximately 1,500 ft downgradient of these source areas until it comingles with impacts attributed to the CFS.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

The storm sewer system at Nose Dock 11 drains to the C2 storm sewer outfall which discharges to the FLDD, **Figure 2-3**. This system piping is interpreted to be above the water table, **Figure 4-28**, however an underdrain system is present, which could drain infiltrating precipitation or discontinuous shallow groundwater in a perched condition. A portion of the historic release could have been washed into the storm sewer network, and discharge to the FLDD. The sanitary sewer present in this area has been diverted to discharge to the storm sewer system (Wright-Pierce, 2011), **Figure 4-29**. Additional discussion of the nature and extent of PFAS in surface water in this area is provided in **Section 5.8.2**.

Ramp #1

PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Ramp #1 is to the south of the Nose Docks and Aircraft Hardstands and to the west of the axis of the approximate east/west drainage divide between Butterfield Brook and Greenlaw Brook. Groundwater flow that can transport this leached mass from Ramp #1 flows to the southwest. Overburden groundwater is present and flows to the southwest, with downward vertical gradients, **Figures 4-13** and **4-22**. Bedrock groundwater flows to the south/southeast, **Figure 4-14**. PFAS leached from soils at Ramp #1 is expected to comingle with the groundwater plume underlying the NDA.

Samples that evaluate soil quality in the vicinity of Ramp #1, which is on the southeast side of the Aircraft Hardstands, are reported with the Aircraft Hardstand samples.

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-13** and **4-14**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of the source area at concentrations that are generally consistent with concentrations identified at Ramp #1. PFOS has been identified at just above or just below the MCL in monitoring well JMW-0416B just north of Ramp #1. The interpolated plume above the MCL extends approximately 500 feet downgradient of the source area until it comingles with impacts attributed to the CFS.
- PFOA is identified above MCLs upgradient of the source area at concentrations that are generally consistent with concentrations identified at Ramp #1. PFOA has been identified at just above or just below the MCL in monitoring well JMW-0416B just north of Ramp #1. The interpolated plume above the MCL extends approximately 500 feet downgradient of the source area until it comingles with impacts attributed to the CFS.
- PFHxS is identified above MCLs upgradient of the source area at concentrations that are generally consistent with concentrations identified at Ramp #1. The interpolated plume above the MCL extends approximately 500 feet downgradient of the source area until it comingles with impacts attributed to the CFS.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

The storm sewer system at Ramp #1 drains to the C1 or C2 storm sewer outfall which discharges to the FLDD, **Figure 2-3**. This system piping is interpreted to be below the water table, **Figure 4-28**. This condition indicates there is the potential for groundwater infiltration into the storm sewer system in this area if subsurface infrastructure is degraded. Additionally, a portion of the historic release could have been washed into the storm sewer network for discharge to the FLDD. The sanitary sewer present in this area has been diverted to discharge to the storm sewer system (Wright-Pierce, 2011), **Figure 4-29**. Additional discussion of the nature and extent of PFAS in surface water in this area is provided in **Section 5.8.2**.

Nose Dock 44

Nose Dock 44 is on the west side of the NDA in the Greenlaw Brook drainage basin. PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. The primary control on groundwater flow that can transport leached mass from this area is the WBGB, to the southwest of this source area, which captures overburden and bedrock groundwater, **Figure 5-1**. Nose Dock 44 contributes to one of the most extensive groundwater plumes of the PFAS source areas at Loring.

Groundwater in overburden is discontinuous in this area, identified along the trace of the drainage swales and a limited periphery near the swales to the west of Nose Dock 44, **Figure 4-13**. The overburden groundwater exists in glacial till and flows to the west. Vertical gradients are typically upward, from deep bedrock to overburden. The magnitude of these vertical gradients varies and there are instances where the gradient

reverses, with higher water levels in overburden or shallow bedrock compared to nearby deep bedrock wells, **Figure 4-22** and **Appendix E-4**.

Bedrock groundwater flows from a local high to the north of Nose Dock 44, to the south and southwest towards the WBGB. PFAS concentrations in bedrock groundwater are highest to the south and southwest of Nose Dock 44, **Figure 4-14**. The WBGB captures most of the impacted groundwater attributed to this source area. This is indicated by modeled groundwater contours diverging towards this drainage from the east and west, the modeled and measured vertical gradients in groundwater, as well as the non-detect concentrations of PFAS in the monitoring network west of WBGB, including the paired bedrock wells GC_BW002S/D. Concentrations of PFAS in groundwater gradually decrease with distance from the source to the south and southwest along WBGB. Vertical hydraulic gradients to the west of the nose docks are generally upward, driving flow from bedrock to overburden, for discharge to the WBGB. To the east of Nose Dock 44, hydraulic gradients are downward, resulting in recharge of bedrock groundwater from the overburden and driving flow towards the EBGB. The extent of vertical impacts attributed to Nose Dock 44 is not delineated, allowing for the potential that regional flow pathways could impact the transport of PFAS in deeper bedrock.

The summary statistics for PFAS compounds that have screening levels for Nose Dock 44 as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Nose Dock No. 44					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	28	28	0	5.1	150
PFBA	28	28	0	4.4	64
PFDA	28	1	1	0.34	10
PFHxS	28	28	28	49.6	930
PFHxA	28	28	0	11.9	366
PFNA	28	25	1	1.4	6.3
PFOS	28	28	28	85.6	4350
PFOA	28	28	28	5.8	130

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-9** and **4-10**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of the source area, however concentrations increase by three orders of magnitude at the source area. The interpolated plume above the MCL extends at least 3,500 feet downgradient of the source area, to the confluence of the WBGB and Tributary 7.
- PFOA is identified above MCLs upgradient of the source area, however concentrations increase by two orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 2,600 feet downgradient of the source area.
- PFHxS is identified above MCLs upgradient of the source area, however concentrations increase by two orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 3,000 feet downgradient to the east of the source area.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

- Shallow groundwater samples, which were not collected from monitoring wells exceed MCLs and have been incorporated into the interpolated plume maps for this area and are shown on **Figure 4-24B**.

Stormwater runoff at Nose Dock 44 is directed through a storm sewer network for discharge to one of two drainage swales. The storm sewer system in this area was installed with underdrains designed to dewater the shallow groundwater in the area. Since base development, the storm sewer and sanitary sewer infrastructure in this area may have degraded, allowing for stormwater inputs at manholes and the infiltration of groundwater in areas where the storm or sanitary sewer pipes are installed below the water table, or where perched groundwater is present. The sanitary sewer system piping has been redirected to discharge to the storm sewer system which discharges to the FLDD (Wright-Pierce, 2011), **Figure 2-3, 4-28** and **4-30**.

The storm and sanitary sewer system piping in this area are installed above the water table, as detailed in **Figures 4-28** and **4-30**. Stormwater discharge monitoring at outfalls ST11001 and ST12001 indicate most of the water discharged from these outfalls is from precipitation runoff while groundwater discharge from the underdrain systems is limited. Discharge is reported only during or shortly after rain events while baseflow is not reported, **Appendix I**. Standing water has been identified in the outfalls during sampling, indicating that the water quality at the outfalls represent a mixture of fresh stormwater runoff and standing water in the drainage swales, **Figure 4-28**. This is suggested by the relatively lower concentrations identified in upgradient storm sewers compared to the higher concentrations identified in the standing water at the outfalls.

These drainage swales act as infiltration basins, resulting in groundwater recharge. The underlying sediment is identified as dense glacial till, resulting in slow infiltration rates of the stormwater discharge. Following the largest precipitation events, overflow consisting of a mixture of fresh stormwater runoff and the standing water from these basins may flow to the west across the land surface to discharge to the WBGB.

PFAS identified in the sediment underlying these basins results in the diffusion of PFAS from sediment to surface water. PFAS are identified at higher concentrations in surface water and sediment samples from the basins than in nearby groundwater or soil boring samples. Stormwater samples from the storm sewer basins upstream of the discharge reported lower concentrations than were identified in surface water. No porewater was collected from these drainage basins as the underlying sediment was characterized as fine-grained glacial till, which did not produce an appreciable volume of water for porewater collection and analysis, **Figure 4-24B** and **Appendix E**. These conditions suggest that leaching of PFAS from sediment in the basins contributes PFAS to surface water and groundwater. Additional discussion of the nature and extent of PFAS in surface water in this area is provided in **Section 5.8.2**.

Nose Dock 40

Nose Dock 40 was identified in the PFAS SI as a storage area for AFFF, however later review indicated the majority of AFFF was stored at Nose Dock 44. PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Located immediately south of Nose Dock 44, groundwater flow that can transport this leached mass from Nose Dock 40 is governed by the same conditions that characterize Nose Dock 44.

PFAS in groundwater resulting from the use of AFFF at Nose Dock 40 may be comingled with the larger groundwater plume resulting from the documented releases at Nose Dock 44.

The summary statistics for PFAS compounds that have screening levels for the Aircraft Hardstands and Hardstand 19 as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Nose Dock No. 40 Area					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	46	40	0	0.18	23
PFBA	46	41	0	0.82	21.9
PFDA	46	0	0	0.86	2.1
PFHxS	46	45	37	0.74	210
PFHxA	46	42	0	0.41	58
PFNA	46	35	0	0.42	2.5
PFOS	46	44	44	0.86	580
PFOA	46	42	42	0.43	25

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-9** and **4-10**, and with interpolated plume maps shown on **Figure 5-2:**

- PFAS concentrations for PFOS, PFOA, PFHxS decrease in concentration in the vicinity of Nose Dock 40 compared to the upgradient impacts which are attributed to Nose Dock #44.

5.4.3 Receptors

The migration pathways from the source zones identified in Flow Field #3 are largely controlled by the surface water drainages. Groundwater flow in overburden and bedrock is generally captured by the WBGB. The WBGB is an outlet for a portion of the storm sewer system that serves the western side of the Nose Docks.

Former Jet Engine Test Cell

PFOS and PFOA in soils exceed residential soil RSLs in shallow soils, **Figure 4-4**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

Groundwater impacts are minimal and are delineated to drinking water standards. Dilution reduces concentrations of impacted groundwater from this source area, prior to discharge to surface water bodies. Surface water and sediment samples in Tributary 8 of the WBGB to the southwest of the FJETC were reported below detection limits, **Figures 4-24B**.

PFAS uptake at this source area can occur through soil into various ecological receptors such as plant tissue, terrestrial invertebrate tissue, small mammal prey tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Fuel Dump Area

PFOS exceeds residential soil RSLs in shallow soils, **Figure 4-4**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

Groundwater flows to the south-southeast at a slight gradient, resulting in potential PFAS leached from soils to groundwater to become comingled with the larger plume underlying the Nose Docks or Runway, **Figures 4-13** and **4-14**.

The local storm sewer system discharges to Tributary 2 of Butterfield Brook to the east of the Runway. An exceedance of the SLs for surface water was identified at the outlet of the storm sewer system; however, sediment samples were reported as below MDLs, **Figure 4-24B**. This suggests that minimal mass from the historical release at the FDA is retained in the sediment of this tributary. Infiltrating precipitation captured by the underdrain system likely contributes to the exceedance just above SLs identified in surface water, **Figure 4-24A**.

PFAS uptake can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Nose Dock 11, Aircraft Hardstands/Hardstand 19, and Ramp #1

Nose Dock 11, the Aircraft Hardstands, and Ramp #1 share common potential receptors. These source areas exhibit exceedances of residential soil RSLs in shallow soils for PFOA and PFOS, **Figure 4-4**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

Surface water at the FLDD may be impacted by the groundwater or recently infiltrated groundwater discharging from the storm sewer system. Recently infiltrated groundwater represents recharge to the aquifer by precipitation events. The storm sewer system, sanitary sewer, and groundwater flow pathways result in discharge to the FLDD**, Figures 4-28** and **4-30**.

PFAS uptake can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Nose Dock 44

PFOS and PFOA exceed residential soil RSLs in shallow soils. If the area were to be redeveloped for residential purposes, potential receptors would include future residents. Exceedances of other relevant soil criteria, including industrial standards, also occur, **Figure 4-4**.

The WBGB receives discharge of the groundwater plume emanating from Nose Dock 44, as well as the discharge of surface water from the pair of drainage basins/infiltration swales. These conditions result in downstream transport of PFAS from Nose Dock 44 and impacts to Greenlaw Brook. Overburden and bedrock groundwater is captured by the WBGB to the southwest of the source area.

Surface water discharges from the two infiltration basins to the west of Nose Dock 44 during high precipitation periods result in the discharge of this surface water to the WBGB. This discharge to the larger surface water body results in downstream surface water concentrations generally decreasing with distance from the source area, however exceedances of the swimming SLs are identified along the extent of the WBGB through discharge to Malabeam Lake, Chapman Pit, and to the confluence with the EBGB. Surface water upstream of the stormwater infiltration basins exhibit either non-detect or low-level detections below SLs.

Sediment along the stretch of the WBGB from the infiltration basins down to Malabeam Lake exhibit exceedances of the wading sediment SLs. The concentrations of PFAS compounds are greatest in the sediment of the northern infiltration basin, at several orders of magnitude above the SLs. While still above the SLs, concentrations in sediment generally decrease with distance from the source area until Malabeam Lake, where concentrations in sediment increase.

PFAS uptake can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Nose Dock 40

Potential impacts to receptors associated with Nose Dock 40 are comingled with impacts attributed to confirmed releases from Nose Dock 44.

PFAS uptake can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

5.5 FLOW FIELD #4 NATURE AND EXTENT

Flow Field #4 contains nine identified source areas, including the CFS, Arch Hangar, JEMS SFS, FLDD/SCF, Base Laundry, KC-135 Crash Area, the FTF, the Burn House, and the WWTP. The Burn House, the CFS and SFS are three of the five primary source areas which have been identified as having a greater mass of PFAS in soil and groundwater and therefore greater potential to impact receptors, compared to the other source areas.

As detailed in **Section 3.2** and **Section 4** and illustrated in **Figures 4-1** through **4-35** and **Appendices C through J**, PFAS RI nature and extent investigations include soil, groundwater, surface water, porewater, sediment sampling as well as stormwater discharge monitoring, aquifer testing and long-term monitoring of water levels.

5.5.1 Source Material

Crash Fire Station

Soil sampling identified exceedances of PFAS residential soil RSLs in the perimeter near the CFS. The highest concentrations, at several orders of magnitude over the residential soil RSLs, are found to the northeast of

the building, where impacts extend through the soil column. Overburden in this area is roughly 25 to 40 feet thick, **Figure 4-6**, and the water table ranges between 15 to 25 feet bgs, **Appendix E-1**. Exceedances of the residential soil RSLs extend to the east, across the taxiway and drainage swales of the Runway. A portion of this area exceeds the industrial RSLs, outlined by the polygon included on **Figure 4-5.** To the south and southwest, exceedances of SLs for PFOA and PFOS remain above the residential soil RSL but decrease in concentration with distance from the source area. Concentrations of PFAS in soil increase closer to the source area soils of the Arch Hangar, **Figure 4-5**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Crash Fire Station					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFBS	86	10	0	0.000033	0.0028
PFBA	86	7	0	0.000099	0.0049
PFDA	86	9	9	0.000037	0.0025
PFHxS	86	50	0	0.000078	0.127
PFHxA	86	29	0	0.000033	0.0044
PFNA	86	21	0	0.00011	0.0039
PFOS	86	59	55	0.000087	0.302
PFOA	86	39	39	0.000053	0.0252

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-5**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend at least 1,600 feet in the east/west direction (from soil boring SB07018 to SB07033) to at least 900 feet in the north/south direction (from soil boring SB07036 to SB07014).
- PFOS has not been delineated to residential RSLs vertically but has been confirmed to extend in sub-surface samples across an area of at least 1,100 feet in the east/west direction (from soil boring SB07009 to SB07032) to at least 700 feet in the north/south direction (from soil boring SB07016 to SB07013).
- PFOA has been confirmed to exceed residential RSLs in surface soils over an area of approximately 1,000 feet in the east/west direction (from soil boring SB07010 to SB07032) to approximately 600 feet in the north/south direction (from soil boring SB07016 to SB07021).
- PFOA has been confirmed to exceed residential RSLs in sub-surface samples across an area of approximately 1,250 feet in the east/west direction (from soil boring SB07018 to SB07032) to approximately 650 feet in the north/south direction (from soil boring SB07028 to SB07026).
- PFOA or PFOS have been confirmed to exceed industrial RSLs to a hazard quotient of 1 and a Total Cancer Risk at $1x10^{-4}$ across an area of at least 900 feet east/west (from soil boring SB07011 to SB07032) to 400 feet north/south (from soil boring SB07025 to SB07011).

- SS18008 also exceeds the industrial soil RSLs. This boring was advanced to evaluate impacts attributed to the Main Runway Foaming Area, however, PFAS concentrations in that sample are orders of magnitude higher than results attributed to the Runway and may be attributed to releases from the CFS.
- PFDA has been confirmed to exceed residential soil RSLs in 9 samples which also exceed screening levels for PFOS or PFOA.

No other PFAS compounds were detected in soils above the residential soil RSLs. The CFS is built on an area that had formerly been at a relative topographic low, **Figure 2-12**. These conditions required the introduction of fill material to build the support structures and associated infrastructure for site operations. Soil borings in the area indicate much of this fill is reworked glacial till, however a portion of the soil borings near utility corridors indicate the presence of more permeable fill material. Site development required the inclusion of multiple utilities to support operations in this area, including the sanitary and storm sewers as well as electric services, **Figure 2-3**. This redevelopment has created preferential pathways for transport of the PFAS mass contained in soils away from the CFS.

The local storm sewer system is designed to discharge to the FLDD at outfall C3. During historic releases, AFFF would have traveled down the storm sewer for discharge directly to the FLDD. Portions of the mass of PFAS in the sediment of the FLDD may have originated from releases at the CFS. Additionally, there is ongoing discharge of groundwater that is captured by the underdrain system that feeds the storm sewer system, which is impacted by PFAS attributed to the CFS, **Appendix I**. Sediment impacts are identified in the FLDD, at the discharge point of the storm sewer system as well as downstream along the EBGB, **Figure 4-24C**. Additional discussion of the nature and extent of PFAS in sediment in this area is provided in **Section 5.8.2**.

Arch Hangar

Soil sampling identified exceedances of PFAS residential soil RSLs in the perimeter near the Arch Hangar. Overburden in this area is roughly 20 to 25 feet thick, **Figure 4-6**, and the water table ranges between 12 to 15 feet bgs at OW08001, to the west of this source area, **Appendix E-1**. Exceedances of residential soil RSLs at the Arch Hangar are delineated vertically, being limited to surface soil samples. Horizontally, soil exceedances are highest in the immediate vicinity of the building to the north and west, however concentrations are much lower to the east. Soil exceedances are delineated to the west and south but comingle with exceedances to the north at the Crash Fire Area and to the east at the Runway source area, **Figure 4-5**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Arch Hangar					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFOS	15	7	7	0.001	0.0118
PFOA	15	1	1	0.00077	0.0013

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-5**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend at least 650 feett in the east/west direction (from soil boring SB08006 to SB08004) to at least 700 feet in the north/south direction (from soil boring SB08002 to SB08005).
- PFOS is delineated vertically as it was not detected above screening levels in sub-surface samples
- PFOA was identified in one surface soil sample above residential RSLs at soil boring, SB08005.
- No other PFAS compounds were detected in soils above the residential soil RSLs.

Jet Engine Maintenance Shop

Soil sampling identified exceedances of PFAS residential soil RSLs to the north and east of the JEMS in shallow surface soil samples. Overburden in this area is roughly 15 to 20 feet thick, **Figure 4-6**, and the water table ranges between 25 to 45 feet bgs, **Appendix E-1**. Soil samples to the south and west of the structure exhibited non-detect concentrations of PFAS, **Figure 4-5**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Jet Engine Maintenance Shop					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFOS	11	3	3	0.00078	0.0017

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-5**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential RSL in surface soils to the east or north but is delineated to the south and west. PFOS has been confirmed to extend at least 500 feet in the east/west direction (from soil boring SB09006 to SB09008) to at least 300 feet in the north/south direction (from soil boring SB09007 to SB09008).
- PFOS is delineated vertically as it was not detected above screening levels in sub-surface samples
- No other PFAS compounds were detected in soils above the residential soil RSLs.

Structural Fire Station

Soil sampling identified exceedances of PFAS residential soil RSLs in the vicinity of the SFS. Exceedances of residential soil RSLs have been identified at concentrations that are orders of magnitude above screening criteria and extend through the soil column. Overburden in this area is roughly 10 to 15 feet thick, **Figure 4-6**, and the water table ranges between 10 to 20 feet bgs, **Appendix E-1**. The highest concentrations are identified in shallow surface samples. A portion of this area exceeds the industrial soil RSLs, outlined by the polygon included on **Figure 4-5**. Exceedances of residential criteria extend through the subsurface underneath the parking lot in front of the building, into a nearby drainage swale north of the facility, and in a wooded area behind the building, **Figure 4-5**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Structural Fire Station					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFBS	76	5	0	0.00003	0.0027
PFBA	76	6	0	0.0001	0.0054
PFDA	76	4	4	0.000054	0.0027
PFHxS	76	41	0	0.000081	0.0941
PFHxA	76	16	0	0.000048	0.0027
PFNA	76	17	0	0.000071	0.0061
PFOS	76	66	62	0.000059	0.407
PFOA	76	28	28	0.000087	0.0107

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-5**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend at least 650 feet in the east/west direction (from soil boring SB05035 to SB05039) to at least 1,100 feet in the north/south direction (from soil boring SB05039 to SB05021).
- PFOS has not been delineated to residential RSLs vertically but has been confirmed in sub-surface samples across an area of approximately 400 feet in the east/west direction (from soil boring SB05023 to SB05031) to approximately 300 feet in the north/south direction (from soil boring SB05008 to SB05019).
- PFOA has been confirmed to exceed residential RSLs in surface soils over an area of approximately 600 feet in the east/west direction (from soil boring SB05035 to SB05038) to approximately 750 feet in the north/south direction (from soil boring SB05038 to SB05019).
- PFOA has been confirmed to exceed residential RSLs in sub-surface samples across an area of approximately 300 feet in the east/west direction (from soil boring SB05014 to SB05031) to approximately 150 feet in the north/south direction (from soil boring SB05031 to SB05014).
- PFOA or PFOS have been confirmed to exceed industrial RSLs to a hazard quotient of 1 and a Total Cancer Risk at 1x10-4 across an area of at least 300 feet east/west (from soil boring SB05024 to SB05026) to 300 feet north/south (from soil boring SB05026 to SB05016).
- PFDA has been confirmed to exceed residential soil RSLs in 4 samples, they were detected in samples which also exceed screening levels for PFOS or PFOA.
- No other PFAS compounds were detected in soils above the residential soil RSLs.

Sediment and surface water samples collected along Tributary 7, directly north of the SFS, exhibit exceedances of screening criteria. This drainage swale originates at the discharge of the local stormwater system shown on **Figure 2-3**. These impacts extend along this drainage, Tributary 7, until discharge to the WBGB roughly 2,800 feet from the stormwater outfall, where it comingles with upstream impacts from Nose Dock 44, **Figure 4-**

24C. The comingled impacts from these source areas discharge to Malabeam Lake, then Chapman Pit, then the convergence with the WBGB. The comingled impacts from source areas within the Greenlaw Brook Drainage contribute to impacts above screening criteria that extend to the Little Madawaska River approximately 2.5 miles southwest of the confluence of the EBGB and WBGB, **Figure 5-1**. Additional discussion of the nature and extent of PFAS in sediment in this area is provided in **Section 5.8.2**.

Flightline Drainage Ditch and Spill Containment Facility

Soil sampling has identified exceedances of PFAS residential soil RSLs in the area surrounding the SCF. The highest concentrations in soils are identified at the perimeter of the infrastructure and to the east, towards the FLDD. Overburden in this area is roughly 10 to 35 feet thick, **Figure 4-6**, and the water table ranges between 3 to 5 feet bgs, **Appendix E-1**. Soil samples exhibiting non-detect concentrations or detections below residential screening standards are identified to the south and west of the structure, **Figure 4-5**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** is provided below.

Excerpt from Table O-1: Soil Summary Statistics - Flightline Drainage Ditch					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFHxS	16	5	0	0.00082	0.0049
PFHxA	16	2	0	0.00017	0.0029
PFNA	16	1	0	0.00014	0.0029
PFOS	16	10	9	0.00061	0.0258
PFOA	16	3	3	0.00024	0.0023

The distribution of PFAS above soil RSLs at the SCF is described below, displayed on **Figure 4-5**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend at least 250 feet in the east/west direction (from soil boring SB21002 to SS21002) to at least 300 feet in the north/south direction (from soil boring SB21001 to SB21003).
- PFOS was identified in one sub-surface soil sample above residential RSLs at soil boring, SB21002.
- PFOA was identified in one surface soil sample above residential RSLs at soil boring, SB21006.
- PFOA was identified in one sub-surface soil sample above residential RSLs at soil boring, SB21002.
- No other PFAS compounds were detected in soils above Residential Soil RSLs.

Sediment sampling has identified exceedances of wading sediment criteria along the length of the FLDD, prior to discharge to the SCF. This stretch of the FLDD receives the discharge from the system of catch basins and culverts that drain the aircraft hardstand areas, flightline, runway, and industrial shop areas including the CFS. The discharge of stormwater at these storm sewer outfalls includes precipitation as well as shallow groundwater discharge. Historic practices included washing surface releases of petroleum or AFFF into the storm sewer system through catch basins or floor drains inside of structures. Groundwater discharge in the storm sewer piping originates from the underdrain system, portions of the storm sewer which are degraded

and below the water table, and from portions of the sanitary sewer which allow for I&I and been diverted to the storm sewer system, **Figure 4-28** and **4-30**.

The FLDD is also a discharge zone for the local groundwater, where hydraulic gradients facilitate groundwater discharge from bedrock to overburden and ultimately to surface water. In portions of the FLDD downgradient of source areas, this condition results in the discharge of PFAS impacted groundwater to the FLDD, **Figure 5-1**.

The discharge of AFFF from surface releases that were washed through the storm sewers, the discharge of PFAS impacted groundwater transported through the storm sewer system, or direct groundwater discharge from upgradient source areas has resulted in the transfer of PFAS to the sediments of the FLDD, **Figure 4-24C**. This retention of PFAS mass in the sediment would allow for the continued leaching of PFAS to surface water if the ongoing release from storm sewers or groundwater were to be eliminated. Additional discussion of the nature and extent of PFAS in sediment in this area is provided in **Section 5.8.2**.

Runway – Southwest Portion

Soil sampling has identified exceedances of PFAS residential soil RSLs in the shallow surface soils in the drainage swales at the perimeter of the ready area at the southern end of the Runway, as well as the drainage swales along the flightline and taxiways. Overburden at the southern end of the runway is roughly 15 to 25 feet thick, **Figure 4-6**, and the water table ranges between 25 to 35 feet bgs, **Appendix E-1**.

Summary statistics for the soil samples collected to evaluate the Runway are included **Section 5.2**, the distribution of impacts identified in the Runway in Flow Field 4 are described below.

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-5**, and detailed on **Table 4-1**:

Along the Runway and taxiways:

- PFOS has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend at least 300 feet in the east/west direction (from soil boring SS18009 to SS18010) to at least 2,200 feet in the north/south direction (from soil boring SB18030 to SS18010). PFOS exceedances in surface soils may be discontinuous in the north/south direction.
- PFOA and PFOS has been confirmed to exceed residential and industrial RSLs in one surface soil sample, at SS18008, however concentrations in this sample are orders of magnitude greater than other samples collected along the Runway and may be attributable releases at the CFS.
- PFOS and PFOA have not been delineated to residential RSLs vertically as no-subsurface samples were collected
- No other PFAS compounds were detected in soils above the residential soil RSLs.

Along the Ready Area at the southern end of the Runway:

- PFOS has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend at least 800 feet in the east/west direction (from soil boring SB18048 to

SB18055) to at least 750 feet in the north/south direction (from soil boring SB18057 to SB18049).

- PFOS was identified in one sub-surface soil sample above residential RSLs at soil boring, SB18045.
- PFOA has been confirmed to exceed residential RSLs in surface soils over an area of approximately 750 feet in the east/west direction (from soil boring SB18049 to SB18043) to approximately 400 feet in the north/south direction (from soil boring SB18043 to SB18048).
- No other PFAS compounds were detected in soils above the residential soil RSLs.

Sediment sampling has identified exceedances of wading sediment criteria at the discharge of the local storm sewer system to Tributary 5 of Greenlaw Brook, as well as along the stretch from the discharge location to its confluence with the EBGB. Historic releases of PFAS may have been washed through this storm sewer system for discharge to this water body, **Figure 4-24C**. Additional discussion of the nature and extent of PFAS in sediment in this area is provided in **Section 5.8.2**.

KC-135 Crash Area

Soil sampling identified exceedances of PFAS residential soil RSLs in shallow surface soils advanced across the release area. Overburden in this area is roughly 25 to 35 feet thick, **Figure 4-6**, and the water table is roughly 25 feet bgs based on results at OW16004 and OW19001, **Appendix E-1**. Two samples, to the south and east, exhibited non-detect concentrations, **Figure 4-5**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - KC-135 Crash Fire					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFOS	8	6	6	0.00069	0.0069

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-5**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend at least 250 feet in the east/west direction (from soil boring SS19012 to SS19010) to at least 150 feet in the north/south direction (from soil boring SS19011 to SS19009).
- PFOS has not been delineated to residential RSLs vertically as no-subsurface samples were collected
- No other PFAS compounds were detected in soils above the residential soil RSLs.

Sediment and hydric soil samples collected in Tributary 7, to the south of the reported crash area, exhibit exceedances of their respective SLs: the wading in sediment and residential soil RSLs. These samples are intermixed with samples that are below these SLs or reported as non-detect below MDLs. Runoff from the release of AFFF may have ended up in these drainages, to be retained in the sediment and soils proximal to the stream traces. Historically, this area was identified as a wetland, and subsequent base development resulted in the channelizing of the current stream to improve drainage, **Figure 2-12**. Sampling logs indicate

these soils have high organic content, **Appendix F**, which has the potential to retain PFAS more effectively than the glacial till and reworked fill material present at the crash site, **Figure 4-24C**. Additional discussion of the nature and extent of PFAS in sediment in this area is provided in **Section 5.8.2**.

Fuel Tank Farm

Soil sampling has identified exceedances of PFAS residential soil RSLs in the area surrounding the FTF. The highest concentrations were identified in shallow soil samples, however PFAS impacts were identified to extend through the soil column in borings completed on the west side of the FTF. Overburden in this area is roughly 20 to 35 feet thick, **Figure 4-6**, and the water table is roughly 5 to 15 feet bgs, **Appendix E-1**. Soil exceedances are delineated on the southern and eastern side of the FTF to non-detect or concentrations below residential screening levels, **Figure 4-5**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Fuel Tank Farm					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFBA	33	1	0	0.000088	0.0051
PFDA	33	1	1	0.000043	0.0025
PFHxS	33	6	0	0.000053	0.0025
PFHxA	33	3	0	0.00004	0.0025
PFNA	33	2	0	0.000062	0.0025
PFOS	33	16	13	0.000086	0.0053
PFOA	33	3	3	0.000057	0.0025

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-5**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential RSL in surface soils horizontally in the northern or western directions but is delineated to the eastern and southern sides of this source area.
- PFOS in surface soils has been confirmed to extend at least 900 feet in the east/west direction (from soil boring SB16018 to SB16019) to at least 700 feet in the north/south direction (from soil boring SB16014 to SB16012).
- PFOS in sub-surface soils has been confirmed to extend at least 350 feet in the east/west direction (from soil boring SB16018 to SB16015) to at least 600 feet in the north/south direction (from soil boring SB16014 to SB16018).
- PFOA has been confirmed to exceed residential RSLs in two surface soil samples, at SB16018 and SB16016 which are approximately 700 feet apart in the east/west direction and approximately 100 feet in the north/south direction.
- PFOA has been confirmed to exceed residential RSLs in one sub-surface soil sample, at SB16018.
- PFDA has been confirmed to exceed residential RSLs in one sample, at SB16016 which also exceeds for PFOA.

- No other PFAS compounds were detected in soils above the residential soil RSLs.

Sediment sampling has identified exceedances of wading sediment criteria in the channelized stream that runs through the FTF. Other sediment samples collected in this area have results below SLs or reported as below laboratory detection limits. Historically, this area was identified as a wetland and subsequent base development resulted in the channelizing of the current stream to improve drainage, **Figure 2-12**. Descriptions of the sediment in the sampling records indicate the substrate is variable, some samples contain silty gravel while others are described with higher portions of organic content. The highly organic samples will retain PFAS more effectively than the silty gravels. Additional discussion of the nature and extent of PFAS in sediment in this area is provided in **Section 5.8.2**.

Base Laundry

No soil borings were advanced at Base Laundry due to the lack of potential for this area to be a source area for PFAS. Overburden in this area is roughly 15 to 20 feet thick, **Figure 4-6**, and the water table is roughly 20 to 30 feet bgs, **Appendix E-1**. As detailed in **Section 4.1.4**, samples from groundwater monitoring wells show no increase in downgradient monitoring wells, including JMW1981, compared to upgradient monitoring wells, including JMW3601. This suggests that leaching of PFAS mass from soils is not occurring.

Burn House

Soil sampling has identified exceedances of PFAS residential soil RSLs in the area surrounding the Burn House. Soil samples exceeding residential RSLs are present throughout the unsaturated soil column in a perimeter near the Burn House and are up to several orders of magnitude greater than SLs in shallow surface soils. Overburden in this area is roughly 15 to 20 feet thick, **Figure 4-6**, and the water table is roughly 5 to 25 feet bgs, **Appendix E-1**. A portion of this area exceeds the industrial soil RSLs. Concentrations in soils generally decrease with distance from the Burn House, however, soil concentrations remain up to several orders of magnitude above SLs to the north in the soils underlying the drainage swale running parallel to Pennsylvania Road, **Figure 4-5**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - Burn House					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFBS	46	6	0	0.000023	0.0027
PFBA	46	7	0	0.00011	0.0054
PFDA	46	5	5	0.000043	0.0027
PFHxS	46	16	0	0.000033	0.0037
PFHxA	46	12	0	0.00003	0.0027
PFNA	46	11	0	0.0001	0.0027
PFOS	46	36	34	0.00018	0.104
PFOA	46	13	13	0.000078	0.0027

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-5**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend at least 750 feet in the east/west direction (from soil boring SB06025 to SB06024) to at least 800 feet in the north/south direction (from soil boring SB06011 to SB06026).
- PFOS has not been delineated to residential RSLs vertically but has been confirmed in sub-surface samples across an area of approximately 500 feet in the east/west direction (from soil boring SB06020 to SB06022) to approximately 700 feet in the north/south direction (from soil boring SB06011 to SB06026).
- PFOA has been confirmed to exceed residential RSLs in surface soils over an area of approximately 500 feet in the east/west direction (from soil boring SB06020 to SB06022) to approximately 550 feet in the north/south direction (from soil boring E-T-SO02N to SB06019).
- PFOA has been confirmed to exceed residential RSLs in sub-surface samples across an area of approximately 250 feet in the east/west direction (from soil boring SB06020 to SB06018) to approximately 100 feet in the north/south direction (from soil boring SB06020 to SB06018).
- PFOS has been confirmed to exceed industrial RSLs to a hazard quotient of 1 and a Total Cancer Risk at 1x10-4 across in one boring, SB06006.
- PFDA has been confirmed to exceed residential soil RSLs in five samples which also exceed screening levels for PFOS or PFOA.
- No other PFAS compounds were detected in soils above the residential soil RSLs.

Sediment samples exceeded wading sediment criteria in Tributary 5 of the EBGB that intersects Pennsylvania Road to the north of the Burn House. Concentrations identified at this intersection and downstream are consistently higher than those upstream in Tributary 5. Upstream impacts are attributed to AFFF releases at the KC-135 Crash Area and FTF source areas. Releases associated with the Burn House, which resulted in the washing of AFFF into these drainage swales or aerial deposition of PFAS foam carried by the wind during training exercises, are responsible for the higher concentrations identified along Pennsylvania Road and in the downstream portion of Tributary 5 of EBGB**, Figure 4-24C**. Additional discussion of the nature and extent of PFAS in sediment in this area is provided in **Section 5.8.2**.

Wastewater Treatment Plant

Soil samples exceeded PFAS residential soil RSLs in the area surrounding the WWTP. Soil samples exceeding residential soil RSLs are present throughout the unsaturated soil column in a perimeter in the area of the WWTP and are up to one order of magnitude greater than SLs in samples to the west and northeast of the WWTP, **Figure 4-5**. Overburden in this area is roughly 30 to 35 feet thick, **Figure 4-6**, and the water table is roughly 5 to 10 feet bgs, **Appendix E-1**. The impacts to soil are attributed to the drying of septic sludge impacted with PFAS on the land surface.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.1.1** are provided below.

Excerpt from Table O-1: Soil Summary Statistics - WWTP					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential Soil RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFDA	27	1	1	0.000087	0.0025
PFHxS	27	6	0	0.00075	0.0025
PFHxA	27	3	0	0.000069	0.0025
PFNA	27	2	0	0.00014	0.0025
PFOS	27	20	19	0.00061	0.017
PFOA	27	5	5	0.00013	0.0025

The distribution of PFAS above soil RSLs is described below, displayed on **Figure 4-5**, and detailed on **Table 4-1**:

- PFOS has not been delineated to the residential RSL in surface soils horizontally but has been confirmed to extend at least 600 feet in the east/west direction (from soil boring SB22009 to SB22002) to at least 500 feet in the north/south direction (from soil boring SB22001 to SB22010).
- PFOS has not been delineated to residential RSLs vertically but has been confirmed in sub-surface samples across an area of approximately 600 feet in the east/west direction (SB22009 to SB22002) to approximately 350 feet in the north/south direction (from soil boring SB22001 to SB22003).
- PFOA has been confirmed to exceed residential RSLs in surface soils over an area of approximately 450 feet in the east/west direction (from soil boring SB22012 to SB22002) to approximately 150 feet in the north/south direction (from soil boring SB22013 to SB22012).
- PFOA has been confirmed to exceed residential RSLs in two sub-surface samples, from SB22013 and SB22012, which are roughly north/south and approximately 150 feet away from each other.
- PFDA has been confirmed to exceed residential soil RSLs in one sample, SB22012, which also exceeds screening levels for PFOS or PFOA.
- No other PFAS compounds were detected in soils above the residential soil RSLs.

Sediment samples exceeded wading sediment criteria in Greenlaw Brook directly west of the EBGB. The site history indicates that AFFF was not stored or released at the WWTP. The concentrations identified in the sediment of Greenlaw Brook in upstream and downstream samples of the WWTP are of similar concentrations to those collected immediately west of the WWTP. These conditions indicate that the sediment impacts in Greenlaw Brook directly west of the WWTP are associated with the downstream transport of PFAS from upstream source areas, **Figure 4-24D**. Additional detail regarding surface water and sediment impacts in this area are provided in **Section 5.8.2**.

5.5.2 Migration Pathways

Crash Fire Station

The primary control on the migration of groundwater away from the CFS is the FLDD, just to the southwest of this source area. PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. The FLDD captures overburden and bedrock groundwater that can transport this leached mass from the soils of this source area. The discharge from the storm sewer system is directed to the FLDD to be discharged at

outfall C1, **Figure 4-26** and **Figure 5-1**. Utility corridors where storm sewers or sanitary sewers are present create migration pathways, transporting impacted groundwater to the FLDD. This transport occurs through the storm sewer system underdrains, through degraded storm sewer system piping below the water table, or from degraded sanitary sewer system piping subject to infiltration that has been diverted to the storm sewer system, **Figure 4-28** and **4-30**.

Overburden groundwater is present underlying the CFS. Overburden groundwater flow is from the northeast to the southwest, from the Runway and Nose Docks, towards the FLDD. Vertical gradients from overburden to bedrock are downward to neutral and can vary seasonally, **Figure 4-22** and **Appendix E-4**. Water level monitoring using pressure transducers at overburden well OW07001 and shallow bedrock well BW07001 indicate water levels are consistent between these two wells. Throughout the entire monitoring period, water levels were very similar, only diverging to slight upward gradients during periods with relatively little precipitation. This is an indication that there is relatively good hydraulic connection between overburden and bedrock in this area, **Appendix E-3**. Downgradient of the CFS there is an upward gradient along a trace that leads to the FLDD, corresponding to the trace of several storm sewer systems, including C1, C2, and C3, **Figure 4-22**.

Hydraulic conductivity measured during aquifer testing indicates that overburden monitoring wells in this area can have relatively high hydraulic conductivity values compared to what would be expected in typically lower conductivity glacial tills. This increase in overburden permeability is likely a result of the placement of fill and construction of utilities during base development, creating more permeable pathways for groundwater flow, **Appendix H**.

Bedrock groundwater in this area is flowing from the northeast to southwest, towards the FLDD. PFAS concentrations in this area are greatest in monitoring wells to the south and southwest of the source area soils. The FLDD captures most of the impacted groundwater associated with this source area. This is indicated by the modeled hydraulic gradients diverging towards this drainage from the east and west, the measured vertical gradients in groundwater, as well as low-level detections of PFAS in the monitoring network west of the FLDD, in monitoring wells JBW7314 and MMW0004. The extent of vertical impacts is not delineated, allowing for the potential that regional flow pathways could impact the transport of PFAS in deep bedrock. Concentrations of PFAS in groundwater gradually decrease with distance from the source to the south and southwest along the FLDD, **Figures 4-15** and **4-16**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Crash Fire					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	81	80	0	0.93	300
PFBA	81	81	0	2.5	1210
PFDA	81	28	28	0.35	77
PFHxS	81	81	81	11.3	3500

Excerpt from Table O-2: Groundwater Summary Statistics - Crash Fire					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFHxA	81	81	6	2.3	2340
PFNA	81	73	47	0.27	336
PFOS	81	81	81	8.8	18000
PFOA	81	81	81	2.4	2340

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of the source area, however concentrations increase by three orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 9,000 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the SFS, the FLDD/SCF, Arch Hangar, and the Burn House.
- PFOA is identified above MCLs upgradient of the source area, however concentrations increase by three orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 8,500 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the SFS, the FLDD/SCF, Arch Hangar, and the Burn House.
- PFHxS is identified above MCLs upgradient of the source area, however concentrations increase by three orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 8,200 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the SFS, the FLDD/SCF, Arch Hangar, and the Burn House.
- PFNA is not identified upgradient of the source area and increases by two orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 800 feet downgradient of the source area.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

Arch Hangar

The Arch Hangar is to the southwest of the CFS. PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Groundwater that can transport this leached mass flows in bedrock from the northeast to southwest, towards the FLDD. The Arch Hangar is on the edge of saturated overburden groundwater. Concentrations of PFAS in groundwater are higher in deeper wells in this area, likely attributed to the downgradient transport of groundwater impacts at the CFS. PFAS leached from the soil at the Arch Hangar will comingle with groundwater impacts sourced from the CFS, **Figure 5-5**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Arch Hangar					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	67	64	0	0.41	23
PFBA	67	66	0	2.3	40
PFDA	67	15	15	0.32	2
PFHxS	67	67	63	1.3	640
PFHxA	67	67	0	1.6	150
PFNA	67	57	1	0.19	6.1
PFOS	67	67	67	1.3	450
PFOA	67	67	67	1.3	180

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified in concentrations above MCLs upgradient of the source area, however concentrations decrease by an order of magnitude compared to upgradient impacts identified at the CFS. The interpolated plume above the MCL extends approximately 8,000 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the CFS, SFS, the FLDD/SCF, and the Burn House.
- PFOA is identified in concentrations above MCLs upgradient of the source area, however concentrations decrease by an order of magnitude compared to upgradient impacts identified at the CFS. The interpolated plume above the MCL extends approximately 7,500 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the CFS, SFS, the FLDD/SCF, and the Burn House.
- PFHxS is identified in concentrations above MCLs upgradient of the source area, however concentrations decrease by an order of magnitude compared to upgradient impacts identified at the CFS. The interpolated plume above the MCL extends approximately 7,200 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the CFS, SFS, the FLDD/SCF, and the Burn House.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

Jet Engine Maintenance Shop

The JEMS is to the south of the CFS. PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Groundwater that can transport this leached mass in bedrock flows from the northeast to southwest, towards the FLDD. Overburden groundwater is not saturated in this area. Concentrations of PFAS in groundwater are higher in deeper wells in this area, likely attributed to the downgradient transport of groundwater impacts at the CFS. Potential leaching from the soil at the JEMS will comingle with groundwater impacts sourced from the CFS, **Figure 5-5**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Jet Engine Maintenance					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	108	106	0	0.57	9.8
PFBA	108	103	0	1.7	35
PFDA	108	2	2	0.37	8.9
PFHxS	108	108	105	7.5	275
PFHxA	108	108	0	1.1	47
PFNA	108	59	0	0.17	2.2
PFOS	108	108	108	0.96	220
PFOA	108	108	108	2.3	52.5

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified in concentrations above MCLs upgradient of the source area, however concentrations decrease by an order of magnitude compared to upgradient impacts. The interpolated plume above the MCL extends approximately 7,500 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the CFS, Arch Hangar, SFS, the FLDD/SCF, and the Burn House.
- PFOA is identified in concentrations above MCLs upgradient of the source area, however concentrations decrease by an order of magnitude compared to upgradient impacts. The interpolated plume above the MCL extends approximately 6,800 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the CFS, Arch Hangar, SFS, the FLDD/SCF, and the Burn House.
- PFHxS is identified in concentrations above MCLs upgradient of the source area, however concentrations decrease by an order of magnitude compared to upgradient impacts. The interpolated plume above the MCL extends approximately 7,000 feet downgradient of the source area, with other source areas that may contribute to the groundwater plume including the CFS, Arch Hangar, SFS, the FLDD/SCF, and the Burn House.

Structural Fire Station

The primary control on the migration of groundwater away from the SFS is its location just to the east of the EBGB and WBGB groundwater divide. PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. This condition results in groundwater that can transport the leached mass from this source area flowing to the southeast, to be captured by the EBGB. Local storm sewers discharge to a drainage swale, which discharges north to Tributary 7 of WBGB, **Figure 5-7**.

Overburden groundwater is present underlying the SFS in a typically thin layer above bedrock. Overburden groundwater flow is to the southeast, towards the EBGB. Vertical gradients from overburden to bedrock are downward based on modeled results and measured water levels in the field, **Figure 4-22** and **Appendix E-4**. Water level monitoring using pressure transducers at overburden well OW05002 and bedrock well BW05007 indicate water levels are consistently slightly higher in the representative overburden well. Downgradient of

the SFS there is a modeled and measured upward gradient in groundwater along the trace of the EBGB, **Figure 4-22**, and that section of stream is identified as a groundwater discharge zone, **Figure 5-1**.

Bedrock groundwater in this area is flowing from the northwest to the southeast, towards the EBGB. PFAS concentrations in this area are greatest in monitoring wells to the south and southeast of the source area soils. The EBGB likely captures most of the impacted groundwater associated with this source area. The extent of vertical impacts is not delineated, allowing for the potential that regional flow pathways could impact the transport of PFAS in deep bedrock. Concentrations of PFAS in groundwater gradually decrease with distance from the source to the south and southwest along the EBGB, **Figures 4-15** and **4-16**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Structural Fire Station					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	89	65	0	0.23	114
PFBA	89	62	0	0.67	160
PFDA	89	14	14	0.3	2.3
PFHxS	89	82	47	0.46	1300
PFHxA	89	73	0	0.15	388
PFNA	89	47	35	0.2	51.5
PFOS	89	82	82	0.46	2800
PFOA	89	77	77	0.24	287

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of the source area, however concentrations increase by three orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 6,200 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the CFS, the FLDD/SCF, Arch Hangar, and the Burn House.
- PFOA is identified above MCLs upgradient of the source area, however concentrations increase by two orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 6,100 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the CFS, the FLDD/SCF, Arch Hangar, and the Burn House.
- PFHxS is identified above MCLs upgradient of the source area, however concentrations increase by two orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 5,900 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the CFS, the FLDD/SCF, Arch Hangar, and the Burn House.
- PFNA is not identified upgradient of the source area and increases by an order of magnitude at the source area. The interpolated plume above the MCL extends approximately 900 feet downgradient of the source area.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of

PFOS above the USEPA MCL.

The storm sewer system at the SFS drains to a discharge point just to the northeast of the building, a drainage channel identified as Tributary 7 of the WBGB, **Figure 2-3**. Portions of the storm sewer system in this area are submerged below the water table, resulting in the potential for groundwater discharge to this drainage. Additionally, a portion of the historic releases could have been washed into this storm sewer network, and a portion of this mass could have been retained. Current stormwater discharge could leach these compounds from the sediment. These conditions allow for downstream transport of impacts attributed to the SFS to the WBGB, **Figure 5-1**. Additional discussion of the nature and extent of PFAS in surface water in this area is provided in **Section 5.8.2**.

Flightline Drainage Ditch and Spill Containment Facility

The FLDD is a discharge zone for overburden and bedrock groundwater and receives discharge from the storm sewer network. The FLDD facilitates the downstream transport of PFAS associated with historic base activities to the headwaters of the EBGB. Upward gradients from bedrock to overburden and ultimately into surface water result in PFAS discharging to this surface water body from upgradient groundwater source areas, **Figures 4-22** and **5-1**. Groundwater that has infiltrated into the storm sewer network to be discharged through the C1, C2, or C3 outfalls is transported through the FLDD. The mass of PFAS in the sediment and porewater that was historically discharged through the storm sewer system has the potential to be leached out of sediments by groundwater passing through these sediments and into surface water. While this portion of the stream system has been found to be gaining, meaning groundwater is discharging to the surface water, downstream portions of the stream may be losing, meaning the surface water recharges groundwater. This loosing condition could allow PFAS sourced from the sediment of the FLDD/SCF to recharge groundwater downstream, **Figure 5-1**. This retention of PFAS mass in the sediment allows for the continued leaching of PFAS to surface water if the ongoing release from storm sewers or groundwater were to be eliminated. Additional discussion of the nature and extent of PFAS in surface water in this area is provided in **Section 5.8.2**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Flight Line Drainage Ditch					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	44	41	0	0.47	22
PFBA	44	41	0	1.99	28.6
PFDA	44	3	3	0.28	9.5
PFHxS	44	41	34	0.97	770
PFHxA	44	43	0	1.4	170
PFNA	44	30	2	0.15	8
PFOS	44	38	38	0.19	1300
PFOA	44	43	43	1.5	180

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified in concentrations above MCLs upgradient of the source area, however concentrations decrease by an order of magnitude compared to upgradient impacts. The interpolated plume above the MCL extends approximately 7,300 feet downgradient of the head of the FLDD, with other source areas contributing to the groundwater plume including the CFS, Arch Hangar, SFS, and the Burn House.
- PFOA is identified in concentrations above MCLs upgradient of the source area, however concentrations decrease by an order of magnitude compared to upgradient impacts. The interpolated plume above the MCL extends approximately 7,000 feet downgradient of the head of the FLDD, with other source areas contributing to the groundwater plume including the CFS, Arch Hangar, SFS, and the Burn House.
- PFHxS is identified in concentrations above MCLs upgradient of the source area, however concentrations decrease by an order of magnitude compared to upgradient impacts. The interpolated plume above the MCL extends approximately 7,100 feet downgradient of the source area, with other source areas that may contribute to the groundwater plume including the CFS, SFS, the FLDD/SCF, and the Burn House.

Base Laundry

Groundwater impacts at the Base Laundry are consistent with upgradient and downgradient monitoring wells. PFAS in soils that could potentially leach to groundwater would be comingled with groundwater impacts from upgradient sources. The contribution of PFAS from the Base Laundry is not apparent based on groundwater analytical results, **Figures 4-15** and **4-16**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Base Laundry					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	51	45	0	0.75	4.6
PFBA	51	48	0	1.9	8.8
PFDA	51	2	2	0.33	2.2
PFHxS	51	51	43	5.2	85.8
PFHxA	51	51	0	1.4	23.7
PFNA	51	33	0	0.36	2.2
PFOS	51	51	51	6.9	280
PFOA	51	51	51	4.4	31.2

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified in concentrations above the MCL upgradient of the source area do not show an increase in downgradient wells. The interpolated plume above the MCL extends approximately 4,900 feet downgradient of the Base Laundry, with other source areas contributing to the groundwater plume including the CFS, Arch Hangar, SFS, and the Burn House.
- PFOA is identified in concentrations above the MCL upgradient of the source area and do not show an increase in downgradient wells. The interpolated plume above the MCL extends approximately 4,500 feet downgradient of the head of the Base Laundry, with other source areas contributing to the groundwater plume including the CFS, Arch Hangar, SFS, and the Burn House.
- PFHxS is identified in concentrations above the MCL upgradient of the source area and do not show an increase in downgradient wells. The interpolated plume above the MCL extends approximately 4,700 feet downgradient of the head of the Base Laundry, with other source areas contributing to the groundwater plume including the CFS, Arch Hangar, SFS, and the Burn House.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

KC-135 Crash Area

The KC-135 Crash Area is directly south of the Runway along the axis of the groundwater divide between the EBGB and Butterfield Brook. PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. However, concentrations of PFAS in bedrock and overburden groundwater that can transport this leached mass are below the USEPA drinking water MCLs in the monitoring wells immediately downgradient of the source area, **Figures 4-15** and **4-16**. Slight upward gradients from bedrock to overburden are modeled in this area, **Figure 4-22** and **Appendix E-4**. Migration of PFAS from this source area through groundwater is shown to be minimal.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - KC-135 Crash Area					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	14	9	0	0.55	2.1
PFBA	14	11	0	2	7.9
PFHxS	14	14	1	2.7	11.4
PFHxA	14	9	0	0.57	2.5
PFNA	14	2	0	0.25	2.1
PFOS	14	12	12	1	10.7
PFOA	14	13	13	0.82	4.3

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is not identified above the MCL in the closest downgradient monitoring wells of the KC-135 Crash Site, however concentrations do increase above the MCL in downgradient monitoring wells, proximal to the Fuel Tank Farm. PFOS is not interpolated to be present in groundwater at the KC-135 Crash Site.
- PFOA is not identified above the MCL in the closest downgradient monitoring wells of the KC-135 Crash Site, however concentrations do increase above the MCL in downgradient monitoring wells, proximal to the Fuel Tank Farm. PFOS is not interpolated to be present in groundwater at the KC-135 Crash Site.
- PFHxS is not identified above the MCL in the closest downgradient monitoring wells of the KC-135 Crash Site, however concentrations do increase in downgradient monitoring wells, proximal to the Fuel Tank Farm. PFOS is not interpolated to be present in groundwater at the KC-135 Crash Site.
- The area of exceedance as compared to the Maine Sum of 6 is not interpolated to be present at the KC-135 Crash Site.

Sediment impacts are identified in Tributary 5 of the EBGB due south of the KC-135 Crash Area. These impacts are likely associated with the AFFF release at the crash site resulting in preferential storage of PFAS compounds in the organic fraction of soil and sediments, which have the potential to diffuse slowly to surface water. Possible diffusion from this source area has the potential for transport and incorporation into higher magnitude impacts identified downstream, such as those associated with the FTF and Burn House, **Figures 4-24C** and **5-1**. Additional discussion of the nature and extent of PFAS in surface water in this area is provided in **Section 5.8.2**.

Fuel Tank Farm

The FTF is to the southwest of the Runway and to the west of the axis of the groundwater divide between the EBGB and Butterfield Brook. PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Concentrations of PFAS in bedrock and overburden groundwater that can transport this leached mass are above the USEPA drinking water MCLs in the monitoring wells immediately downgradient of the source area, **Figures 4-15** and **4-16**. Vertical gradients indicate downward flow from overburden to bedrock,

Figure 4-22. Downgradient of the FTF, modeling indicates there are upward gradients at the EBGB and along Tributary 5 of the EBGB west of the FTF. As shown on **Figure 5-1**, the groundwater plume from the FTF flows west and becomes relatively dilute, with a limited extent exceeding the MCLs prior to comingling with the larger magnitude plume associated with the Burn House.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Fuel Tank Farm					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	89	63	0	0.17	5.6
PFBA	89	69	0	1.1	33
PFDA	89	2	2	0.36	2.7
PFHxS	89	77	53	0.47	170
PFHxA	89	75	0	0.39	39
PFNA	89	32	0	0.17	2.7
PFOS	89	73	73	0.43	218
PFOA	89	75	75	0.13	61

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is not identified in concentrations above MCLs upgradient of the source area. The interpolated plume above the MCL extends approximately 7,000 feet downgradient of the source area, however concentrations of PFOS increase by orders of magnitude in monitoring wells attributed to the Burn House. Other source areas contribute to the groundwater plume including the SFS, the FLDD/SCF, and the CFS.
- PFOA is not identified in concentrations above MCLs upgradient of the source area. The interpolated plume above the MCL extends approximately 6,500 feet downgradient of the source area, however concentrations of PFOS increase by orders of magnitude in monitoring wells attributed to the Burn House. Other source areas contribute to the groundwater plume including the SFS, the FLDD/SCF, and the CFS.
- PFHxS is not identified in concentrations above MCLs upgradient of the source area. The interpolated plume above the MCL extends approximately 6,800 feet downgradient of the source area, however concentrations of PFOS increase by orders of magnitude in monitoring wells attributed to the Burn House. Other source areas contribute to the groundwater plume including the SFS, the FLDD/SCF, and the CFS.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

Sediment impacts are identified in Tributary 5 of the EBGB that is channelized through the FTF source area. These impacts are likely associated with the release at the KC-135 Crash Area or the FTF where PFAS compounds were preferentially stored in the organic fraction of the soil or sediment and have the potential to leach slowly into surface water. Leaching of PFAS from this source area has the potential for transport and incorporation into higher magnitude surface water impacts identified downstream, including those associated with the Burn House, **Figures 5-1** and **5-7**. Additional discussion of the nature and extent of PFAS in surface water in this area is provided in **Section 5.8.2**.

Burn House

The primary control on the migration of groundwater away from the Burn House is the EBGB. PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Groundwater that can transport this leached mass through overburden and bedrock underlying this site travels to the west to be captured by the EBGB. Local drainage swales along Pennsylvania road drain to the north to discharge into Tributary 5 of the EBGB.

Overburden groundwater is present to the north, east, and west of the Burn House, which sits at the edge of a local bedrock topographic high. The elevated bedrock under the Burn House results in unsaturated conditions in the relatively thin overburden material. In areas where it is present, overburden groundwater flow is to the west, towards the EBGB. Vertical gradients from overburden to bedrock are downward based on modeled results from measured water levels in the field, **Figure 4-22** and **Appendix E-4**. Downgradient of the Burn House there is a modeled and measured upward gradient along the trace of the EBGB, **Figure 4-22** and that section of stream is identified as a groundwater discharge zone, **Figure 5-1**.

Bedrock groundwater in this area is flowing to the west, towards the EBGB. PFAS concentrations in this area are greatest in monitoring wells west of the source area soils. The EBGB likely captures most of the impacted groundwater associated with this source area. The extent of vertical impacts is not delineated, allowing for the potential that regional flow pathways could impact the transport of PFAS in deep bedrock. Concentrations of PFAS in groundwater gradually decrease with distance from the source to the west and southwest along the EBGB, **Figures 5-1** and **5-7**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Burn House					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	57	56	0	0.82	42
PFBA	57	57	0	1.9	121
PFDA	57	16	16	0.3	2
PFHxS	57	57	53	7.9	437
PFHxA	57	57	0	1.4	188
PFNA	57	54	20	0.3	23.9
PFOS	57	57	57	10.5	1130
PFOA	57	57	57	1.8	112

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of the source area, however concentrations increase by two orders of magnitude at the source area. The interpolated plume above the MCL extends approximately 3,000 feet downgradient of the source area, with other source areas contributing to the groundwater plume including the CFS, the FLDD/SCF, Arch Hangar, and the SFS.
- PFOA is identified above MCLs upgradient of the source area, however concentrations increase by an order of magnitude at the source area. The interpolated plume above the MCL extends approximately 2,700 feet downgradient of the source area, with other source areas that may contribute to the groundwater plume including the CFS, the FLDD/SCF, Arch Hangar, and the SFS.
- PFHxS is identified above MCLs upgradient of the source area, however concentrations increase by an order of magnitude at the source area. The interpolated plume above the MCL extends approximately 2,900 feet downgradient of the source area, with other source areas that may contribute to the groundwater plume including the CFS, the FLDD/SCF, Arch Hangar, and the SFS.
- PFNA is not identified upgradient of the source area and increases by an order of magnitude at the source area. The interpolated plume above the MCL extends approximately 300 feet downgradient of the source area.

Wastewater Treatment Plant

The WWTP is in the southwest corner of Loring along Greenlaw Brook, roughly 2,000 feet downstream of the confluence of the EBGB and WBGB. PFAS mass held in soils can leach into groundwater during the infiltration of precipitation. Groundwater flow that can transport this leached mass through overburden and bedrock is to the southwest, along the trace of Greenlaw Brook. Upward vertical gradients from bedrock to overburden and ultimately surface water are modeled and identified in water level measurements, **Figure 4-22** and **Appendix E-4**. PFAS leached to soils from septic sludge that was dried out on the land surface has the potential to leach into groundwater. Groundwater impacts associated with the sludge drying activities can comingle with PFAS mass from upstream and upgradient sources transported through preferential pathways in groundwater and surface water along the EBGB or WBGB. The extent of groundwater impacts above the USEPA MCL drinking water standards are not delineated in the overburden or bedrock groundwater, **Figures 4-15** and **4-16**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - WWTP					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	18	9	0	0.16	2.5
PFBA	18	5	0	1.1	19
PFHxS	18	18	11	1.4	30.8
PFHxA	18	14	0	0.31	6

Excerpt from Table O-2: Groundwater Summary Statistics - WWTP					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFNA	18	6	0	0.45	2.2
PFOS	18	17	17	1.6	54.9
PFOA	18	15	15	0.34	7.3

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is identified above MCLs upgradient of the source area. The interpolated plume above the MCL extends approximately 1,100 feet downgradient of the source area, however other source areas in the Greenlaw Brook Watershed, including the Burn House, the SFS, the FLDD/SPF, the CFS, Malabeam Lake, and Chapman Pit likely contribute PFAS to groundwater in this area, either through preferential pathways in groundwater or through surface water transport.
- PFOA is identified to be slightly above the MCL intermittently in a limited number of monitoring wells at the WWTP and is not interpolated to be present at the WWTP above the MCL based on 2025 data.
- PFHxS is identified above MCLs upgradient of the source area. The interpolated plume above the MCL extends approximately 500 feet downgradient of the source area, however other source areas in the Greenlaw Brook Watershed, including the Burn House, the SFS, the FLDD/SPF, the CFS, Malabeam Lake, and Chapman Pit likely contribute PFAS to groundwater in this area, either through preferential pathways in groundwater or through surface water transport.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

5.5.3 Receptors

The migration pathways from the source zones identified in Flow Field #4 are largely controlled by the surface water drainages. The FLDD provides an outlet for the storm sewer system, which also captures portions of groundwater plumes emanating from the source areas. The Greenlaw Brook drainage is the receiving water body for much of the storm sewer system discharge and captures overburden and bedrock groundwater that passes through the source areas in Flow Field #4.

Receptors that use Flow Field #4 include the Mi'kmaq Nation, which own several parcels within this area, **Figure 2-1**. Practices within this community include foraging for sustenance and medicinal purposes. Further discussion of the risk associated with the identified PFAS impacts attributed to the source areas are detailed in **Section 7**.

Crash Fire Station

PFOS and PFOA in soils exceed residential soil RSLs through the soil column. If the area were to be redeveloped for residential purposes, potential receptors would include future residents. Exceedances of industrial soil RSLs are identified on **Figure 4-5**.

The FLDD receives discharge of groundwater impacted by PFAS attributed to the CFS from storm sewer outfall C3. As detailed on **Figure 4-28**, immediately west and southwest of the CFS the storm sewer system piping is installed below the water table, allowing for infiltration where the piping has degraded. The underdrain system is designed to dewater shallow groundwater for discharge to the storm sewer system in this area. **Figures 4-15** and **4-16** illustrate the extent of groundwater impacts identified in the area of the CFS, detailing exceedances of the USEPA MCL for PFOS at several orders of magnitude. A portion of this groundwater is captured by the storm sewer system, resulting in discharge to the FLDD and downstream transport of PFAS associated with the CFS, **Figure 4-28** and **5-1**.

Overburden and bedrock groundwater flow towards the FLDD, which captures much of the mass identified in the groundwater system. Downward gradients from overburden to bedrock exist at the source area while upward gradients and surface water discharge zones are present along the FLDD, resulting in groundwater discharge along this drainage, **Figure 4-22** and **5-1**. This condition results in the discharge of impacted groundwater associated with the CFS to the FLDD. The vertical extent of impacted groundwater has not been delineated to the USEPA MCLs. There is a potential that PFAS fate and transport in the deep bedrock underlying the CFS may be controlled by the larger regional drainage system.

Historic practices would have included flushing released AFFF on the ground surface into the storm sewer system. This practice would have resulted in the discharge of AFFF to the FLDD. Sediment and porewater impacts above SLs in the FLDD may persist from the retention of mass from historic releases or the ongoing discharge of impacted groundwater. Sediment and porewater along the FLDD to the EBGB and past the confluence with the Little Madawaska River exhibit exceedances of their respective SLs, **Figure 5-1**.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Arch Hangar

PFOS and PFOA exceed residential soil RSLs in shallow surficial soils, **Figure 4-5**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

The potential contribution of PFAS to groundwater attributed to the Arch Hangar is considered minimal compared to the contribution attributed to mass loading from the upgradient CFS. Potential contribution to the groundwater plume attributed to the leaching of soils from the Arch Hangar will be comingled with the larger magnitude plume attributed to impacts at the CFS, **Figure 5-5**. Groundwater impacts attributed to the Arch Hangar have the potential to be discharged to the FLDD through direct groundwater discharge downgradient of this source area or from the storm sewer system as a result of potential infiltration in submerged sections of the degraded piping or from the underdrain system designed to dewater shallow groundwater in this area, **Figure 4-28**.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Jet Engine Maintenance Shop

PFOS exceeds residential soil RSLs in shallow surficial soils, **Figure 4-5**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

The potential contribution of PFAS to groundwater attributed to JEMS is minimal compared to the contribution attributed to mass loading from the upgradient CFS. Concentrations of PFAS in groundwater upgradient of the JEMS are consistent with concentrations downgradient, confirming contribution to the overall groundwater plume is minimal, **Figure 5-5**.

PFAS uptake in this source area can occur through soil into various ecological receptors such as plant tissue, terrestrial invertebrate tissue, small mammal prey tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Structural Fire Station

PFOS and PFOA exceed residential soil RSLs through the soil column. If the area were to be redeveloped for residential purposes, potential receptors would include future residents. Industrial soil criteria were also exceeded, **Figure 4-5**.

The EBGB receives discharge of groundwater impacted by PFAS attributed to the SFS. The SFS is located near the groundwater divide between the EBGB and WBGB, resulting in a minor component of flow to the WBGB, **Figure 5-7**. Downward gradients from overburden to bedrock exist at the source area while upward gradients along the EBGB result in groundwater discharge along this drainage, **Figure 4-22**. This condition results in the direct discharge of impacted groundwater associated with the SFS to the EBGB. The vertical extent of impacted groundwater has not been delineated to the USEPA MCLs. There is a potential that PFAS fate and transport in the deep bedrock underlying the SFS may be controlled by the larger regional drainage system.

Historic practices would have included flushing AFFF released to the ground surface into the storm sewer system. This practice would have resulted in the discharge of AFFF to a drainage running parallel to Cupp Road, prior to discharge to the WBGB. Portions of the storm sewer system in this area are submerged below the water table, resulting in the potential for groundwater discharge to this drainage. Sediment and porewater impacts above SLs along this drainage may persist from the retention of mass from historic releases or the ongoing discharge of impacted groundwater. Sediment and porewater along the WBGB and past the confluence with the Little Madawaska River exhibit exceedances of their respective SLs, **Figures 4-24C, 4-24D, 4-26** and **5-1**.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue,

fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Flightline Drainage Ditch and Spill Containment Facility

PFOS and PFOA exceed residential soil RSLs in shallow surface samples and through the soil column at the SCF, **Figure 4-5**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

Surface water discharged to the FLDD is diverted through the SCF and discharged directly to the EBGB. Historically, the FLDD was identified as a perennial stream, while base development used this portion of the upper reaches of the EBGB as a discharge area for the storm sewer system, **Figure 2-12**. The historic practices of washing releases of AFFF into nearby drainage and the ongoing discharge of groundwater to the FLDD have resulted in the porewater, sediment, and surface water screening value exceedances in the FLDD, EBGB, and ultimately Greenlaw Brook, **Figures 4-24C** and **5-5**.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Base Laundry

The potential contribution of PFAS to groundwater attributed to the Base Laundry is considered minimal compared to the contribution attributed to mass loading from upgradient sources. Impacts to receptors are not anticipated, **Figure 4-5**.

PFAS uptake in this source area can occur through soil into various ecological receptors such as plant tissue, terrestrial invertebrate tissue, small mammal prey tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

KC-135 Crash Area

PFOS and PFOA exceed residential soil RSLs in shallow soil samples, **Figure 4-5**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

The headwaters of Tributary 5 of the EBGB begin directly south of the KC-135 Crash Area. Sediment, surface water, and porewater samples have identified impacts above their respective SLs in this area, which are attributed to the historic release at the KC-135 Crash Area. These impacts are identified upstream of additional source areas which contribute to impacts in this stream, including the FTF and Burn House. Tributary 5 of the EBGB runs through parcels owned by the Mi'kmaq Nation, **Figures 4-24C** and **5-1**.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Fuel Tank Farm

PFOS and PFOA exceed residential soil RSLs in shallow soil samples, **Figure 4-5**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

Tributary 5 of the EBGB begins just upstream of the FTF. Sediment, surface water, and porewater samples have identified impacts above their respective SLs in the FTF. These impacts are identified upstream of additional source areas which contribute to impacts in this stream, including the Burn House, and are downstream of impacts attributed to the KC-135 Crash Area. Tributary 5 of the EBGB runs through parcels owned by the Mi'kmaq Nation, **Figures 4-24C** and **5-1**.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Burn House

PFOS and PFOA exceed residential soil RSLs in shallow soil samples and throughout the soil column. If the area were to be redeveloped for residential purposes, potential receptors would include future residents. Exceedances of other relevant soil criteria, including industrial criteria, are also identified. These soil impacts are identified at the Burn House and extend to the north, along a drainage swale that runs along Pennsylvania Road, **Figure 4-5**.

Tributary 5 of the EBGB, which begins just south of the KC-135 Crash Area, runs to the north of the Burn House. Sediment, surface water and porewater samples have identified impacts above their respective SLs where Pennsylvania Road runs over this stream. While upgradient impacts above SLs are identified, concentrations in sediment, porewater, and surface water increase at this intersection and downstream. Exceedances of SLs are identified upstream and downstream of the confluence of Tributary 5 with the EBGB. Tributary 5 of the EBGB runs through parcels owned by the Mi'kmaq Nation, **Figures 4-24C** and **5-1**.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

Wastewater Treatment Plant

PFOS and PFOA exceed residential soil RSLs in shallow soil samples, **Figure 4-5**. If the area were to be redeveloped for residential purposes, potential receptors would include future residents.

The WWTP as a source area for PFAS has minimal impact on the nearby surface water drainage of Greenlaw Brook. Concentrations of PFAS in surface water, sediment, and porewater are consistent upstream and downstream of the WWTP, **Figures 4-24D** and **5-1**.

The sanitary sewer system utility corridors that are connected to the WWTP act as an additional transport pathway for PFAS to impact potential receptors. As discussed in **Appendix J,** the sanitary sewer is subject to I&I from impacted groundwater at Loring. Portions of this system are installed below the water table and are likely leaking, resulting in PFAS concentrations of similar magnitude and signature as the PFAS in the storm sewer system and primary source areas.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

5.6 FLOW FIELD #5 NATURE AND EXTENT

Flow Field #5 is on the west side of Loring and spans a capped landfill and developed rural area. Wolverton Brook and Tributary 9 constitute the drainage system in Flow Field #5, with Wolverton Brook flowing southwest into the Little Madawaska River. As detailed in **Sections 3.2** and **Section 4** and illustrated in **Figures 4-1** through **4-35** and **Appendices C through J**, PFAS RI nature and extent investigations included groundwater sampling. Landfill 2 is the sole source area in Flow Field #5.

5.6.1 Source Material

Landfill 2

Soil samples were not collected from Landfill 2 during the PFAS RI, as possibly contaminated materials originating from elsewhere on the Site were capped within the landfill. Disturbance of this cap to sample those materials could impact the integrity of the landfill, potentially resulting in the mobilization of PFAS and other site COCs. Overburden in this area is roughly 50 to 60 feet thick, **Figure 4-6**, and the water table is roughly 30 to 40 feet bgs, **Appendix E-1**.

5.6.2 Migration Pathways

Landfill 2

Glaciofluvial deposits have been mapped as sand and gravel aquifers in areas nearby and southeast of Landfill 2. PFAS mass that may be held in soils can leach into groundwater during the infiltration of precipitation. Overburden materials are variably saturated. Groundwater flow that could transport leached mass in the overburden generally follows the more permeable northwest to southeast trending sand and gravel deposits. This results in groundwater flow from Landfill 2 heading northwest, towards Wolverton Brook and Tributary 9. Wolverton Brook flows southwest into the Little Madawaska River. Modeled water levels indicate relatively neutral vertical gradients in the area**, Figure 4-22**. PFAS leached from contaminated soils within Landfill 2 to groundwater can migrate following groundwater flow northwest to Wolverton Brook and ultimately the Little Madawaska River, **Figure 4-17** and **Figure 4-18**.

PFAS concentrations in overburden and bedrock groundwater within Landfill 2 exceed the MCL for PFOA, PFHxS, PFOS, and Maine's MCL for sum of six PFAS. PFAS concentrations in groundwater become more dilute

following the northwest flow downgradient of the landfill, but still exceed the MCL for PFOA and PFOS. Downgradient PFAS concentrations are greater to the north than the south of Nebraska Road, which passes directly north of Landfill 2, **Figure 4-17** and **Figure 4-18**.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Landfill No. 2					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	61	27	0	0.15	2.6
PFBA	61	29	0	0.55	25
PFDA	61	2	2	0.29	2.6
PFHxS	61	52	12	0.22	18
PFHxA	61	43	0	0.29	7
PFNA	61	19	0	0.15	2.6
PFOS	61	51	51	0.47	51.8
PFOA	61	47	47	0.25	17

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is not identified in concentrations above MCLs upgradient of the source area. The interpolated plume above the MCL extends approximately 1,900 feet northwest of the source area.
- PFOA and PFHxS impacts are identified to be slightly above the MCL intermittently in a limited number of monitoring wells and are not interpolated to be above the MCL based on 2024 data.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

5.6.3 Receptors

Landfill 2

A developed rural area is present on the west side of Loring, downgradient of Landfill 2. Landfill 2 is upgradient of residents of Caribou whose water is supplied by private drinking water wells.

The potential contribution of PFAS to Wolverton Brook, a downgradient surface water body and groundwater discharge zone, is considered minimal. PFAS concentrations in groundwater downgradient of Landfill 2 are either below MCLs or are unlikely to pose a risk to SL exceedances in surface water due to dilution throughout the local groundwater and surface water drainage systems.

Restrictions on former base property located in the vicinity and downgradient of Landfill 2 prohibit installation of drinking water wells and prohibit the use of underlying and downgradient groundwater. The landfill cover system prevents direct contact exposure to PFAS contaminated soil or waste by human or ecological receptors. Gates and warning signs restrict vehicular access and discourage trespassers.

PFAS uptake in this source area can occur through soil, sediment, surface water, and porewater into various ecological receptors such as plant tissue, aquatic and terrestrial invertebrate tissue, small mammal prey tissue, fish and amphibian tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

5.7 FLOW FIELD #6 NATURE AND EXTENT

Flow Field #6 is on the west side of Loring and spans a capped landfill and developed rural area. Wolverton Brook and Tributary 9 constitute the drainage system in Flow Field #6, with Wolverton Brook flowing southwest into the Little Madawaska River. As detailed in **Section 3.2** and **Section 4** and illustrated in **Figures 4-1** through **4-35** and **Appendices C through J**, PFAS RI nature and extent investigations included groundwater sampling. Landfill 3 is the only known source area in Flow Field #6.

5.7.1 Source Material

Landfill 3

Soil samples were not collected from Landfill 3 during the PFAS RI as possibly contaminated materials originating from elsewhere on the Site were capped within the landfill. Disturbance of this cap to sample those materials could impact the integrity of the landfill, potentially resulting in the mobilization of PFAS and other site COCs which have been consolidated at the landfill. Overburden in this area is roughly 50 to 60 feet thick, **Figure 4-6**, and the water table is roughly 25 to 30 feet bgs, **Appendix E-1**.

5.7.2 Migration Pathways

Landfill 3

Glaciofluvial deposits have been mapped as sand and gravel aquifers in the western portion of Loring in the area and southeast of Landfill 3. PFAS mass that may be held in soils can leach into groundwater during the infiltration of precipitation. Overburden materials are variably saturated. Landfill 3 is adjacent to a groundwater divide. On the northwest portion of Landfill 3, groundwater flow that could transfer leached mass in overburden and bedrock is primarily northwest toward Wolverton Brook. East of Landfill 3, groundwater flow that could transfer leached mass is primarily southeastern toward the WBGB. PFAS leached from contaminated soils within Landfill 3 to groundwater can migrate following groundwater flow northwest to Wolverton Brook or southeast to the WBGB and ultimately the Little Madawaska River, **Figure 4-19** and **Figure 4-20**.

PFAS concentrations in overburden and bedrock groundwater within Landfill 3 exceed the MCL for PFOA, PFHxS, PFOS, and Maine's MCL for sum of six PFAS. PFAS concentrations in groundwater become more dilute and fall below the MCLs along the southeast flow downgradient of the landfill.

The summary statistics for PFAS compounds that have screening levels as detailed in **Appendix O** and **Section 4.2.1** are provided below.

Excerpt from Table O-2: Groundwater Summary Statistics - Landfill No. 3

Analyte	Number of Samples	Number of Detections	Number of USEPA Tap Water RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	98	28	0	0.19	32.2
PFBA	98	28	0	0.7	19.4
PFDA	98	2	2	0.61	2.4
PFHxS	98	58	8	0.27	102
PFHxA	98	51	0	0.15	57.1
PFNA	98	15	0	0.16	2.4
PFOS	98	58	58	0.43	65
PFOA	98	62	62	0.13	25

The distribution of PFAS above groundwater MCLs is described below, with monitoring well results detailed on **Table 4-2,** displayed on **Figure 4-15** and **4-16**, and with interpolated plume maps shown on **Figure 5-2:**

- PFOS is not identified in concentrations above MCLs upgradient of the source area. The interpolated plume above the MCL extends approximately 2,000 feet southeast of the source area where the plume comingles with impacts identified along the WBGB. To the northwest, PFOS impacts attenuate to below the MCL prior to the edge of the landfill extents.
- PFOA is identified in concentrations above MCLs extending approximately 750 feet southeast from the southeast corner of Landfill 3 and is not interpolated above the MCL to the northwest.
- PFHxS impacts are identified to be slightly above the MCL intermittently in a limited number of monitoring wells and is not interpolated to be above the MCL based on 2025 data.
- The area of exceedance as compared to the Maine Sum of 6 is within the interpolated extent of PFOS above the USEPA MCL.

5.7.3 Receptors

Landfill 3

A developed rural area with private drinking water wells is located near the western boundary of the former base, downgradient of Landfill 3 to the northwest and southeast.

Restrictions on former base property located in the vicinity and downgradient of Landfill 3 prohibit installation of drinking water wells and prohibit the use of underlying and downgradient groundwater. The landfill cover system prevents direct contact exposure to PFAS contaminated soil or waste by human or ecological receptors. Gates and warning signs restrict vehicular access and discourage trespassers.

PFAS uptake in this source area can occur through soil into various ecological receptors such as plant tissue, terrestrial invertebrate tissue, small mammal prey tissue, and more. Additional information on ecological receptors for this source area is presented in the BERA Report.

5.8 LOCAL DRAINAGE BASINS

The source areas described in **Sections 5.2 through 5.7** are influenced by the local surface water drainages of Greenlaw Brook and Butterfield Brook. The extent of the local watershed contamination distribution

compared to SLs is detailed on **Figure 5-1** and was developed based on the results displayed on **Figures 4-24A** through **4-24D**. Controls on water quality in these drainages are described in **Section 5.1.1**.

Butterfield Brook and Greenlaw Brook capture the majority of PFAS mass attributed to historic base activities that is leached from the soils and transported through the groundwater system. This interpretation is supported by measured increases in discharge along these drainages reported in **Appendix E-2**, vertical gradients in groundwater detailed in **Appendix E-1**, contaminant distributions shown on **Figures 4-24A** through **4-24D**, and groundwater modeling efforts detailed in **Appendix N**. Portions of these streams, particularly the headwaters closer to Loring, are discharge zones for groundwater. In areas where the groundwater table is lower in relation to the land surface, these streams can be losing, meaning they are recharging groundwater, **Figure 5-1**.

Greenlaw Brook and Butterfield Brook are the receiving water bodies of the local storm sewer system. Through design or degradation, this system drains shallow groundwater across the developed portions of Loring. A portion of the mass from historic releases to the land surface at source areas within the bounds of these stormwater drainage basins would have been flushed through the storm sewer or sanitary sewer system after release.

5.8.1 Limestone Stream and Butterfield Brook

The Limestone Stream and Butterfield Brook drainage basin is generally east of the Runway. Flow Fields #1 and #2 and portions of Flow Field #3 contribute groundwater and surface water to this water body. The section of Butterfield Brook that passes to the east and through the eastern side of Loring has several smaller tributaries that feed headwaters on the east side of the Runway. Butterfield Brook discharges to the Durepo Reservoir, which discharges to Limestone Stream, **Figures 4-24A** and **5-1**.

The summary statistics for PFAS compounds detected in surface water, sediment, porewater, hydric soils, and shallow groundwater that have screening levels as detailed in **Appendix O** and **Section 4.3** are provided below.

Excerpt from Table O-3: Surface Water Summary Statistics - Butterfield Brook					
Analyte	Number of Samples	Number of Detections	Number of Swimming SL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	35	10	0	0.52	2.5
PFBA	35	18	0	1.13	15.6
PFDA	35	1	1	1.2	2.7
PFHxS	35	32	0	1.8	34.5
PFHxA	35	29	0	0.65	8.5
PFNA	35	6	0	0.88	2.5
PFOS	35	33	19	1.1	481
PFOA	35	32	32	0.78	8.6

Excerpt from Table O-4: Sediment Summary Statistics - Butterfield Brook					
Analyte	Number of Samples	Number of Detections	Number of Wading Sediment SL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)

PFHxS	35	3	0	0.00049	0.0085
PFOS	35	21	9	0.00013	0.0184

1

Excerpt from Table O-5: Hydric Soil Summary Statistics - Butterfield Brook					
Analyte	**Number of Samples**	**Number of Detections**	**Number of USEPA Residential RSL Exceedances**	**Minimum (mg/kg)**	**Maximum (mg/kg)**
PFDA	10	1	1	0.00018	0.0098
PFHxS	10	2	0	0.00027	0.0066
PFNA	10	2	0	0.00015	0.0098
PFOS	10	8	5	0.00036	0.0168
PFOA	10	2	2	0.0002	0.0098

2

Excerpt from Table O-6: Shallow Groundwater Summary Statistics -Butterfield Brook					
Analyte	**Number of Samples**	**Number of Detections**	**Number of USEPA Tapwater RSL Exceedances**	**Minimum (ng/L)**	**Maximum (ng/L)**
PFBS	6	1	0	1.9	10
PFBA	6	4	0	4.1	54.5
PFHxS	6	5	2	2	42.2
PFHxA	6	4	0	1.2	20.7
PFNA	6	4	1	0.63	14.5
PFOS	6	5	5	2	58.3
PFOA	6	3	3	1	38.4

3

Excerpt from Table O-7: Pore Water Summary Statistics - Butterfield Brook					
Analyte	**Number of Samples**	**Number of Detections**	**Number of Ecological Pore Water Benchmark Exceedances**	**Minimum (ng/L)**	**Maximum (ng/L)**
PFBS	10	4	0	1	4.6
PFBA	10	5	0	2.1	17.8
PFDA	10	3	0	0.7	2.7
PFHxS	10	10	0	2	109
PFHxA	10	10	0	0.88	57.5
PFNA	10	7	0	0.86	3.5
PFOS	10	9	6	2.8	174
PFOA	10	10	0	1.7	12.8

4 Throughout Butterfield Brook and Limestone Stream, concentrations of PFAS identified in surface water,
5 sediment, and porewater is shown to be variable due to variation in precipitation patterns, proximity to
6 impacted groundwater discharge zones, and stream/pond substrate material, **Figure 4-24A** and **Appendices**
7 **C-10** and **C-17**. Exceedances of surface water or sediment criteria for one or more PFAS compounds extend at
8 least 25,000 feet, from the stormwater outfall just east of the B-52 Crash Site at Tributary 1 past the
9 confluence of Tributary 4 just upstream of Limestone Pond. Exceedances of greater than one order of

magnitude above the surface water or sediment criteria for one or more PFAS compounds are identified up to approximately 400 feet downstream of the stormwater outfall at Tributary 1, just east of the B-52 Crash Area. This distribution is displayed on **Figure 5-1**.

PFOS is the only PFAS compound that exceeds sediment SLs, however laboratory detection limits for sediment are higher than the SLs for PFOA or PFDA. PFOA is the most widespread compound with exceedances in surface water, however PFOS and PFDA also exceed SLs in samples that exceed for PFOA. Laboratory detection limits for PFDA in surface water are higher than the SLs.

5.8.1.1 Tributaries and Stormwater Drainages

ELL receives inputs from Butterfield Brook and its tributaries that are upstream and upgradient of PFAS impacts attributed to source areas at Loring. Samples collected from Butterfield Brook upstream of ELL are non-detect for PFAS in surface water and sediment. Tributaries 1, 2, and 3, directly east of the Runway, receive discharge from portions of the storm sewer system, **Figures 2-3, 4-24A,** and **5-1**.

Tributary 1 begins immediately south of the B-52 Crash Area. The stormwater outfall and downstream surface water, sediment, and porewater exhibit concentrations of PFOS and PFOA that are up to an order of magnitude above SLs for their respective media for approximately 400 feet downstream of the outfall. PFDA is identified as an exceedance in surface water in one sample, AA20SD-02. In sediment, PFOS is the only identified PFAS compound with exceedances. Concentrations of PFAS decrease with distance from the outfall but remain elevated above surface water SLs for approximately 3,000 feet downstream until Tributary 1's confluence with ELL, **Figure 4-24A**.

Tributary 2 receives discharge from a portion of the storm sewer network which drains the northern side of the nose docks. Impacts to surface water are above SLs at the outfall for PFOA and PFOS, however concentrations in sediment are below laboratory detection limits, **Figure 4-24A**.

Tributary 3, just east of the middle of the Runway, has several small feeder streams which are fed by the eastern portion of the storm sewer system that drains the middle portion of the Runway. Concentrations of PFAS including PFOS and PFOA are elevated above SLs in surface water at the outfall and downstream locations, at least 3,000 ft downstream of the stormwater outfall. . Sediment impacts, including exceedances of PFOS extend up to 1,500 ft downstream of the stormwater outfall. Hydric soils and shallow groundwater samples collected between Tributary 3 and the FTA exhibit exceedances of both soil and groundwater SLs. Hydric soil exceeds the residential RSL for PFOS and shallow groundwater exceeds the MCLs for PFHxS and PFOS, **Figure 4-24A**.

Tributary 4, with headwaters to the southeast of the ready area at the southern end of the Runway, discharges to Limestone Stream southeast of Loring. The headwaters of this tributary include wetlands and intermittent streams that receive stormwater discharge from the ready area at the southeast side of the Runway. Concentrations of PFAS are above SLs for surface water, sediment, hydric soils or shallow groundwater in these wetlands and intermittent streams, however these concentrations decrease to below SLs in the perennial stream and Noyes Pond prior to discharge to Limestone Stream. A surface water sample, LS_002

exceeds the SL for PFOA, however it is located on a smaller tributary, to the south of Noyes Pond, which is not downgradient of source areas at Loring.

5.8.1.2 East Loring Lake

To the east of the Runway and northeast of the FTA is ELL, which is an impounded section of Butterfield Brook. ELL receives inputs from Butterfield Brook and its tributaries that are upstream and upgradient of PFAS impacts attributed to source areas onsite. One samples collected from Butterfield Brook upstream of ELL exceeds the SL for surface water for PFOA, however no detections of PFAS were identified in sediment. Surface water and sediment samples collected at ELL exhibit variable impacts, with a portion of samples above SLs, while other samples are below SLs or do not have detections of PFAS compounds. Porewater samples either do not have detections or are below SLs, **Figure 4-24A**. ELL exhibits exceedances of PFAS including PFOS or PFOA above SLs for surface water and exceedances of PFOS in sediment. Exceedances of PFOS or PFOA extend at least 20,000 feet downstream of the outlet of ELL along Butterfield Brook and Limestone Stream, **Figure 5-1**.

The presence of ELL impacts the local expected hydraulic gradient in groundwater. Upstream and downstream sections of Butterfield Brook exhibit strong upward gradients in groundwater. Stream gauge results in the spring of 2024 at LSG-13 and LSG-14, which are upstream of ELL, indicate a combined discharge of roughly 5,400 gallons per minute (gpm) while LSG-11, just downstream of the outlet of ELL, had a discharge of approximately 6,100 gpm, **Appendix E-2** and **Figure 4-21**. The elevated hydraulic head of this impoundment alters this portion of the drainage to greatly reduce the magnitude of the upward gradient in ELL**, Figure 4-22**. ELL is identified in **Figure 5-1** as a groundwater discharge zone to surface water. **Figure 5-4** displays the conceptual flow through the local groundwater surface water system. A portion of the shallow overburden monitoring wells exhibit concentrations below the USEPA MCLs. These results indicate that there is dilution of PFAS impacts in shallow groundwater in the vicinity of ELL, **Figure 4-9**.

5.8.1.3 Butterfield Brook

The outlet of ELL discharges to a segment of Butterfield Brook which runs along the eastern side of Loring prior to discharge to Durepo Reservoir. This segment of the brook also receives inputs from Willard Brook, Tributary 3, and several other smaller unnamed tributaries that are outside Loring's boundary. Surface water, sediment, and porewater samples collected along Butterfield Brook exhibit variable impacts, with a portion of samples above SLs and other samples below SLs or without detections, **Figure 4-24A**. PFOA and PFOS exceed SLs in surface water while PFOS exceeds SLs in sediment and porewater. Exceedances of PFOS or PFOA extend approximately 8,000 feet along this section of stream and at least 12,000 feet downstream of the confluence of Butterfield Brook with the Durepo Reservoir, **Figure 5-1**.

This segment of stream is subject to groundwater discharge associated with upward hydraulic gradients along the stream trace. This is supported by groundwater modeling results provided in **Appendix N,** and confirmed by the increase in discharge measured at stream gauges along Butterfield Brook, with locations shown on **Figure 4-21** and results detailed in **Appendix E-2**. The stream gauge results indicate that discharge increases at each subsequent downstream gauge during contemporaneous readings. Notably, discharge in the spring of 2024 was noted at the furthest upstream gauge, LSG-13, at approximately 3,500 gpm. Further downstream at LSG-11, discharge was approximately 6,100 gpm. Discharge increased further downstream to 9,300 gpm at LSG-08, and approximately 14,000 gpm at LSG-18. Smaller tributaries contribute water along this drainage, which are also fed by groundwater discharge. The groundwater plume attributed to the FTA likely discharges to the south of the ELL outlet, **Figure 4-9**. The impacted groundwater that is discharged to surface water is then transported downstream where it is diluted by surface water and groundwater inputs from the larger watershed.

5.8.1.4 Durepo Reservoir

Butterfield Brook and two off base tributaries discharge to the Durepo Reservoir, a manmade reservoir used for irrigation water and as a secondary water supply for the town of Limestone. Samples collected from the reservoir exhibit variable concentrations of PFAS in surface water, sediment, and porewater. A portion of the samples exceed their respective SLs, while others are below SLs or do not have detections of PFAS. Exceedances of SLs are identified in each surface water sample for PFOA and PFOS and in porewater for PFOS. Concentrations of PFOS and PFOA are highest in the surface water sample, SWI_002, collected proximal to the outlet of Durepo Brook. Durepo Brook is fed from the watershed outside of Loring source areas. Sediment samples from the reservoir do not exhibit exceedances. Exceedances of PFOS or PFOA extend the approximately 3,000 foot length of the reservoir and at least 9,000 feet downstream of the confluence of Butterfield Brook with the Durepo Reservoir, **Figure 5-1**.

Groundwater modeling indicates that the upstream portion of the reservoir is a groundwater discharge zone, while the downstream portion, closer to the dam, acts to recharge groundwater, **Appendix N** and **Figure 5-1**. The concentrations identified at the Durepo Reservoir are lower than are found upstream at ELL and along Butterfield Brook and closer to the FTA, **Figure 4-24A**.

5.8.1.5 Limestone Stream

Limestone Stream begins at the outlet of the Durepo Reservoir, just east of the Loring boundary, and continues south until it discharges to the Aroostook River. Consistent with the upstream portions of this drainage, concentrations in surface water and sediment are shown to be variable. A portion of the samples along Limestone Stream are above their respective SLs; others are below their SLs or do not have detections. Surface water samples exceed SLs for PFOA and or PFOS. Sediment exceedances are limited to PFOS in two samples, LS_SED001 and LS_SED002. The porewater sample collected does not exceed SLs. Concentrations in this approximately 9,000 foot section of stream are generally lower than samples collected at the Durepo Reservoir and lower still than samples collected in Butterfield Brook just south of ELL, **Figure 4-24A**.

Groundwater modeling indicates that this section of stream is also gaining, **Appendix N**. These results are supported by the increase in discharge at LSG-20, which was measured at almost 19,000 gpm in the spring of 2024, compared to the upstream gauge LSG-18, which reported discharge of approximately 14,000 gpm during the same gauging event.

5.8.2 Greenlaw Brook Drainage Basin

The Greenlaw Brook drainage basin is west of the Runway. The headwaters of Greenlaw Brook are within the Loring boundary. Flow Fields #3 and #4 contribute groundwater and surface water to this waterbody. The FLDD and Tributary 5 discharge to the EBGB, which then combine with the WBGB to form Greenlaw Brook, which discharges to the Little Madawaska River, **Figures 4-24C, 4-24D,** and **5-1**.

Throughout Greenlaw Brook concentrations of PFAS identified in surface water, sediment, and porewater is shown to be variable due to variation in precipitation patterns, proximity to impacted groundwater discharge zones, and stream or pond substrate material. The headwaters of Greenlaw Brook at the EBGB and WBGB are near several of the source areas across Loring and are the receiving waters for most of the storm sewer system.

The summary statistics for PFAS compounds detected in surface water, sediment, porewater, hydric soils, and shallow groundwater that have screening levels as detailed in **Appendix O** and **Section 4.3** are provided below.

Excerpt from Table O-3: Surface Water Summary Statistics - Greenlaw Brook

Analyte	Number of Samples	Number of Detections	Number of Swimming SL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	100	76	0	0.54	49.2
PFBA	100	87	0	2.1	74
PFDA	100	9	9	0.86	9
PFHxS	100	94	0	1	701
PFHxA	100	89	0	0.65	200
PFNA	100	75	0	0.72	55.7
PFOS	100	92	82	1.8	5590
PFOA	100	91	91	0.9	214

Excerpt from Table O-4: Sediment Summary Statistics - Greenlaw Brook

Analyte	Number of Samples	Number of Detections	Number of Wading Sediment SL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFDA	103	2	2	0.00023	0.086
PFHxS	103	17	0	0.00014	0.017
PFHxA	103	3	0	0.000093	0.017
PFNA	103	1	0	0.00014	0.086
PFOS	103	83	46	0.0002	0.315
PFOA	103	9	9	0.00013	0.017

Excerpt from Table O-5: Hydric Soil Summary Statistics - Greenlaw Brook					
Analyte	Number of Samples	Number of Detections	Number of USEPA Residential RSL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFBA	35	2	0	0.00086	0.029
PFDA	35	3	3	0.00016	0.02
PFHxS	35	10	0	0.00026	0.015
PFHxA	35	7	0	0.00015	0.014
PFNA	35	7	0	0.00016	0.02
PFOS	35	29	24	0.00014	0.144
PFOA	35	15	15	0.00014	0.02

Excerpt from Table O-6: Shallow Groundwater Summary Statistics - Greenlaw Brook					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tapwater RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	17	9	0	0.8	35.5
PFBA	17	16	0	2.8	88.6
PFDA	17	2	2	1	17
PFHxS	17	13	7	0.85	2370
PFHxA	17	11	0	0.96	286
PFNA	17	15	2	0.69	18.3
PFOS	17	15	15	1.3	1110
PFOA	17	14	14	0.92	172

Excerpt from Table O-7: Pore Water Summary Statistics - Greenlaw Brook					
Analyte	Number of Samples	Number of Detections	Number of Ecological Pore Water Benchmark Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	32	27	0	0.57	9.6
PFBA	32	30	0	2.2	19.6
PFDA	32	2	0	0.55	2.5
PFHxS	32	31	0	1.9	347
PFHxA	32	30	0	0.88	57.2
PFNA	32	24	0	0.63	6.3
PFOS	32	30	23	0.57	300
PFOA	32	30	0	0.59	56.5

At the WBGB, exceedances of surface water or sediment criteria for one or more PFAS compounds extend approximately 15,000 feet from the headwaters of the WBGB at Tributary 8 to the confluence of the EBGB and WBGB to form Greenlaw Brook. At the EBGB, exceedances of surface water or sediment criteria for one or more PFAS compounds extend approximately 14,000 feet from the headwaters of the EBGB at Tributary 5 to the confluence of the EBGB and WBGB to form Greenlaw Brook. At Greenlaw Brook, exceedances of surface water or sediment criteria for one or more PFAS compounds extend approximately 13,000 feet from the confluence of the EBGB and WBGB to the Little Madawaska River.

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Exceedances of surface water swimming or sediment wading screening levels with a hazard quotient of 1 and total cancer risk at $1x10^{-4}$ for one or more PFAS compounds are identified in portions of the WBGB and the EBGB. Along the WBGB, those exceedances extend approximately 9,000 feet downstream of the stormwater outfalls just west of Nose Dock 44 to Malabeam Lake. Approximately 2,500 feet of Tributary 7 exceeds these SLs, from its origination at a drainage swale at the SFS to it's discharges to the WBGB. Along the EBGB, those exceedances extend approximately 5,100 ft along the entire length of the FLDD, to past the confluence with Tributary 5. Exceedances above these SLs are identified along Tributary 5, approximately 1,500 feet, from past the confluence with the EBGB to the portion of the Tributary just north of the Burn House. This distribution is displayed on **Figure 4-24A** and highlighted on **Figure 5-1** and detailed in **Tables 4-3 through 4-8**.

5.8.2.1 Tributaries and Stormwater Drainages

One tributary contributes water to Greenlaw Brook after the confluence of the EBGB and WBGB. This tributary is southwest of the Loring boundary with a watershed outside of identified PFAS source areas. One collocated surface water and sediment sample from this tributary, GB_004, did not have detections of PFAS, **Figure 4-24D**.

Two tributaries discharge to the EBGB. Tributary 6 is south of the EBGB with most of the watershed outside the Loring boundary. This tributary was not sampled as impacts associated with base activities are not anticipated to be present.

Tributary 5 begins directly south of the Runway and the KC-135 Crash Area, then flows west through the FTF and to the north of the Burn House prior to discharge to the EBGB. This tributary exhibits PFOS and PFOA impacts to surface water, sediment, porewater, hydric soils, and shallow groundwater above their respective SLs along the entire drainage, approximately 7,000 feet. In surface water, exceedances of the SL for PFDA are identified in a portion of the samples where exceedances of PFOA and PFOS are identified. In shallow groundwater, exceedances of the SL for PFHxS and PFDA are identified in samples that also exceed SLs for PFOA or PFOS. In hydric soils, PFDA is identified in samples that also exceed for PFOA and PFOS, and in one sample, E-T-SO02M, where PFDA is the only exceedance. PFOS and PFOA are the only PFAS with exceedances in sediment while PFOS is the only compound with exceedances in porewater. Concentrations of PFAS are more variable in the samples collected closer to the headwaters, with some samples reported as having no detections or detections below SLs in contrast with others reported with concentrations increase by several orders of magnitude to the north of the Burn House, **Figure 4-24C** and **Tables 4-3 through 4-8**.

Tributary 8, sourced from wetlands or former wetlands that were drained and channelized during base development, discharges to the WBGB. This tributary includes a series of small discontinuous or intermittent stream channels immediately north of the NDA which drain a series of wetlands. Exceedances of surface water and sediment SLs are identified for PFOA and PFOS in a portion of samples. Two exceedances of PFDA are identified in sediment samples, at E-A-SD03I and E-A-SD02J. Exceedances of hydric soil and shallow groundwater concentrations are identified in the collocated samples, HSSO01 and HSSG01. The remaining surface water, sediment, and porewater samples from these drainages are reported below detection limits or exhibit concentrations of PFAS below SLs, **Figure 4-24B** and **Tables 4-3 through 4-8**.

Three stormwater drainages discharge to the WBGB, **Figure 2-3**. These include the two infiltration basins just west of Nose Dock 44 and a third, Tributary 7, which is just north of the SFS. In surface water, exceedances are identified in the majority of the samples for PFOS, PFOA, and in a smaller portion of samples, PFDA. Exceedances of PFOS and to a lesser extent, PFOA, are identified in sediment. Hydric soil samples collected in the vicinity of the infiltration basins west of the Nose Docks exhibit exceedances of PFOS and PFOS. A shallow groundwater sample, HSSG02, exceeds SLs for PFOS, PFOA, PFNA, and PFHxS. Surface water and sediment samples in the drainage west of the Nose Docks exhibit concentrations of PFAS that increase by several orders of magnitude compared to upstream concentrations. The surface water sample at Tributary 7 exhibits concentrations that are several orders of magnitude above the respective screening levels for PFOS, PFOA, and PFDA **Figure 4-24B** and **Tables 4-3 through 4-8**.

5.8.2.2 Flightline Drainage Ditch

The FLDD is the receiving water body for the storm sewer system at outfalls C1, C2, and C3 as well as a series of outfalls which drain smaller stormwater drainage basins. As detailed in **Section 5.5**, as well as **Figures 4-28** and **4-29,** these storm sewer outfalls discharge water including I&I from degraded portions of their respective segments of the storm sewer and sanitary sewer systems, the underdrain system, and stormwater runoff. The FLDD was included on the 1930's topographic map as an unnamed perennial tributary of Greenlaw Brook, **Figure 2-12**. Base development resulted in culverting and channelizing portions of the stream and included the diversion of flow to the SCF prior to discharge to the EBGB.

Water level monitoring and groundwater flow modeling indicate there are upward gradients in groundwater from bedrock to overburden along the FLDD, **Figure 4-22** and **Appendix N**. Detailed in **Section 5.1.3**, water level monitoring at monitoring wells JPZ0348 and JPZ0349, included in **Appendix E-3**, confirm upward gradients in groundwater from bedrock to overburden, leading to discharge to surface water. As detailed in **Appendix I**, outfall discharge measurements indicate there is an average discharge of approximately 1,500 gpm from the storm sewer system at outfalls C1, C2, and C3 compared to the downstream gauge along the FLDD, LSG-06, which has an average discharge of approximately 2,000 gpm. The storm sewer evaluation indicates that approximately 69% of the mass flux of PFOA and PFOS identified at LSG-06 is attributed to PFOA and PFOS discharged from the storm sewer system at outfalls C1, C2, and C3. These findings are consistent with groundwater discharge to the FLDD, confirmed by the modeled water table being present above the land surface, **Figure 5-1**. These conditions indicate that a portion of surface water flow in the FLDD is sourced from groundwater discharge from the surrounding area, with the remainder of the discharge from the storm sewer system. Upgradient source areas for the FLDD include the CFS, the Arch Hangar, and FJETC as well as portions of the NDA, Aircraft Hardstands, and Runway.

PFAS has been identified at concentrations up to several orders of magnitude above SLs along the entire portion of the FLDD, which is approximately 3,000 feet, **Figure 4-24C** and **5-1** and **Tables 4-3 through 4-8**. In surface water, exceedances are identified for PFOS or PFOA along the entire length of the FLDD. In sediment and porewater, exceedances are identified for PFOS along the entire length of the FLDD. Hydric soil and shallow groundwater samples were not collected in the vicinity of the FLDD. Outfall discharge monitoring in conjunction with targeted sampling allows for the quantification of mass flux from the storm sewer system

discharged at C1, C2, and C3 to the FLDD, **Figures 4-25, 4-26** and **Appendix I**. Surface water, sediment and porewater at the discharge of outfalls C1, C2, and C3 are identified with concentrations that are orders of magnitude above their respective SLs, **Figure 4-24C**. Exceedances of SLs in sediment, porewater, and surface water persist along the FLDD until it discharges to the unchanneled portion of EBGB at the outlet of the SCF.

5.8.2.3 East Branch of Greenlaw Brook

The EBGB begins at the outlet of the FLDD and SCF. It is a discharge point for Tributary 5 which begins just south of the KC-135 Crash Area and runs through the FTF and just north of the Burn House, as well as Tributary 6, which is largely south of Loring. Stream gauges indicate that there is a continued increase in discharge along this surface water body. As detailed in **Appendix E-2**, with locations shown on **Figure 4-21**, contemporaneous gauging results from the spring of 2024 show discharge measurements of approximately 660 gpm at LSG-06 along the FLDD. Discharge increases to approximately 1,000 gpm at LSG-17 and further increases to approximately 2,000 gpm at LSG-02. Inputs from surface water flow from Tributary 5 measured at LSG-03 were reported as approximately 220 gpm during the spring 2024 event, which indicates that surface water flow does not account for the increase in discharge between LSG-06 and LSG-17. Groundwater that contributes to this stream is impacted by PFAS attributed to releases at the SFS, Burn House, and the FTF, **Figures 5-1** and **5-5**.

PFAS has been identified above SLs for surface water, sediment, and porewater along the entire portion of the EBGB up to several orders of magnitude above their respective SLs, **Figure 4-24C** and **Tables 4-3 through 4-8**. This is a distance of approximately 8,500 feet from the outlet of the SCF to its confluence with the WBGB. In surface water, exceedances are identified for PFOS or PFOA along the entire length of the EBGB. In sediment and porewater, exceedances are identified for PFOS along the entire length of the EBGB. Hydric soil and shallow groundwater samples were collected near the confluence of Tributary 5 and the EBGB. In hydric soils exceedances are identified for PFOS and PFOA. In shallow groundwater exceedances of SLs are identified for PFOS, PFOA, and PFHxS. Exceedances of SLs in their respective media persist along the EBGB until it combines with the WBGB to form Greenlaw Brook, **Figure 5-1**.

5.8.2.4 West Branch of Greenlaw Brook

The WBGB runs along the western side of Loring. It is a discharge point for several storm water drainage basins, relatively small tributaries, wetlands, and groundwater within its watershed. Surface water, sediment, and porewater samples collected to the north of the two stormwater infiltration basins that are directly west of Nose Dock 44 are reported at concentrations that are orders of magnitude lower than samples after the infiltration basins. Collocated sediment and surface water samples collected from within these basins, including E-A-SD01M/E-A-SW01M, SW/SD12007, SW/SD12010, and E-A-SD01K/E-A-SW01K exhibit concentrations of PFOS that are orders of magnitude greater than the screening levels, while sediment samples exhibit higher concentrations than are found in the source area soils to the east of these infiltration basins. Downstream of these two stormwater infiltration basins, concentrations of these media are up to several orders of magnitude above their SLs until the WBGB discharges to Malabeam Lake, **Figures 4-24C** and **5-1** and **Tables 4-3 through 4-8**.

In surface water, exceedances are identified for PFOS or PFOA along the WBGB downstream of the infiltration basins. In sediment and porewater, exceedances are identified for PFOS along the WBGB downstream of the infiltration basins, although concentrations are variable and some samples do not exceed SLs. In hydric soils exceedances are identified for PFOS and PFOA. In shallow groundwater exceedances of SLs are identified for PFOS, PFOA, PFNA, and PFHxS.

Detailed in **Section 5.1.3,** water level monitoring at BW12006 and SB/OW12001 at Nose Dock 44 confirm downward gradients from surface water to groundwater. The presence of downward gradients in these basins is consistent with the results of the groundwater modeling, **Appendix N**, that show the water table is lower than the land surface in this area, conducive to groundwater recharge, **Figure 5-1**. Water levels range between elevation 704 and 714 ft NAVD88 in overburden, but land surface at these basins is reported between 714 and 718 ft NAVD88.

PFAS impacts to surface water, sediment, and porewater are identified throughout Malabeam Lake and Chapman Pit. Concentrations of PFAS in the porewater and the collocated sediment samples from Malabeam Lake and Chapman Pit, at E-A-PW02O, E-A-PW01O, E-A-PW01P, and E-A-PW01R, are greater than concentrations in upstream sections of the brook, at samples collocated with E-A-PW01N or E-A-PW02N. PFOS concentrations at locations E-A-PW02O, E-A-PW01O, E-A-PW01P, and E-A-PW01R are greater in these porewater than their respective collocated surface water samples or groundwater samples collected from monitoring wells adjacent to these surface water bodies. This condition is attributed to the retention of PFAS mass in the sediment of these impoundments from ongoing mass loading from surface water or retained mass from the historic releases at Nose Dock 44 or SFS, **Figures 4-24C** and **5-6** and **Tables 4-3 through 4-8**. Concentrations of PFAS in the sediment and porewater of Chapman Pit are generally lower than in Malabeam Lake.

Portions of Malabeam Lake and Chapman Pit provide recharge to the local groundwater system, **Figure 5-1**. This is evidenced by water level measurements at monitoring wells 043-MW03, just south of Chapman Pit, and BW05012S, just south of Malabeam Lake. Water levels at Chapman Pit are approximately 590 ft NAVD88 while water levels in the monitoring well are approximate 579 to 580 ft NAVD88. Water levels at Malabeam Lake are approximately 610 ft NAVD88 while water levels in the nearby monitoring well were measured at 600 ft NAVD88. Impacts to shallow groundwater above MCLs in these same monitoring wells cannot be hydraulically tied to potentially upgradient source areas from these surface water bodies, **Figures 4-15** and **4-16**. The presence of downward gradients at these impoundments is consistent with the results of the groundwater modeling, **Appendix N**, that show the water table is lower than the land surface in this area, conducive to groundwater recharge, **Figure 5-1.** This is further evidenced by stream gauge results at LSG-07, which is upstream of these impoundments, and LSG-16, which is downstream. Results from the spring of 2024 show a reduction in flow, from approximately 1,700 GPM at LSG-07 to approximately 1,500 gpm at LSG-16. This is evidence that the drainage is losing surface water between these two gauges.

The retention of PFAS mass from the historic releases of AFFF and ongoing transport of PFAS impacted groundwater discharged to upstream surface water results in these surface water bodies serving as source areas, impacting the local surface water and groundwater. These two source areas were not identified through the SI or PA however they should be considered as the 23rd and 24th confirmed source areas.

5.8.2.5 Greenlaw Brook

EBGB and WBGB converge at the southwest side of Loring to form Greenlaw Brook. Greenlaw Brook flows to the southwest, towards the Little Madawaska River. Concentrations of PFAS in the surface water, sediment, and porewater along this section of brook are above their respective SLs until discharge to the Little Madawaska River, **Figures 4-24D** and **5-1** and **Tables 4-3 through 4-8**. In surface water, exceedances are identified for PFOS or PFOA along the length of Greenlaw Brook. In sediment, exceedances are identified for PFOS along the length of Greenlaw Brook. In porewater, exceedances are identified for PFOS along Greenlaw Brook although concentrations are variable and one of the four samples do not exceed SLs. Hydric soils and shallow groundwater samples were not collected along this portion of the watershed.

Greenlaw Brook continues to receive groundwater discharge, supported by the measurement of the combined flows from LSG-02 and LSG-16 in the spring of 2024 at approximately 3,500 gpm, while the measured discharge at LSG-19 was reported as 4,400 gpm, which further increases to 5,600 gpm at the furthest downstream gauge, LSG-01, **Appendix E-2**. This evidence is supported by modeling results, which shows this section of the stream as gaining, **Appendix N** and **Figure 5-1**.

5.8.3 Little Madawaska River

The Little Madawaska River runs to the west and southwest of Loring. The Little Madawaska River receives discharge from Greenlaw Brook. Surface water and sediment samples collected just downstream of this confluence exceed their respective SLs at LT2B. The surface water sample exceeds its respective SLs for PFOS and PFOA. The sediment sample exceeds the SL for PFOS. Concentrations of PFAS decrease to below SLs in samples collected several hundred feet downstream of the confluence, at LMR_002, **Figure 4-24D** and **5-1** and **Tables 4-3 through 4-8**.

5.8.4 Reference Drainages

Samples were collected from two separate drainages that are tributaries of the Aroostook River to the southwest of Loring and outside of the influence of potential impacts attributed to base activities. These include Caribou Stream to the northwest of Caribou, and Prestile Brook to the south of Caribou. The results from these locations are shown on **Figure 4-24E**. Samples collected in Prestile Brook reported no detections or low-level detections below SLs for surface water, sediment pore water, and hydric soils. A shallow groundwater sample collected near Prestile Brook exceeds SLs for PFOA.

The sediment and porewater samples collected from Caribou Stream reported either no detections or low-level detections. Two out of the three surface water samples exceed the surface water SLs for PFOA. The low-level detections and exceedances in these samples indicate that there are potential sources of PFAS in this region which are not attributable to historic operations at Loring.

One surface water sample, SWI_007 was collected along Limestone Stream, several miles south of the base. This sample was collected downstream of several agricultural fields where sludge spreading has been identified. This sample was also collected after the confluence of several more tributaries which drain largely agricultural areas in the US and across the Canadian border. This sample exceeds surface water criteria for PFOS and PFOA.

The summary statistics for PFAS compounds detected in surface water, sediment, porewater, hydric soils, and shallow groundwater that have screening levels as detailed in **Appendix O** and **Section 4.3** are provided below.

Excerpt from Table O-3: Surface Water Summary Statistics - Reference Drainages					
Analyte	Number of Samples	Number of Detections	Number of Swimming SL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBS	9	1	0	0.48	2
PFBA	9	5	0	1.9	4
PFHxS	9	1	0	1.8	6
PFHxA	9	1	0	1.6	2
PFOS	9	5	1	0.60	10.1
PFOA	9	5	5	0.72	2.2

Excerpt from Table O-4: Sediment Summary Statistics - Reference Drainages					
Analyte	Number of Samples	Number of Detections	Number of Wading Sediment SL Exceedances	Minimum (mg/kg)	Maximum (mg/kg)
PFOS	7	1	0	0.00066	0.0014

Excerpt from Table O-6: Shallow Groundwater Summary Statistics -Reference Drainages					
Analyte	Number of Samples	Number of Detections	Number of USEPA Tapwater RSL Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFOA	1	1	1	0.81	0.81

Excerpt from Table O-7: Pore Water Summary Statistics - Reference Drainages					
Analyte	Number of Samples	Number of Detections	Number of Ecological Pore Water Benchmark Exceedances	Minimum (ng/L)	Maximum (ng/L)
PFBA	2	1	0	3	4
PFOS	2	1	0	0.76	2
PFOA	2	1	0	0.73	1

5.8.5 Aroostook River

One surface water sample was collected on the Aroostook River downstream of the confluence with the Little Madawaska River. The sample reported detections below the current surface water SLs, Figure 4-24E. Additional sampling reported in this PFAS RI has been conducted by MEDEP and has been incorporated as part of the Sanitary Sewer Evaluation, Appendix J. Surface water samples collected upstream and downstream of

the Caribou Utility District WWTP off Grimes Road in Caribou report detections of PFAS including PFOA and PFOS below surface water SLs.

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6.0 PRELIMINARY IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

6.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs are substantive federal or state environmental laws and standards that CERCLA response actions must comply with to ensure selected remedies are protective of human health and the environment. CERCLA, the SARA (1986), and the National Contingency Plan (NCP) require identification of ARARs throughout the RI/FS process (CFR, 2023; USEPA, 1988a).

CERCLA and the NCP require that remedial actions attain federal standards, requirements, limitations, or more stringent state standards determined to be legally applicable or relevant and appropriate to the circumstances at a given site. ARARs are federal environmental, state environmental, and facility siting requirements used to:

- Evaluate the extent of site contamination and appropriate extent of site cleanup;
- Define and formulate remedial action alternatives; and
- Govern implementation and operation of the selected action or remedy.

To properly consider ARARs and to clarify their function in the remedy selection process, the NCP defines two ARAR components: (1) applicable requirements; and (2) relevant and appropriate requirements. These are defined as follows:

- **Applicable Requirements.** Applicable requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site (40 CFR 300.400(g)). To be applicable, a requirement must directly and fully address a CERCLA activity. To be considered applicable, state standards must be of general applicability and legally enforceable (i.e., promulgated), identified by the state in a timely manner, and more stringent than federal requirements (40 CFR 300.400(g)(4)).
- **Relevant and Appropriate Requirements**. Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the Site that their use is well-suited to the particular site (40 CFR 300.400(g)(2)).

Requirements under federal or state law may be either applicable or relevant and appropriate to CERCLA cleanup actions, but not both. However, requirements must be both relevant and appropriate to require compliance. In the case where both a federal and a state ARAR are available, or where two potential ARARs address the same issue, the more stringent regulation must be selected. The NCP states that a state standard

must be legally enforceable and more stringent than a corresponding federal standard to be relevant and appropriate (40 CFR 300.400(g)(4)).

The NCP in 40 CFR 300.430(f)(1)(ii)(C) provides the following options for waving ARARs used, providing that the basic premise of protection of human health and the environment is not ignored:

- The alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement.
- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.
- Compliance with the requirement is technically impracticable from an engineering perspective.
- The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirements, or limitation through use of another method or approach.
- With respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state.

CERCLA onsite remedial response actions must comply with substantive requirements that are "applicable" or "relevant and appropriate," and pertain directly to the actions or conditions at a site; however, compliance with administrative requirements for facilitating implementation of the ARRAs (e.g., federal, state, or local permits) are not required (CERCLA §121(e)). As noted in the ARARs guidance (USEPA, 1988a): "The CERCLA program has its own set of administrative procedures, which assure proper implementation of CERCLA. The application of additional or conflicting administrative requirements could result in delay or confusion." To ensure that CERCLA response actions proceed as rapidly as possible, USEPA has reaffirmed this position in the final NCP. The USEPA recognizes that certain administrative requirements, such as consultation with state agencies and reporting, are accomplished through the state involvement and public participation requirements of the NCP.

It is important to note that ARARs pertain to onsite activities. The NCP defines onsite as "the areal extent of contamination and areas in very close proximity to the contamination for implementation of the response action." Off-site response actions must comply with both the substantive and administrative requirements of an applicable (but not a relevant and appropriate) regulation, but such regulations pertaining to off-site actions are not classified as ARARs (OSWER 9347.1-0; USEPA, 1998b).

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, and guidance values that are not legally binding, but may serve as useful guidance for response actions. These are "to-be-considered" (TBC) guidance (USEPA, 1988a). These guidelines or advisory criteria should be identified if used to develop clean-up goals or if they provide important information needed to properly design or perform a remedial action. Three categories of TBC information are: (1) health effects information with a high degree of certainty (e.g., reference doses [RfDs]); (2) technical information on how to perform or evaluate site

investigations or response actions; and (3) regulatory policy or proposed regulations (53 Federal Register [FR] 51436).

This PFAS RI is being conducted in accordance with CERCLA. Potential ARARs identified here will be used in the FS process to evaluate how each remedial alternative being considered attains federal and state ARARs. ARARs are divided into the three categories listed below.

- Location specific ARARs relate to the geographical and physical location of the Site. They include restrictions or requirements placed on the concentrations of hazardous substances or conduct of remediation and related activities because of the Site's location (USEPA, 1989). They could also affect the selection of or implementation of the cleanup technology due to culturally or environmentally sensitive areas that may be impacted. The jurisdictional prerequisites of each regulation will be considered for selected remedial actions.
- Chemical specific ARARs are laws and regulations that identify health or risk based numerical values that, when applied to Loring, provide cleanup limits for specific hazardous substances. The limits will establish the acceptable amount or concentration that may remain in air (indoor and outdoor) and in soil and groundwater or discharged to the environment. (USEPA, 1989)
- Action specific ARARs define acceptable performance, design or similar controls or restrictions imposed on remediation activities. They are usually technology or activity-based requirements (USEPA, 1989). Selection of a particular response action at the Site will invoke the appropriate action-specific ARARs that may specify performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals. These ARARs will be determined in the FS as remedial alternatives are screened and evaluated.

6.2 LOCATION SPECIFIC ARARS

Location-specific ARARs are triggered by the presence of specific natural or manmade features or potentially affected resources at a disposal or cleanup site.

At Loring the following types of ARARs have been identified that may affect response actions:

- wetlands,
- water bodies,
- endangered species,
- facility siting,
- wildlife resources,
- historic sites, and
- First Nation sovereign lands.

Details on the potential Location-Specific ARARs and Criteria TBC are listed in **Table 6-1**.

6.3 CHEMICAL SPECIFIC ARARS

Chemicals of Concern at Loring in this PFAS RI are limited to PFAS compounds. Both Federal and State of Maine statutes and regulations require use of Safe Drinking Water MCLs and State of Maine Groundwater Quality Criteria for developing remedial alternatives for groundwater.

The PFAS RI includes completion of a CERCLA-based human health risk assessment. In completing this risk assessment, USEPA Health Advisories, RfDs and Carcinogen Assessment Group Potency Factors will be considered in computing risks and in selecting groundwater and soil cleanup goals.

Details on potential Chemical-Specific ARARs and TBCs are listed in **Table 6-2.**

6.4 ACTION SPECIFIC ARARS

As discussed previously, action specific ARARs will be addressed in the FS.

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7.0 BASELINE RISK ASSESSMENT

The full BHHRA and BERA reports will be included in the PFAS RI Report, which will be published at a later date. The Pathways Assessment is currently lagging and will be incorporated into a later version of this report for review. The BERA is also lagging and will be incorporated into a later version of this report for review.

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8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

The primary objectives of this RI Site Characterization Summary Report are to:

- Provide information on physical characteristics of the environmental setting;
- Characterize the nature and distribution of PFAS contamination;
- Draw conclusions regarding types of potential COCs present, their sources, nature and extent;
- Estimate the quantity of the contaminant;
- Evaluate COC migration pathways, receptors and exposures; and
- Provide information for development of risk assessments and an FS Report.

The PFAS RI as described throughout this report includes the collection of samples and subsequent chemical analysis for PFAS. Logging of physical data regarding the nature and distribution of overburden and bedrock materials, structural features in bedrock, discharge measurements of stormwater and surface water bodies, aquifer testing, and water level monitoring was also completed. These data were compiled into a numerical model which was developed to create a representation of the current site conditions and predict the behavior of the system in the future.

These datasets have been compiled into the CSM, further detailed in **Section 5,** which will be used to inform the human health and ERAs. Detailed descriptions of specific source areas, migration pathways, and receptors are included in **Section 5,** while high level conclusions are included below.

The impacts of PFAS identified from releases at source areas and the subsequent transport through the environment through the processes described in this PFAS RI are attributed to the historic use and release of AFFF during Air Force activities.

8.1.1 Flow Field #1:

<u>B-52 Crash Area:</u>

An unknown quantity of AFFF was applied at the north end of the Runway in response to the crash of a B-52 aircraft upon takeoff on 28 December 1984. PFAS impacts attributed to this release are limited to the immediate area near the crash site and in a segment of Tributary 1 of Butterfield Brook at the discharge of the local storm sewer network. The extent of PFAS impacts are not delineated to the residential soil RSLs, however no soils exceed industrial soil RSLs. PFAS impacts to groundwater attributed to the B-52 Crash Area are delineated horizontally to USEPA MCLs. The risk to receptors attributed to PFAS impacts at this source area is expected to be minimal due to the limited spatial extent and limited mass identified in soils, surface water, sediment, and groundwater.

Fire Training Area:

The FTA was used for fire training exercises, where AFFF was the primary extinguishing agent used between 1970 and 1989. The FTA is one of the primary source areas identified as having the largest volume of PFAS in soils and groundwater, with identified impacts to receptors including ELL and the Butterfield Brook watershed. The extent of PFAS impacts is not delineated to the residential soil RSLs, however the extent of PFAS in soils above industrial soil RSLs is delineated. The exceedances of industrial criteria in soils at this source correspond to the core of the groundwater plume where concentrations of PFAS are up to several orders of magnitude higher than the MCLs. PFAS impacts to groundwater attributed to the FTA are delineated to USEPA MCLs horizontally but not vertically. Groundwater is transporting PFAS from the source area soils downgradient along groundwater flow pathways and is discharging to surface water bodies including ELL and Butterfield Brook, **Figures 5-1** and **5-4**.

8.1.2 Flow Field #2:

Runway:

The Runway was subject to at least one testing exercise of a runway foamer, which was designed to distribute a layer of fire suppression foam on the Runway prior to an emergency landing. Soil samples collected along the perimeter of the Runway typically exhibit either no detections or low-level detections in soils below SLs. However, at the perimeter of the ready areas on the south and southeast end of the Runway, PFAS was detected in soils at up to an order of magnitude above residential soil RSLs. PFAS in soils are leaching to groundwater, which flows east towards water supply wells associated with the USFWS ANWR buildings. PFAS impacts detected above MCLs in the USFWS and ANWR water supply wells are attributed to the Runway source area. The PFAS groundwater plume is delineated to concentrations below MCLs downgradient of those water supply wells and is less than SLs prior to discharge to downgradient surface water bodies.

8.1.3 Flow Field #3:

Former Jet Engine Test Cell:

The FJETC is north of the NDA and is where various tests on jet engines were performed. Most soil samples collected in this area did not have detections of PFAS; however, two of the soil samples from this area exceed the residential screening criteria. The limited amount of PFAS mass in the soil is likely leaching to groundwater and contributing to the overall groundwater plume. Groundwater flow at the FJETC is to either the west, east, or south. Flow to the south and east results in the comingling of PFAS mass to the larger groundwater plume under the NDA and flightline/Runway. This larger PFAS plume is delineated to the USEPA MCLs. Groundwater flow to the west results in gradual attenuation of PFAS impacts through dilution prior to discharge to the WBGB. The risk to receptors attributed to PFAS impacts at this source area is expected to be minimal due to the limited spatial extent and limited mass identified in soils, surface water, sediment, and groundwater.

Fuel Dump:

The Fuel Dump is north of the NDA where an estimated 1,000 gallons of AFFF was applied in response to the release of approximately 20,000-gallons of fuel from a fuel tanker truck. Three soil samples were collected at this release area. Each sample exhibited exceedances of residential screening criteria in shallow soils, but exhibited non-detect results in deeper samples. Surface water and sediment samples collected just north of the drainage swale exhibited either non-detect or concentrations of PFAS below their respective SLs. The limited amount of PFAS mass in the soil can leach to groundwater. Groundwater flow at the FDA is to either the south or east, resulting in contribution of PFAS mass to the overall groundwater plume underlying the area north of the NDA and flightline/Runway. This larger PFAS plume is delineated to the USEPA MCLs. The risk to receptors attributed to PFAS impacts at this source area is expected to be minimal due to the limited spatial extent and limited mass identified in soils, sediment, surface water, and groundwater.

Nose Docks and Aircraft Hardstands

The NDA is located west of the Runway and encompasses previously identified areas where the historical release of AFFF was confirmed or suspected. These include Nose Dock 11, Aircraft Hardstands, Hardstand 19, Ramp 1, and Nose Dock 40. Specific release mechanisms for each of these areas are detailed in **Section 3.1.** PFAS concentrations in soil at the Nose Docks are variable, with samples that range from no detections to detections up to an order of magnitude above residential soil RSLs. Soil impacts are generally highest on the eastern and southeast side of the NDA, corresponding to identified source areas and areas where landfarming of VOC impacted soils from historic remediation occurred. These soil impacts leach to groundwater, resulting in widespread but relatively low-level groundwater impacts that are comingled with PFAS in groundwater from other sources underlying Loring. This larger PFAS plume is delineated to the USEPA MCLs. The NDA is drained by the storm sewer system, with most of the discharge being directed to the FLDD and drainage on the north side of the NDA discharging to the Butterfield Brook watershed. The risk to receptors attributed to PFAS impacts at this source area is expected to be minimal due to the spatial extent and mass of PFAS identified in soils, stormwater, and groundwater.

Nose Dock 44:

There were four documented releases of AFFF from the fire suppression system at Nose Dock 44. Concentrations of PFAS in soil and sediment attributed to these releases are up to several orders of magnitude greater than their respective SLs and extend through the soil column. Soil concentrations are greatest to the west of Nose Dock 44, particularly along the drainage swales adjacent to Quarry Road. The AFFF releases were washed into the local storm sewer system, which discharges to two stormwater infiltration basins. The leaching of impacts from soil and sediment result in a groundwater plume with concentrations that are orders of magnitude above the MCLs and is distinct from the lower level, but widespread groundwater impacts associated with the NDA. PFAS impacts to groundwater attributed to Nose Dock 44 are delineated to USEPA MCLs horizontally but not vertically. This groundwater plume discharges to the WBGB, resulting in downstream transport of PFAS mass attributed to this source area.

8.1.4 Flow Field #4:

Crash Fire Station:

The CFS is located south of the control tower and historically supported airfield operations with emergency fire suppression, resulting in intentional and accidental releases of AFFF to the environment. Concentrations of PFAS in soil attributed to these releases are up to several orders of magnitude above the residential soil RSLs and extend through the soil column. Exceedances of the industrial soil RSLs are identified and delineated to the east of the CFS. PFAS in the soil leaches to groundwater, resulting in a groundwater plume that flows towards the FLDD. Shallow groundwater in this area is drained by the storm sewer system, resulting in the discharge of impacted groundwater to the FLDD. Most of the mass of PFAS in groundwater which is not captured by the storm sewer system is captured by the FLDD. PFAS impacts to groundwater attributed to the CFS are delineated to USEPA MCLs horizontally but not vertically. There is a potential that a component of groundwater flow in the fractured bedrock is controlled by regional groundwater flow pathways to the south/southeast.

Arch Hangar:

The Arch Hangar stored AFFF periodically throughout its use as a maintenance facility, however there was no AFFF fire suppression system and no identified releases. PFAS impacts to soil have been identified in the vicinity of the facility above residential soil RSLs, however the soil impacts are limited to shallow soils and do not exceed industrial soil RSLs. PFAS leached from soils at this source area comingle with the more substantial groundwater plume attributed to the upgradient CFS. This larger PFAS plume is delineated to the USEPA MCLs horizontally. The risk to receptors attributed to PFAS impacts at this source area is expected to be minimal due to the limited spatial extent and limited mass identified in soils and groundwater.

Jet Engine Maintenance Shop:

Historical activities at the JEMS were associated with the draining, maintenance, repair, teardown, and modification of jet engines. In June 1994, a 55-gallon drum of AFFF was punctured by a forklift, resulting in an accidental release of drum contents. PFAS impacts to soil have been identified in the vicinity of the facility above residential soil RSLs, however the soil impacts are limited to shallow soils and do not exceed industrial soil RSLs. PFAS leached from soils comingle with the more substantial groundwater plume attributed to the upgradient CFS. This larger PFAS plume is delineated to the USEPA MCLs horizontally. The risk to receptors attributed to PFAS impacts at this source area is expected to be minimal due to the limited spatial extent and limited mass identified in soils and groundwater.

Structural Fire Station:

AFFF was used at the SFS during equipment calibration activities and testing exercises, resulting in releases to the ground surface in the area of the building. Concentrations of PFAS in soil attributed to these releases are up to several orders of magnitude higher than the residential soil RSLs and extend through the soil column. Exceedances of the industrial soil RSLs are identified and delineated in the area of the SFS. PFAS

in the soil at this source leaches to groundwater, resulting in a groundwater plume that flows towards the EBGB. The storm sewer system discharges to a drainage swale and intermittent stream north of the SFS. This storm sewer system piping is above the water table, so discharge is from precipitation. Surface water impacts are identified in Tributary 7 and retained in the organic rich soils from the historic releases. PFAS impacts to groundwater attributed to the SFS are delineated to USEPA MCLs horizontally but not vertically. There is a potential that a component of groundwater flow in the fractured bedrock is controlled by regional groundwater flow pathways to the south/southeast.

FLDD and SCF:

The FLDD consists of an unlined, open conveyance system in the trace of a perennial stream that was present prior to base development. This surface water body receives stormwater discharge that incorporates precipitation runoff and groundwater discharge. Drainage from the FLDD passes through the SCF prior to discharge to the EBGB. Sediment impacts are identified at orders of magnitude above SLs along the entire reach of the FLDD and extend past the discharge point of the SCF to the EBGB. Soil impacts at the SCF are identified above residential soil RSLs, however no exceedances of industrial criteria are identified. PFAS mass leached from soils at the SCF comingle with the more substantial groundwater plumes attributed to the upgradient CFS and SFS. This larger PFAS plume is delineated to the USEPA MCLs horizontally. Sediment impacts are identified in a groundwater discharge zone, allowing for the leaching of PFAS to surface water. The FLDD is a conduit for the transport of PFAS mass from upgradient source areas to downstream surface water bodies. The BERA identified the FLDD aquatic exposure area as an area where adverse affects were found to be uncertain for the benthic invertebrate community.

KC-135 Crash Area:

An unknown quantity of AFFF was reportedly applied to a fuel spill resulting from the crash of a KC-135 aircraft off the southern end of the flightline in 1974. PFAS impacts to soil have been identified in the vicinity of the crash site above residential soil RSLs, however the soil impacts do not exceed industrial soil RSLs. Groundwater impacts above MCLs are not identified in monitoring wells in this area. Sediment and surface water impacts are identified above SLs to the south of this source area in the headwaters of Tributary 5 of the EBGB. The wetlands and surface water in this area retain PFAS mass from the historic release due to the relatively high adsorption capacity of the organic rich soils. Tributary 5 flows west, through parcels managed by the Mi'kmaq Nation. The risk to receptors attributed to PFAS impacts at the crash site is expected to be minimal due to the limited spatial extent and limited mass identified in soils and groundwater. Risk to receptors in the wetlands and stream to the south of the crash site should be subject to additional evaluation to determine potential methods of mitigating potential exposure pathways in the Mi'kmaq Nation parcels.

Fuel Tank Farm:

The FTF is located on the south end of Loring and was constructed in the early 1950s for bulk fuel storage. AFFF was routinely applied to fuel spills to minimize fumes and prevent potential fires. PFAS impacts to soil have been identified in the vicinity of the crash site above residential soil RSLs, however the soil

impacts do not exceed industrial soil RSLs. Surface water and sediment impacts exceed their respective SLs in only a portion of samples due to variations in sediment material and hydrologic conditions. PFAS leached from soils contribute to groundwater impacts above MCLs, which flow west towards the EBGB and comingle with impacts from the Burn House. This larger PFAS plume is delineated to the USEPA MCLs horizontally. Risk to receptors in the channelized stream that runs through the FTF should be the subject of additional evaluation to determine potential methods of mitigating potential exposure pathways in the Mi'kmaq Nation parcels.

Base Laundry:

There is no documentation of AFFF usage at the Base Laundry, however PFAS may be associated with laundry operations. Soil samples were not collected, and groundwater samples indicate there is no increase in PFAS concentrations in groundwater downgradient of this source area compared to impacts attributed to upgradient source areas. This larger PFAS plume is delineated to the USEPA MCLs horizontally. The risk to receptors attributed to PFAS impacts at this source area is minimal due to the limited usage of PFAS associated with historic base operations and the lack of groundwater impacts identified.

Burn House:

The Burn House area was used for firefighter training, including the operation and use of AFFF systems, which resulted in the release of AFFF to the ground surface. Concentrations of PFAS in soil attributed to these releases are up to several orders of magnitude higher than the residential soil RSLs and extend through the soil column. Exceedances of the industrial soil RSLs are identified and delineated in the area of the Burn House. Drainage swales along Pennsylvania road discharge to Tributary 5, north of the Burn House. Surface water and sediment impacts are identified in Tributary 5, retained in the soils from the historic releases, and are at concentrations up to several orders of magnitude greater than upstream impacts associated with the FTF and KC-135 crash site. PFAS mass in the soil and sediment leaches to groundwater, resulting in a groundwater plume that flows towards the EBGB. PFAS impacts to groundwater attributed to the Burn House are delineated to USEPA MCLs horizontally but not vertically. There is a potential that a component of groundwater flow in the fractured bedrock is controlled by regional groundwater flow pathways to the south/southeast.

LDA Wastewater Treatment Plant:

The LDA WWTP is located on the main stem of Greenlaw Brook and was used for processing wastewater from the sanitary sewer system. Sanitary sewer sludge containing PFAS was dried on the ground surface on the west side of the WWTP prior to disposal. PFAS impacts to soil above residential soil RSLs have been identified in the areas where sludge drying was conducted, however the soil impacts do not exceed industrial soil RSLs. PFAS leached from soils comingle with the more substantial groundwater plume attributed to upgradient sources. This larger PFAS plume is delineated to the USEPA MCLs horizontally in overburden but is not delineated in bedrock groundwater. Impacts to nearby surface water and sediment on Greenlaw Brook are attributed to PFAS transport from upstream source areas. The risk to receptors

attributed to PFAS impacts at this source area is expected to be minimal due to the limited spatial extent and limited mass identified in soils and groundwater.

8.1.5 Flow Fields #5 and #6

Landfill 2 and Landfill 3:

The area occupied by Landfill 2 and Landfill 3 was historically quarried for gravel during Site construction. From 1956 to 1974, the landfill sites were used as a waste disposal area which may have contained PFAS. Soil sampling was not completed at the landfills to preserve the integrity of the cap. Groundwater sampling indicates there are exceedances of MCLs which are upgradient of one drinking water well. PFAS impacts to groundwater attributed to the Landfills are delineated to USEPA MCLs vertically but not horizontally.

8.1.6 Local Drainage Basins

Butterfield Brook and Limestone Stream

The Limestone Stream and Butterfield Brook drainage basin is generally east of the Runway with headwaters that extend north and east of Loring. Flow Fields #1 and #2 and portions of Flow Field #3 contribute groundwater and surface water to this water body. The watershed includes the B-52 Crash Site, the FTA, and the east side of the Runway. Portions of the storm sewer system at the north end of the NDA discharge to the Butterfield Brook watershed.

Throughout Butterfield Brook and Limestone Stream concentrations of PFAS identified in surface water, sediment, and porewater is shown to be variable due to variation in precipitation patterns, proximity to impacted groundwater discharge zones, and stream/pond substrate material. The groundwater plume attributed to the FTA discharges to ELL and Butterfield Brook just downstream of the outlet of ELL. It is recommended that supplemental data collection to further understand the dynamics of the groundwater and surface water interactions in this area be completed to inform potential remedial methods that may mitigate these impacts and improve downstream water quality.

Greenlaw Brook

The Greenlaw Brook drainage basin is west of the Runway. The headwaters of Greenlaw Brook are within the Loring boundary. Flow Fields #3 and #4 contribute groundwater and surface water to this waterbody. The headwaters of Greenlaw Brook at the EBGB and WBGB receive groundwater discharge downgradient of several of the primary source areas across Loring, including the CFS, Nose Dock 44, SFS, and Burn House, and are the receiving waters for much of the storm sewer system.

Concentrations of PFAS in Greenlaw Brook are shown to be variable due to variation in precipitation patterns, proximity to impacted groundwater discharge zones, and stream or pond substrate material. Concentrations of PFAS in the surface water, sediment and porewater are greatest in surface water bodies which would have been subject to direct discharge of historical releases of AFFF, including the FLDD and Tributary 5 of EBGB directly north of the Burn House, Tributary 7 of the WBGB directly north of the SFS,

the stormwater infiltration basins west of Nose Dock 44, Malabeam Lake, and Chapman Pit. These portions of Greenlaw Brook are also subject to ongoing discharge of PFAS impacted groundwater. Concentrations of PFAS remain elevated above SLs in surface water downstream of these portions of the watershed. At Malabeam Lake and Chapman Pit the infiltration of PFOS and PFOA impacted surface water through impacted sediment of the ponds results in an increase in concentrations of these compounds in groundwater. These two ponds are identified as source areas, with designations as:

- Source Area #25 – Malabeam Lake
- Source Area #26 – Chapman Pit

The addition of these two source areas brings the total number of confirmed source areas to 24.

8.2 DATA GAPS

1. A site-specific background study of PFAS concentrations in soil, groundwater, surface water, sediment, and precipitation has not been completed. This data gap prevents the completion of a holistic evaluation of the nature and extent of PFAS impacts attributable to historic activities at Loring.
2. Soil, groundwater, surface water, and sediment PFAS impacts are not delineated to their respective SLs. This is attributed to confirmed detections of compounds including PFOS above SLs, as well as limitations to the analytical methods that result in the inability to detect certain compounds to their SLs. Following the completion and evaluation of a site-specific background study, further assessment of PFAS distribution related to identified source areas to relevant SLs may be necessary.
3. Surface water bodies that have been subject to historic releases of AFFF or ongoing mass loading of PFAS through stormwater or groundwater discharge have been identified. Questions remain regarding the dynamics of groundwater/surface water interactions and PFAS volumes stored in sediment which can inform the feasibility of potential remedial options to mitigate these impacts.
4. Groundwater contaminant fate and transport modeling has identified the potential for off-site transport and impacts to groundwater above the USEPA MCLs along Greenlaw Brook and the Little Madawaska River. Ground truthing of these modeled outputs should be conducted to inform future remedial objectives and conduct the delineation of impacts attributable to historic activities at Loring.
5. The evaluation of the storm sewer system has identified concentrations of PFAS and volume of discharge at select outfalls, allowing for calculations of the mass flux PFAS discharging to the FLDD and along Greenlaw Brook. Further evaluation of the storm sewer system at the FLDD is required to inform the feasibility of remedial action to mitigate the ongoing mass transfer of PFAS impacted groundwater to surface water.
6. The Sanitary Sewer Evaluation has reviewed I&I evaluations, previously proposed and completed repairs to the sanitary system, and evaluated the potential sources of PFAS entering the sanitary sewer system. Review of the efficacy of the currently planned sanitary sewer repairs will be

evaluated to inform the feasibility of mitigating potential impacts associated with this PFAS transport mechanism.

7. The groundwater monitoring program indicates that regional flow pathways influenced by the Aroostook and St. Johns River have the potential to impact contaminant fate and transport to the south, southwest, or southeast of Loring. The understanding of potential impacts associated with this regional flow pathway on receptors has not been fully investigated.

8.3 RECOMMENDATIONS

1. Collection of multimedia samples including soil, groundwater, surface water, sediment, porewater, and precipitation to evaluate site specific background concentrations of PFAS in the vicinity of Loring.
2. Additional soil sampling to delineate impacts attributed to historic activities at Loring, to be informed by the results of the background study.
3. Evaluation of remedial alternatives to mitigate mass loading of PFAS from soils/sediment to groundwater.
4. Refinement of the understanding of groundwater/surface water dynamics and contaminant mass in surface water bodies impacted by historic or ongoing discharge of PFAS.
5. Ground-truthing of outputs of the numerical groundwater model including off-site evaluation outside of the current investigation area.
6. Refinement of understanding of the dynamics of contaminant transport through the storm sewer system and ultimate discharge to surface water bodies.
7. Refinement of understanding of the dynamics of contaminant transport through the sanitary sewer system and ultimate discharge to surface water bodies and potential impacts to receptors.
8. Data collection and refinement of the groundwater model for consistency with the latest DoD guidance on PFAS soil leaching evaluations and ground truthing results of the model with respect to contaminant transport and potential impacts to receptors.

This RI Site Characterization Summary Report forms the basis for a RI Report. Completion of a background study, addressing certain data gaps, and conducting a BHHRA and BERA will better advise an FS to evaluate remedial alternatives to address exposure pathways and ARARs.

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