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ECOLOGICAL RISK ASSESSMENT WORK PLAN
CDRL A007B

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

Prepared for:
Air Force Civil Engineer Center
Joint Base San Antonio – Lackland, Texas

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WSP USA Environment & Infrastructure Inc.

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LIST OF ACRONYMS AND ABBREVIATIONS

95% UCL	95th percent of the upper confidence level on the mean
AFCEC	USAF Civil Engineer Center
AFFF	Aqueous Film Forming Foam
ANWR	Aroostook National Wildlife Refuge
ATSDR	Agency for Toxic Substances and Disease Registry
BERA	Baseline Ecological Risk Assessment
BHHRA	baseline human health risk assessment
bgs	Below Ground Surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COCs	Contaminants of Concern
COPEC	Contaminants of Potential Ecological Concern
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
DoD	Department of Defense
EPC	Exposure Point Concentrations
ERA	Ecological Risk Assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
FFA	Federal Facilities Agreement
FS	Feasibility Study
ft	feet
FTA	Fire Training Area
FYRs	Five Year Reviews
GMZs	Groundwater Management Zones
HA	Health Advisory
HI	Hazard Index
HQ	Hazard Quotient
IC	Institutional Controls
IRP	Installation Restoration Program

LDA	Loring Development Authority
LF	Landfill
LOEC	Lowest-Observed-Effect-Concentration
LUC	Land Use Controls
MEDEP	Maine Department of Environmental Protection
MEG	Maximum Exposure Guideline
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
NOEC	No-Observed-Effect-Concentrations
OU	Operable Unit
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PFAS	Per- and Polyfluoroalkyl Substance
PFBA	Perfluorobutanoic acid
PFBS	Perfluorobutanesulfonic acid
PFDA	Perfluorodecanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SERDP	Strategic Environmental Research and Development Program
SI	Site Inspection
SLERA	Screening Level Ecological Risk Assessment
SVOC	Semivolatile Organic Compound
TPH	Total Petroleum Hydrocarbon

USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOC	Volatile Organic Compound
WSP	WSP USA Environment & Infrastructure Inc

1.0 INTRODUCTION

WSP USA Environment & Infrastructure Inc (WSP, formerly Wood) has prepared this Ecological Risk Assessment (ERA) Work Plan in support of the Remedial Investigation (RI) at the former Loring Air Force Base (Loring or Site) located in Limestone, Maine (**Figure 1.0-1**). This Work Plan has been prepared for the United States Air Force (USAF) under Contract Number FA8903-16-D-0027 Task Order FA8903-21-F-1048.

The purpose of this Work Plan is to describe the technical approach to complete the Tier I Screening Level Ecological Risk Assessment (SLERA) and first step of the Tier II Baseline Ecological Risk Assessment (BERA) which is primarily focused on per- and polyfluoroalkyl substances (PFAS). Data collection and reporting focused on defining the nature and extent of PFAS are being executed under separate tasks.

The objective of the SLERA is to determine if the available data support a finding of no ecological risk and a conclusion that no further ecological risk assessment is needed, or whether there is evidence for potential ecological risks that require more detailed investigation and analysis conducted as part of a Baseline Ecological Risk Assessment (BERA).

The SLERA will be completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP) 40 Code of Federal Regulations (CFR) Part 300 (United States Environmental Protection Agency [USEPA], 1988).

1.1 ECOLOGICAL RISK ASSESSMENT APPROACH

PFAS encompass a heterogeneous group of more than 5,000 chemicals. For most PFAS, data suitable for assessing risks to the environment such as toxicity thresholds, effects, and bioaccumulation and elimination rates are lacking. This knowledge gap provides challenges for assessing risks from PFAS to the environment. However, the body of knowledge for this group of chemicals is expanding, and there are sufficient data to assess risks from eight PFAS compounds (PFBA, PFHxA, PFOA, PFNA, PFDA, PFBS, PFHxS, and PFOS) in soil, sediment pore water, and surface water, and are discussed further in **Section 2.3**.

The ERA will be conducted consistent with USEPA CERCLA ERA guidance documents, including:

- *Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997)
- *Guidelines for Ecological Risk Assessment* (USEPA, 1998)
- *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments, ECO Update* (USEPA, 2001)
- *ECO Updates published between 1991 and 2008* (USEPA 1991–2008)
- *Air Force Instruction 32-7020* (USAF, 2020)
- *Tri-Services Remedial Project Manager's Handbook for Ecological Risk Assessment* (USACE, 2000)
- *A Guide to Screening Level Ecological Risk Assessment (Tri-Services Environmental Risk Assessment Work Group* (TSERAWG, 2008).

- *Defense Environmental Restoration Program (DERP) Manual* (DERP, 2018)

Documents developed by the Department of Defense (DoD) *Strategic Environmental Research and Development Program* (SERDP) related to screening of PFAS concentrations in assessing potential ecological risks will also be considered and include:

- *A Framework for Assessing Bioaccumulation and Exposure Risks of PFAS in Threatened and Endangered Species* (ER18-1502) (Gobas et al., 2020)

Additionally, documents developed under contract with DoD in coordination and consultation with interagency subject-matter experts from across the DoD Tri-Services Environmental Risk Assessment Work Group and including USEPA will also be considered:

- *Derivation of PFAS Ecological Screening Values* (Grippo, et al., 2021)

Although some of these PFAS-specific documents were written to address risks to threatened and endangered species, they provide frameworks and technical support that can also apply to common (i.e., unendangered) species.

The ERA may consider additional future guidance or technical documents available at the time the ERA is written, if technically appropriate and approved by the USAF Civil Engineer Center (AFCEC).

Under USEPA CERCLA guidance (USEPA, 1997), an ERA is carried out in a two-tiered approach:

- Tier I –SLERA
- Tier II –BERA

The Tier I SLERA includes the first two of the eight steps in an ERA identified in the ERAGS (USEPA, 1997):

- Step 1 is the Screening Level Problem Formulation and Ecological Effects Evaluation.
- Step 2 is the Screening-Level Exposure Estimate and Risk Calculation.

The goal of the Tier I SLERA includes the identification of the preliminary chemicals of potential ecological concern (COPECs), assessment endpoints, and exposure pathways that will be the focus for any additional investigation and analysis, if it is determined that the BERA process should continue to Tier II.

The Tier II BERA evaluates contaminants in greater detail and in the context of site-specific factors and is composed of Step 3 through Step 7:

- Step 3 is a refinement of risk estimates using more realistic assumptions than those that were applied in the Tier I SLERA.
- Steps 4 through 7 of the BERA involve revisions to the Conceptual Site Model (CSM) and detailed toxicity testing, tissue sample collection, or other collection, analysis, and characterization of site-specific ecological data.

Step 8 is a risk management step performed after the BERA is completed.

Technically, Step 3 Refinement is the first step of the Tier II BERA, but several available desktop tools can be applied immediately after the screening-level risk characterization to introduce additional lines of evidence and further refine risk estimates. Therefore, Step 3 is commonly provided as part of the SLERA Report.

This ERA Work Plan consists of Steps 1 through 3 and thus will include the first step of a Tier II BERA. The need to perform subsequent steps will be determined only after completion of Step 3. This ERA Work Plan does not describe activities that may be associated with Steps 4 through 8.

1.2 SITE HISTORY AND SETTING

In 1946, the Strategic Air Command developed a plan for a global Air Force. The plan called for the Limestone Air Force Base at the northeastern tip of the United States. Loring was first established as Limestone Air Force Base in 1947 and was later renamed after Korean War aviator Charles J. Loring in 1954. Construction began in 1947 and was completed in 1953. Loring Air Force Base was operated by the USAF from 1950 to 1994.

The installation became active in 1953 with the 42nd Bombardment Wing in residence to a series of state of-the art bombers and support aircraft. In 1955, the 42nd Air Refueling Squadron was activated. Starting in 1981, substantial renovations were made to the installation, including the addition of a second runway. Base improvements continued through 1991 with the completion of a renovated alert facility, a new medical center, and a new maintenance facility and upgraded aircraft refueling. The installation was officially deactivated on 30 September 1994. Upon closure, responsibility for environmental cleanup at the installation transferred to the Air Force Base Conversion Agency (AFCEC, 2011).

Aqueous film forming foam (AFFF) containing PFOS and PFOA was used at Loring to respond to petroleum fires and during fire training exercises (Amec Foster Wheeler, 2015). In 1970, the USAF began purchasing and using AFFF containing PFAS (PFOS and/or PFOA) for extinguishing petroleum fires and firefighting training activities (USAF, 2012). AFFF was used at USAF installations in and around fire training areas (FTAs). AFFF also could have been used at other areas within installations, such as in and around hangars that had AFFF fire suppression systems, plane crash and fire emergency response sites, firefighting equipment testing areas, wash racks, areas where fire trucks and/or emergency vehicles were washed, and AFFF storage areas, to name a few. An installation layout map also showing potential PFAS source areas is provided as **Figure 1.2-1**.

The installation was placed on USEPA's National Priorities List of sites in 1990. Under the CERCLA 120, a Federal Facilities Agreement (FFA) between USEPA Region 1, the Maine Department of Environmental Protection (MEDEP), and the USAF, was signed into action January 1991 and amended in 1995. The FFA governs the environmental activities being conducted at Loring. Following the signing of the FFA, Loring was placed on the U. S. Congress 1991 Base Closure List 1991 and was closed in September 1994.

After the Base closure in 1994, the Maine State Legislature created the Loring Development Authority (LDA) to acquire and manage the properties within the geographic boundaries of Loring. The USAF 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 local Aroostook Band of Mi'kmaq (Wood, 2018). Current property boundaries are depicted by the red and white dotted line in **Figure 1.2-1**.

Loring is located approximately west longitude 67°89'21" by north latitude 46°94'56" occupying approximately 8,704 acres in the community of Limestone, Maine located in Aroostook County (**Figures 1.0-1 and 1.2-1**). The land surrounding the installation is primarily rural and agricultural. Currently there is limited commercial and industrial use at Loring. Use of former base property includes, but is not limited to, an inn on Virginia Place, a residential community consisting of a series of rental units managed by a single property agent on Manser Road, and several additional homes on Development Drive. Former Air Force Base properties are supplied by municipal water. The airflight control tower is not operational. Planes landing at Loring are infrequent and are typically unscheduled.

Parcels within the Loring boundary are now owned by other entities including the ANWR, which is open to the public for recreational use in designated areas. A large parcel to the south is owned by the Mi'kmaq and is depicted on **Figure 1.2-2**.

Loring lies in the lower Aroostook River Basin. Topography of the basin is typified by a succession of gently rolling to steeply sloping ridges separated by narrow valleys. Elevations of the ridges range from 600 to 800 feet (ft) above sea level (referenced elevations are based on the National Geodetic Vertical Datum [NGVD]). Narrow swamps and bogs extend between the ridges. The valleys range in elevation from 500 to 600 ft above the NGVD (ABB, 1997a,b).

Loring is split by a bedrock groundwater divide (**Figure 1.2-3**) and by an overburden divide (**Figure 1.2-4**). These divides define the natural drainage basins. Butterfield Brook Drainage (**Figure 1.2-5**) generally lies to the east of the runway, and the Greenlaw Brook Drainage (**Figure 1.2-6**) lies generally to the west.

The Butterfield Brook Drainage Basin (**Figure 1.2-5**) is composed of storm sewers, open drainage ditches, and unnamed streams that flow into East Loring Lake or Butterfield Brook, and eventually into Durepo Reservoir and Limestone Stream**.** The southeastern portion of Loring drains into the main stem of Limestone Creek Source through Noyes Pond. Source areas within the Butterfield Brook Drainage Basin or source areas which could drain into Butterfield Brook via surface runoff or storm sewer conveyance include:

- FTA (Area 1),
- Part of the Nose Dock Area (Areas 10, 11, 12, 13, 14, and 15),
- Fuel Dump Area (Area 17),
- Part of the Main Runway Foaming Area (Area 18),
- B-52 Crash Area (Area 19), and
- Former Jet Engine Test Cell Area (Area 24).

The Greenlaw Brook Drainage Basin (**Figure 1.2-6)** is composed of storm sewers, open drainage ditches, and unnamed streams that drain the majority of Loring west of the groundwater divide (**Figures 1.6-1 and 1.6-2**). Source areas within the Greenlaw Brook Drainage Basin or source areas which could drain into Greenlaw Brook via surface runoff or storm sewer conveyance include:

- Landfill (LF) No. 2 (Area 2)
- LF No. 3 (Area 3)
- Base Supply (Area 4)
- Structural Fire Station (Area 5)
- Fire Department Training/Burn House (Area 6)
- Crash Fire Station (Area 7)
- Arch Hangar (Area 8)
- Jet Engine Maintenance Building (Area 9)
- Part of the Nose Dock Area (Areas 10, 11, 12, 13, 14 and 15)
- Fuel Tank Farm (Area 16)
- Part of Area 18 Main Runway Foaming Area (Area 18)
- B-52 Crash Area (Area 20)
- Flight Line Drainage Ditch and Industrial Wastewater Treatment Facility (Area 21)
- Wastewater Treatment Plant (Area 22)
- Base Laundry (Area 23)

Some source areas (e.g., B-52 Crash Area) could affect both drainage basins since surface water runoff does flows in a different direction than groundwater. One of the potential PFAS study areas (Base Supply – Area 4) had no documented storage or releases of AFFF and was previously removed from the RI and will not be further evaluated in the ERA.

1.3 INVESTIGATION HISTORY UNDER THE INSTALLATION RESTORATION PROGRAM

Under the FFA for Loring, 15 Installation Restoration Program (IRP) Operable Units (OUs) were established according to geographic location, disposal type (e.g., landfill), or affected media. The primary contaminants of concern (COCs) at the site were chlorinated solvents including chlorinated volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and certain total petroleum hydrocarbon (TPH) compounds. Separate RI and Feasibility Study (FS) reports were prepared for each OU. The IRP sites and AFFF release sites are depicted in **Figure 1.3-1.**

Eleven Records of Decision (RODs) were completed at Loring describing site cleanup plans between 1994 and 1999 (ABB, 1994, 1996 and 1997; and HLA, 1998 and 1999). An amendment to the OU 12 ROD was completed in 2018 for vapor intrusion (USAF, 2018).

Construction work required under each ROD has since finished. Remedy optimization, operation and maintenance, and long-term monitoring work are ongoing until cleanup goals have been met for fuels and solvent related contamination. There are several Groundwater Management Zones (GMZs) implemented as remedy components in final RODs as permanent Land Use Controls/Institutional Controls (LUC/ICs). These are discussed further in subsequent sections. The USAF is responsible for 5-Year Reviews (FYRs) at the Site where the purpose is to evaluate and determine if the implemented remedies are and will continue to be protective of human health and the environment. Five FYRs have been completed and the latest was conducted in 2020 (Aptim, 2020).

Three previous IRP Sites at Loring have been addressed during previous programs and are reported to have used AFFF or received soils that may have been exposed to AFFF. The location of the former sites with AFFF use are discussed below. A more detailed description of each of these sites is provided in Section 5 of the RI Work Plan (Wood, 2022):

- FTA (IRP Site FT-07) was used for fire training exercises, where AFFF was the primary extinguishing agent used between 1970 and 1989. The site consisted of a mock aircraft located in a bermed circular unlined pit. During training exercises, waste fluids consisting of fuels, oils, and solvents were released into the FTA pit, ignited, and extinguished (HLA, 1999a). Extensive excavation has occurred at this location and soils were disposed in LF-3.
- LF-2 (IRP Site LF-02) is unlined and may have received impacted soil from industrial areas on the installation where AFFF may have been used; however, no specific AFFF disposal was documented. The selected source control remedial action for LF-2 in the OU2 ROD (ABB, 1994) is containment using a low-permeability cap. The cover system was designed in accordance with Resource Conservation and Recovery Act (RCRA) Subtitle C and Maine Hazardous Waste Regulations. Site preparation for the cover system began in 1994, and the cover system was constructed in 1996. The landfill was closed with the construction of the RCRA cap. A developed rural area exists on the west side of Loring, which is downgradient of LF-2. LF-2 lies in the apparent upgradient vicinity of a residence in the Town of Caribou where sampling of one private water supply well indicated either non-detect or low concentrations of PFOS and PFOA below the 2016 USEPA lifetime Health Advisory (HA) and the Maine Maximum Exposure Guidelines (MEGs) during sampling rounds in 2015, 2016, and 2017.
- LF-3 (IRP Site LF-20) is unlined and received contaminated soils excavated from FT-07, which has documented AFFF use. The remedial control selected for this landfill in the OU2 ROD (ABB, 1994) uses a low-permeability cap. The cap was designed in accordance with RCRA Subtitle C and Maine Hazardous Waste Regulations. Installation of the cap was completed in 2000. A developed rural area which relies on private drinking water is located proximal to the western boundary of Loring which is downgradient of LF-3. LF-3 lies in the apparent upgradient vicinity of two residences in the Town of Caribou where private well sampling was conducted: one in 2015 and one in 2017. In addition, a multi-resident supply well located downgradient of LF-3 in the rural Westgate area was sampled in 2015, 2016, and 2017. The well's 1,000 ft wellhead protection zone falls within the former installation boundary. Analysis of drinking water collected from the three private wells (two private residential wells and one multi-residence private water supply well) indicated low concentrations of PFOS and PFOA below the 2016 USEPA lifetime HA/Maine MEGs.

In 2006 the Agency for Toxic Substances and Disease Registry (ATSDR) developed a health consultation (ATSDR, 2006) to address concerns expressed by the Mi'kmaq about the safety of using plant and animal resources from Loring lands. The objective of the evaluation was to provide perspective about whether the COCs at Loring are likely to accumulate in plant and animal resources traditionally used by the Mi'kmaq. COCs include metals (barium, cadmium, lead, mercury, silver, and zinc), pesticides (chlordane, DDT [dichlorodiphenyltrichloroethane], DDD [dichlorodiphenyldichloroethane], and DDE

[Dichlorodiphenyldichloroethylene]), PCBs, PAHs, and petroleum compounds. ATSDR presented observations based on literature reviews about the potential for exposure to contaminants from certain traditional Mi'kmaq practices and came to the following conclusions:

- Ingestion of soil presented the highest potential for risk at sites contaminated with heavy metals.
- Workers (basket weavers and/or plant harvesters) may inhale substantial amounts of soil dust due to working in an enclosed environment.
- Plant materials present a potential risk if they are consumed for medicinal purposes, used for dyes or paints (including cosmetics and face paint), or burned in sweat lodges (volatilization of contaminants into the air).
- Root crops and low-lying plants grown in contaminated soil are likely to be more harmful than plants and crops that are higher from the ground because crops that grow higher from the ground are not a significant exposure source to contaminants in the soil.
- Animal skins and furs may contain high levels of mercury according to literature review.

In 2012 the USAF issued guidance on sampling for emerging contaminants PFOS and PFOA (USAF, 2012). As a result, the USAF conducted a Preliminary Assessment (PA) in 2015 (Amec Foster Wheeler, 2015) to evaluate the handling, storage, and usage of AFFF containing PFOS and PFOA at Loring. The PA evaluated 22 potential AFFF areas and recommended 21 for further investigation and characterization. Based on the PA, a Site Inspection (SI) was completed in 2018 (Wood, 2018). The SI included sampling of soil, surface water, sediment, groundwater monitoring wells, private wells, and public water supply wells. Fish tissue was also collected and analyzed during this effort. The results of the PA and the SI are further summarized in Section 1.8 of the RI Work Plan (Wood, 2022).

1.4 PFAS USE AND INVESTIGATION AT LORING

Since 2013, several PFAS investigations have been completed at the Site. These investigations are listed along with a summary of key findings or actions in Section 1.8 of the RI Work Plan (Wood, 2022). The SLERA will consider PFAS analytical results from soil, surface water, sediment, pore water, and groundwater collected from each of these investigation as well as data collected during the RI.

1.5 STAKEHOLDER INVOLVEMENT

A Restoration Advisory Board is not currently active for the Site, however efforts to engage the local community are on-going. These stakeholder involvement efforts have focused principally on public health concerns and have not specifically covered ecological topics, as summarized below.

Two questionnaires were sent in May/June 2022, one to local residents residing within Loring to better understand recreational use at Loring. Residents were also asked about their level of interest for further community involvement regarding the RI. The second questionnaire was sent to local farmers in an effort to identify the source of irrigation water for commercial crops (i.e. groundwater or surface water) and related information. A public information session was held on 8 June 2022 in the town of Limestone. It was noted at the public meeting that much of the irrigation infrastructure directly to the east of Loring is using surface water.

USAF and WSP held a meeting with the Mi’kmaq on 9 September 9 2021 to discuss exposure scenarios for consideration on the parcels within Loring owned by the Mi’kmaq. The Mi’kmaq indicated that future planned uses of the parcels include primarily commercial/industrial uses such as a pellet mill, which may require use of groundwater and potentially developing a campground, which could include a potable well. There are no current residential or recreational uses and no plants or animals are currently harvested as the Mi’kmaq prohibits hunting and foraging; however, there are no land-use controls in the form of deed restrictions on the land preventing traditional cultural exposure scenarios such as harvesting wild plants. The Mi’kmaq provided attendees with a copy of the Maine First Nation Exposure Scenarios: Wabanaki Traditional Cultural Lifeways Exposure Scenario (Harper & Ranco, 2009). The Mi’kmaq also indicated that certain EPA default exposure assumptions such as lifetime scenarios are not necessarily appropriate for First Nations, as USEPA assumes a resident typically lives in one place for 26 years, however a member of the Mi’kmaq are expected to live in one place for their full lifetime. The exposure document was used in conjunction with the information obtained at the meeting to draft exposure scenarios for these parcels, which in turn provides the basis for the CSM discussed in the next section. The CSM was communicated to the Mi’kmaq on 25 January 25 2022.

A second meeting was held on 8 June 2022 with USAF, USEPA, MEDEP, WSP and the Mi’kmaq. The proposed exposure scenarios were discussed. Additionally, the Mi’kmaq expressed a need for technical assistance in reviewing risk assessment documents. The Mi’kmaq raised concerns about hunting moose on the property and WSP suggested reaching out to Maine Fish & Game to identify whether any Agency-led PFAS sampling was being considered. Reaching out to the ANWR was also suggested to see if a joint effort might be possible. The discussion also focused on proposed sample collection on the Mi’kmaq property. WSP will work with the Mi’kmaq to identify additional sampling areas within their parcel where specific plants that would be attractive for harvesting may grow, such as fiddlehead ferns, muskrat root, and Labrador tea. These topics will be primarily addressed via the baseline human health risk assessment (BHHRA).

1.6 REPORT LAYOUT

In accordance with USEPA guidance the ERA will be comprised of the following sections:

- Tier I SLERA, presented in Section 2;
- Tier II BERA– Step 3 Refinement of Risk Estimates, presented in Section 3;
- Uncertainty Assessment, presented in Section 4; and
- A discussion of ecological risk assessment exit criteria in Section 5.

2.0 TIER I SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

A SLERA includes four primary phases: (1) problem formulation, (2) exposure estimate, (3) evaluation of ecological effects, and (4) risk characterization. An ecological CSM is developed during the problem formulation phase to help understand exposure at the Site and to help select assessment and measurement endpoints.

2.1 SCREENING-LEVEL PROBLEM FORMULATION

The problem formulation provides the framework upon which the risk assessment is organized. The problem formulation step includes the following elements:

- A description of the facility's operating and investigation history and known releases.
- A description of the environmental setting and natural communities associated with terrestrial and freshwater aquatic habitats, including the presence of any state or federally threatened or endangered species. The environmental setting discussion will be informed by a visit to the Site by a field ecologist to characterize habitat, flora and fauna. The environmental setting will also be informed by a review of data obtained from agency sources such as National Wetland Inventory maps, USGS soil maps, state and federal wildlife surveys, and information collected during other phases of investigation at the Site such as groundwater transport maps, seep maps, and wetland delineations. Descriptions of environmental setting presented in ecological risk assessments previously conducted at Loring legacy IRP sites may considered, as appropriate.
- A summary of PFAS data obtained during historical investigations and the RI. Analytical data collected during the planned RI and deemed usable following data validation and according to the project-specific Quality Assurance Program Plan will be evaluated in the SLERA. Previously collected relevant data adequately validated and deemed usable at the time of collection will also be evaluated. Data will be summarized and presented in tables listing detected analytes, frequency of detection, range of detection limits (laboratory reporting limits) for non-detects, maximum and average concentration for each detected analyte, and location of the maximum detection. Average concentrations will be calculated using one-half the reporting limit for non-detected concentrations (i.e., U-qualified data).
- A description of contaminant fate and transport mechanisms that affect contaminant migration from source areas to receiving media and ecological receptors.
- A brief summary of toxicity profiles for detected analytes. Considering that studies exploring toxicity mechanisms and effects in ecological receptors for almost all PFAS are scarce, the toxicity profile summary is anticipated to be a general description of the adverse effects that may be experienced by ecological receptors exposed to the PFAS chemical family and will not be more than a paragraph in length.
- An ecological CSM that illustrates the initial assessment of fate and transport mechanisms of chemical constituents, complete exposure pathways (including potentially affected dietary

items), and primary and secondary receptors. The ecological CSM will be developed as part of the ERA work plan execution for inclusion in the ERA report and will include all direct contact pathways with contaminated abiotic media (soil, groundwater, surface water, pore water, sediment) and indirect pathways due to uptake from food items (food chain pathways). If an exposure pathway is not complete for a specific chemical constituent, that exposure pathway would not be evaluated further.

- Identification of assessment and measurement endpoints. Assessment endpoints in the SLERA define ecological attributes that are to be protected. Measurement endpoints are measurable characteristics of those attributes that can be used to gauge the degree of actual or potential impact. Assessment endpoints most often relate to attributes of biological populations or communities. They contain an entity (e.g., invertebrate populations) and an attribute of that entity (e.g., survival rate). The entity in the assessment endpoint is typically a population or community. In the case of specially protected species, the assessment endpoint frequently focuses on individuals. Measurement endpoints are related to the assessment endpoint and the effects that can be measured or observed (e.g., comparison with no-effects concentrations). **Table 2.1-1** presents the assessment and measurement endpoints that will be evaluated in the SLERA.

The initial screening level problem formulation will include the evaluation of potential exposures to all applicable representative ecological receptors and environmental media. The screening process will identify media and pathways for additional evaluation.

2.2 SCREENING-LEVEL EXPOSURE ESTIMATE

This phase of the SLERA identifies exposure areas to be assessed and screening level exposure point concentrations (EPCs).

2.2.1 Exposure Areas

The SLERA will assess risks to the environment. Terrestrial exposures at each of source areas at Loring (**Figure 1.2-1**) will be assessed individually. Freshwater aquatic (i.e., surface water, sediment, and/or pore water) exposures associated with 17 of the source areas (Area 5, Area 8 through Area 22, and Area 24) will be assessed individually. Freshwater aquatic exposures within the off-Base Butterfield Brook Drainage Basin (**Figure 1.2-5**) and Greenlaw Brook Drainage Basin (**Figure 1.2-6**) which occur outside of the boundaries of Loring will also be assessed.

Although there is no direct exposure to groundwater by ecological receptors, groundwater discharging to surface water may result in a complete exposure pathway. If the groundwater exposure pathway is found to be complete, groundwater associated with source areas will also be evaluated.

2.2.2 Screening Level Exposure Point Concentrations

For each terrestrial exposure area, soil EPCs for PFAS will be calculated as the maximum concentration from the 0-2 ft below ground surface (bgs) interval which is the zone of predominant biological activity (USEPA, 2015). Samples located under buildings or other impervious surfaces will be excluded from the EPC calculation because soils under buildings and impervious surfaces are considered to be unavailable to wildlife.

For each aquatic exposure area, sediment and pore water EPCs will be calculated as the maximum concentration from the 0–6-inch bgs interval which is the predominant biologically active zones in sediment (USEPA, 2015). Surface water EPCs will be calculated as the maximum concentration in each exposure area. If the groundwater exposure pathway is found to be complete, groundwater EPCs will be calculated as the maximum concentrations in each exposure area.

2.3 SCREENING LEVEL EFFECTS EVALUATION

This phase of the SLERA identifies thresholds of ecological effects, also called benchmark values or screening values, for soil, surface water, bulk sediment, sediment pore water, and groundwater. Following ERAGS, screening values used in the SLERA represent no-observed-effect-concentrations (NOECs), which are concentrations believed to be non-hazardous to receptors. NOECs are determined from chronic laboratory studies in which test organisms are subjected to various concentration (plants, invertebrates) or dose (bird, mammals) levels of individual chemicals.

USEPA has not yet developed consensus ecological screening benchmarks for PFAS. Therefore, NOEC screening values were obtained from Derivation of PFAS Ecological Screening Values (Grippo et al., 2021), a technical document developed by Argonne National Laboratory under contract with DoD in coordination and consultation with an interagency team of subject-matter experts from across the DoD services through the DoD Tri-Services Environmental Risk Assessment Work Group and in collaboration with AFCEC. Several ecological risk assessors and environmental scientists from the EPA Ecological Risk Assessment Forum and program offices, however, provided technical input and advice. This document provides ecological screening levels for eight PFAS compounds (PFBA, PFHxA, PFOA, PFNA, PFDA, PFBS, PFHxS, and PFOS) in surface water/pore water and soil as summarized in **Table 2.3-1**.

As of the submittal date of this ERA Work Plan, bulk sediment screening benchmarks protective of direct exposure are not available for benthic receptors (Ankley et al., 2020; Grippo et al., 2021) and wildlife (Grippo et al., 2021). Thus, pore water will be used to assess risks to the benthic community. Because soil and surface water benchmarks include values protective of wildlife dietary ingestion, bird and mammal food chain models will not be conducted as part of the Tier I SLERA. As of the submittal date of the ERA Work Plan, USEPA has proposed Draft National Recommended Water Quality Criteria for PFOS and PFOA. However, these draft criteria are subject to change and so will be considered only if finalized before the SLERA is conducted and submitted.

The ERA may consider additional future toxicity values available at the time the ERA is written, if technically appropriate and approved by AFCEC. DoD adopts toxicity values for use across all Service Branches.

2.4 SCREENING LEVEL RISK CHARACTERIZATION

The Tier I SLERA will compare EPCs to screening benchmarks protective of terrestrial and aquatic receptors to calculate a Hazard Quotient (HQ) as shown in Equation 1:

$$HQ = \frac{EPC}{Benchmark} \qquad \text{(Equation 1)}$$

An HQ < 1 indicates that the chemical constituent alone is unlikely to cause adverse ecological effects and may thus be eliminated from further review. An HQ ≥ 1 indicates that an analyte will be retained as a preliminary COPEC for further evaluation in the Tier II BERA. As of the submittal date of the ERA Work Plan, it is not the accepted practice to sum HQs of individual PFAS to calculate a Hazard Index (HI); therefore, HIs will not be calculated.

3.0 TIER II BERA – STEP 3 REFINEMENT OF RISK ESTIMATES

Ecological risk assessment is an iterative process that allows for and encourages modification as additional site information becomes available. At this stage of the risk assessment process (Tier II Step 3), ERAGS provides for the use of additional calculations, analyses, and data review to help characterize risk (or lack thereof). Technically, Step 3 Refinement is the first step of the Tier II BERA, but several available desktop tools can be applied immediately after the screening-level risk characterization to introduce additional lines of evidence and further refine risk estimates. The Step 3 Refinement is therefore commonly included as part of the SLERA report. The Tier II BERA Step 3 will identify refinement COPECs. Contingent on results of screening level risk estimates calculated using maximum concentrations, it may be appropriate to perform one or more of the following desktop refinement tools including EPC refinement, benchmark refinement, and bounding of risk estimates as described below. Additionally, other tools may be available in the future at the time the ERA is written. If appropriate, the risk characterization and ecological CSM may be updated pending the outcome of these refinement steps.

3.1 EPC REFINEMENT

The screening-level risk calculation uses the maximum detected concentration of each analyte to calculate an HQ. Maximum detections overestimate concentrations to which a population or community of receptors could be exposed over time and across an exposure area. Comparing average concentrations with benchmarks allows for more realistic estimates of risk to communities or populations of ecological receptors. Typically, the 95th percent of the upper confidence level on the mean (95% UCL) is used to conservatively estimate average, referred to as the central tendency exposure (CTE) EPC. The 95% UCLs would be calculated using the most recent version of ProUCL software, currently version 5.2 (USEPA, 2022). If the ProUCL software algorithms determine that there are not enough data to calculate a 95% UCL, the CTE may be estimated using an arithmetic mean, median, or other measure of central tendency.

3.2 BENCHMARK REFINEMENT

Screening-level risk calculations are made with conservative NOEC-based benchmarks that represent non-hazardous concentrations. In contrast, lowest-observed-effect-concentration (LOEC)-based benchmarks represent concentrations at or above which adverse effects are possible. A LOEC is the lowest concentration where an effect has been observed in chronic ecotoxicity studies. LOECs will be derived from the same DoD sources previously cited that provide NOECs (e.g., Grippo et al., 2021). The methods used to derive LOECs will depend on the body of literature available for each specific PFAS compound and will follow industry standards and best practices. LOECs may also be derived from other sources which may be available in the future, if approved by the DoD and USAF.

3.3 BOUNDING OF RISK ESTIMATES

The screening-level risk characterization calculates an HQ using maximum concentrations and NOEC benchmark. As part of the Tier II BERA Step 3 Refinement step, additional HQs may be calculated using CTE EPCs and LOEC benchmarks. An HQ based on maximum concentrations and NOEC paired with an HQ based on the CTE EPC and LOEC allows a bracketing of risk predictions. The former results in a conservative estimate of risk and the latter are more likely to be associated with actual adverse effects. HQs would be interpreted by considering the magnitude as well as other pertinent toxicological or spatial distribution.

3.4 COMPARISON TO BACKGROUND DRAINAGE

PFAS concentrations associated with releases in surface water and sediment will also be compared to concentrations collected from two background drainage locations. Background concentrations represent ambient conditions absent site-related releases. Generally, risk management actions are not taken to reduce contaminants to concentrations at or below natural or anthropogenic background levels. Two surface water and sediment background locations have been established as part of the Installation's long-term monitoring network, including Prestile Brook and Caribou stream (**Figure 3.1-1**). Both locations were included in the SI (Wood, 2018) and are being resampled as part of the RI. No terrestrial background sample locations have been established.

4.0 UNCERTAINTY ASSESSMENT

The interpretation of risk estimates is subject to a variety of uncertainties that result from the use of assumptions and the lack of information necessary to quantify actual exposure and effects concentrations. The ERA will summarize major uncertainties and assumptions, describe whether uncertainties lead to an over- or under-estimation of risks, and explain steps taken to mitigate those uncertainties. Topics of uncertainty may include exposure concentrations, detection frequencies, data quality (including whether limits or quantitation limits are adequate for evaluating the ecological risks), chemical speciation, the existence of Draft Nationally Recommended Ambient Water Quality Criteria, and underlying biases in the screening benchmarks (e.g., bioavailability, area use factors, diet composition). Uncertainties associated with PFAS currently lacking toxicity information, or potential additive/synergistic/antagonistic effects, will also be qualitatively discussed.

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5.0 ECOLOGICAL RISK ASSESSMENT EXIT CRITERIA

The Tier I SLERA and Tier II BERA Step 3 may conclude:

- There is sufficient information to assess risks to the environment and the data support no further action;
- The data indicate that adverse effects on receptors are possible and there is enough information to support corrective measures; or
- There is insufficient information to assess risks to the environment and additional information is needed to reduce uncertainty.

Selection of the outcome will depend on several factors including but not limited to: the distribution and frequency of detections, the magnitude of NOEC and LOEC HQs, whether or not nature and extent have been sufficiently defined, or how additional lines of evidence such as the use of food chain models that rely on site-specific measurement of PFAS in plant or animal tissue might affect findings and affect management decisions.

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6.0 REFERENCES

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FIGURES

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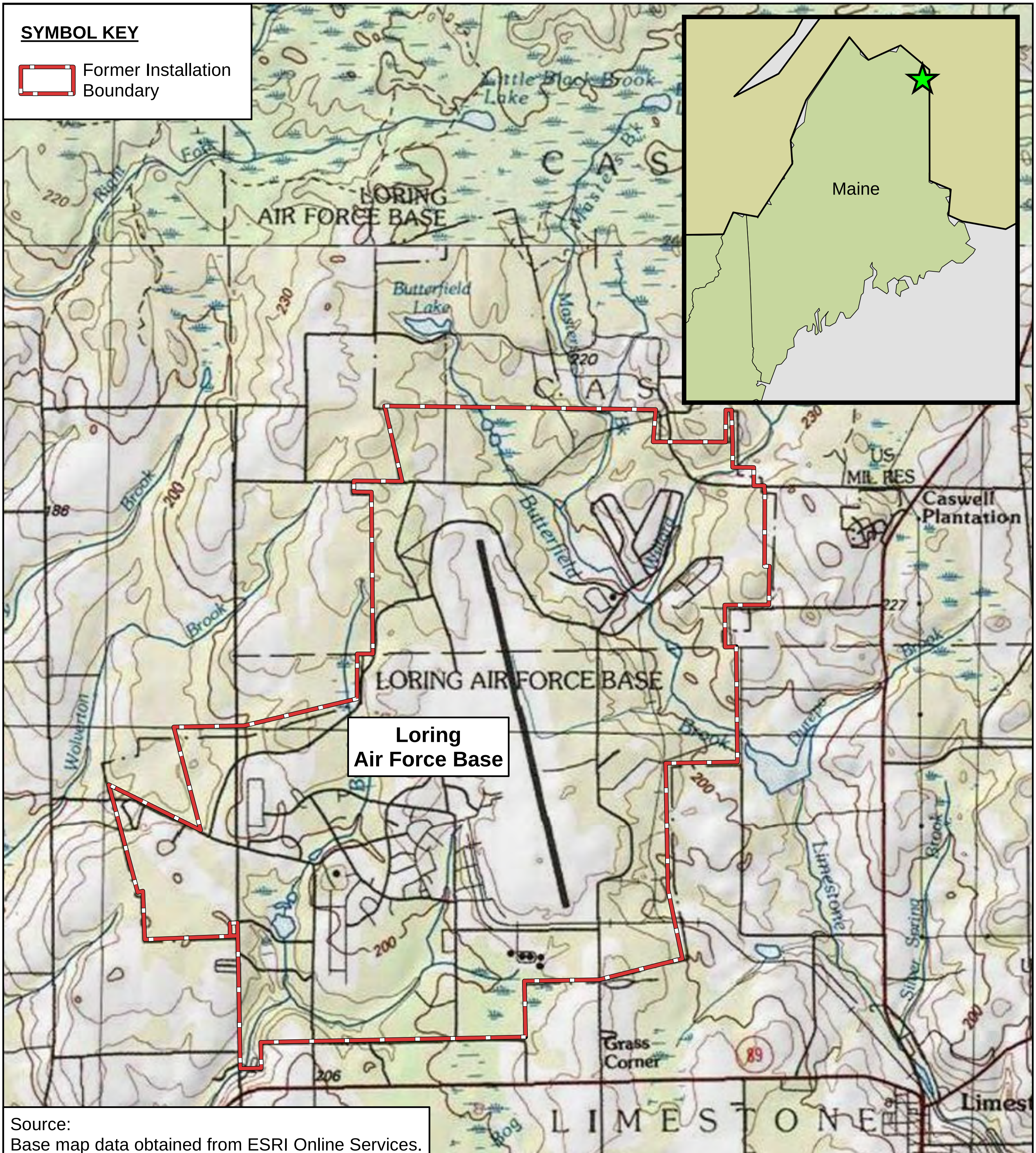

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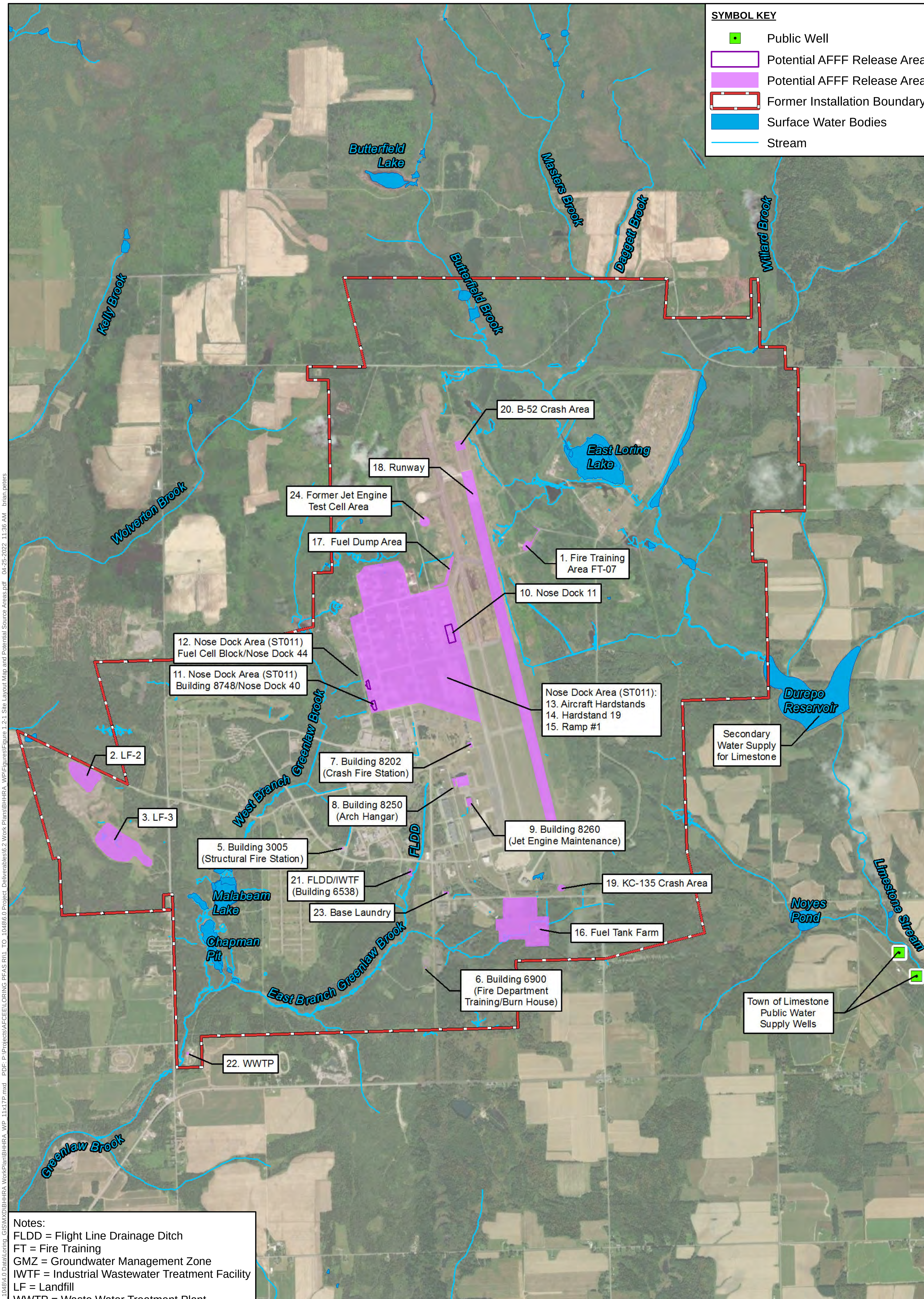
0 1,000 2,000 4,000 6,000 Meters
0 7,000 14,000 21,000 28,000 Feet

Figure 1.0-1
Site Location Map

Ecological Risk Assessment Work Plan
Former Loring Air Force Base, Limestone, ME

04/25/2022	BHHRA_WP_Install_Loc	
PROJ: 775361701	Drawn: BRP	



Notes:
FLDD = Flight Line Drainage Ditch
FT = Fire Training
GMZ = Groundwater Management Zone
IWTF = Industrial Wastewater Treatment Facility
LF = Landfill
WWTP = Waste Water Treatment Plant

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Figure 1.2-1
Site Layout Map and Potential Source Areas

Ecological Risk Assessment Work Plan Work Plan
Former Loring Air Force Base, Limestone, ME

0 400 800 1,600 2,400 3,200 Meters
0 1,400 2,800 5,600 8,400 11,200 Feet

N

NOTES:
-Aerial Imagery obtained through ESRI Online Services

04/25/2022	Rev:	BHHRA_WP_11x17P
Drawn: BRP	Chk:	PROJ: 775361701

SYMBOL KEY

Approximate Parcel Boundaries:

- DFAS Parcel (A)
- Job Corps Parcels (B-1, 2, 3 and B-5, 6, 7)
- MEARNG Parcels (C, C-1)
- BIA Parcels (D, D-1)
- USFWS Parcels (E, E-1)
- LDA Parcels (F, F-1)
- Stream
- Surface Water Bodies
- Former Installation Boundary

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Figure 1.2-2
Parcel Boundaries

Ecological Risk Assessment Work Plan
Former Loring Air Force Base, Limestone, ME

0 150 300 600 900 1,200 Meters
0 600 1,200 2,400 3,600 4,800 Feet

NOTES:
-Aerial Imagery obtained through ESRI Online Services

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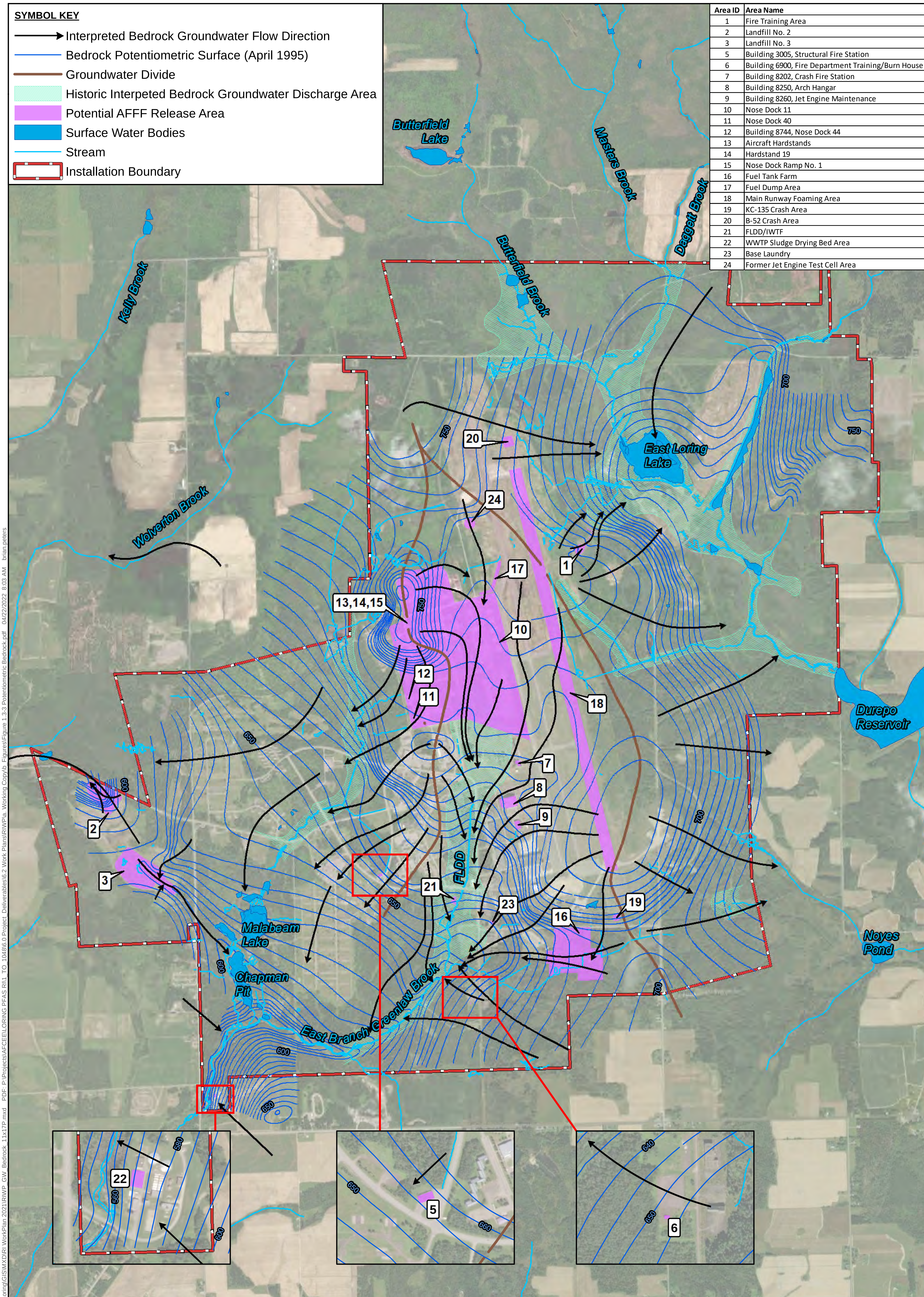

Area ID	Area Name
1	Fire Training Area
2	Landfill No. 2
3	Landfill No. 3
5	Building 3005, Structural Fire Station
6	Building 6900, Fire Department Training/Burn House
7	Building 8202, Crash Fire Station
8	Building 8250, Arch Hangar
9	Building 8260, Jet Engine Maintenance
10	Nose Dock 11
11	Nose Dock 40
12	Building 8744, Nose Dock 44
13	Aircraft Hardstands
14	Hardstand 19
15	Nose Dock Ramp No. 1
16	Fuel Tank Farm
17	Fuel Dump Area
18	Main Runway Foaming Area
19	KC-135 Crash Area
20	B-52 Crash Area
21	FLDD/IWTF
22	WWTP Sludge Drying Bed Area
23	Base Laundry
24	Former Jet Engine Test Cell Area

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Figure 1.2-3
Potentiometric Map of Bedrock

Ecological Risk Assessment Work Plan
Former Loring Air Force Base, Limestone, ME

0 400 800 1,600 2,400 3,200 Meters

0 1,300 2,600 5,200 7,800 10,400 Feet

N

NOTES:

-Aerial Imagery obtained through ESRI Online Services

12/29/2021	Rev:	RIWP_GW_Bedrock_11x17P
Drawn: BRP	Chk:	PROJ: 775361701

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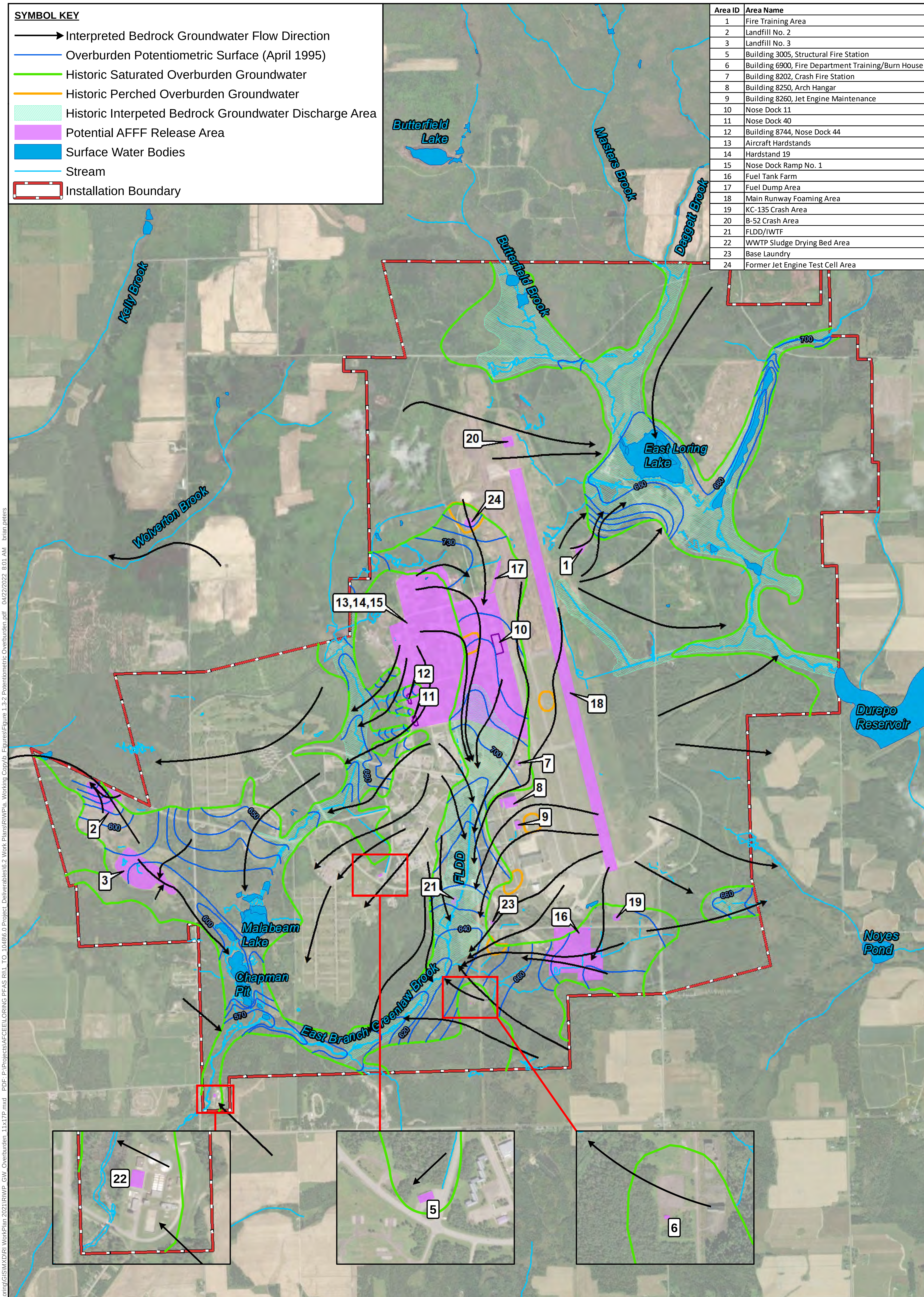

SYMBOL KEY

- Interpreted Bedrock Groundwater Flow Direction
- Overburden Potentiometric Surface (April 1995)
- Historic Saturated Overburden Groundwater
- Historic Perched Overburden Groundwater
- Historic Interpeted Bedrock Groundwater Discharge Area
- Potential AFFF Release Area
- Surface Water Bodies
- Stream
- Installation Boundary

Area ID	Area Name
1	Fire Training Area
2	Landfill No. 2
3	Landfill No. 3
5	Building 3005, Structural Fire Station
6	Building 6900, Fire Department Training/Burn House
7	Building 8202, Crash Fire Station
8	Building 8250, Arch Hangar
9	Building 8260, Jet Engine Maintenance
10	Nose Dock 11
11	Nose Dock 40
12	Building 8744, Nose Dock 44
13	Aircraft Hardstands
14	Hardstand 19
15	Nose Dock Ramp No. 1
16	Fuel Tank Farm
17	Fuel Dump Area
18	Main Runway Foaming Area
19	KC-135 Crash Area
20	B-52 Crash Area
21	FLDD/IWTF
22	WWTP Sludge Drying Bed Area
23	Base Laundry
24	Former Jet Engine Test Cell Area

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Figure 1.2-4
Potentiometric Map of Overburden

Ecological Risk Assessment Work Plan
Former Loring Air Force Base, Limestone, ME

0 400 800 1,600 2,400 3,200 Meters

0 1,300 2,600 5,200 7,800 10,400 Feet

N

NOTES:

-Aerial Imagery obtained through ESRI Online Services

04/22/2022 | Rev: | RIWP_GW_Overburden_11x17P

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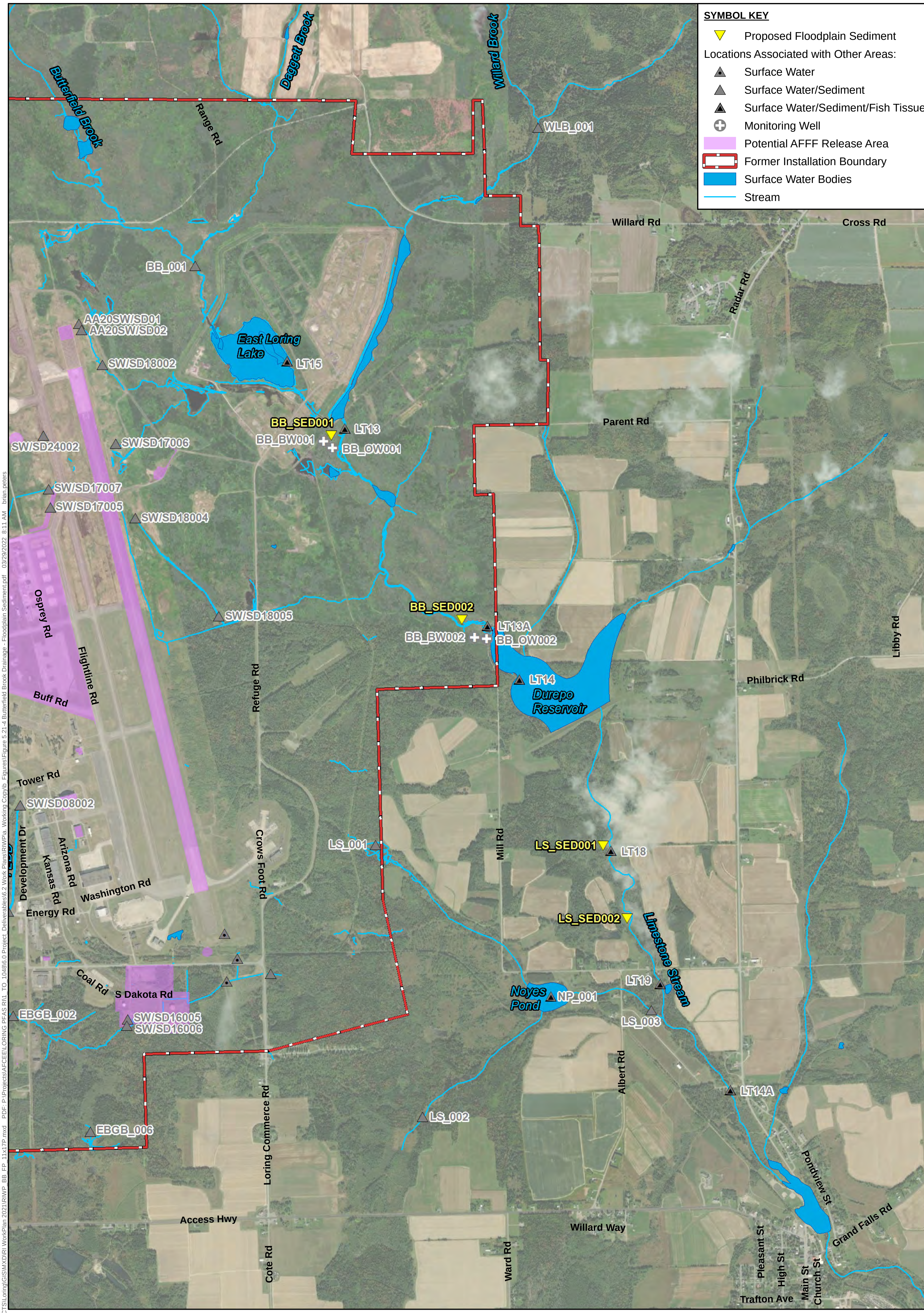

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Figure 1.2-5
Butterfield Brook Drainage - Proposed Floodplain Sediment Sample Locations

Ecological Risk Assessment Work Plan
Former Loring Air Force Base, Limestone, ME

0 250 500 1,000 1,500 2,000 Meters
0 1,000 2,000 4,000 6,000 8,000 Feet

N

NOTES:
-Aerial Imagery obtained through ESRI Online Services

03/29/2022	Rev:	RIWP_BB_FP_11x17P
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SYMBOL KEY

- Proposed Floodplain Sediment
- Locations Associated with Other Areas:
- Surface Water
- Surface Water/Sediment
- Surface Water/Sediment/Fish Tissue
- Existing Well
- Potential AFFF Release Area
- Former Installation Boundary
- Surface Water Bodies
- Stream

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Figure 1.2-6
Greenlaw Brook Drainage – Proposed Floodplain Sediment Sample Locations
Ecological Risk Assessment Work Plan
Former Loring Air Force Base, Limestone, ME

0 125 250 500 750 1,000 Meters
0 500 1,000 2,000 3,000 4,000 Feet

NOTES:
-Aerial Imagery obtained through ESRI Online Services

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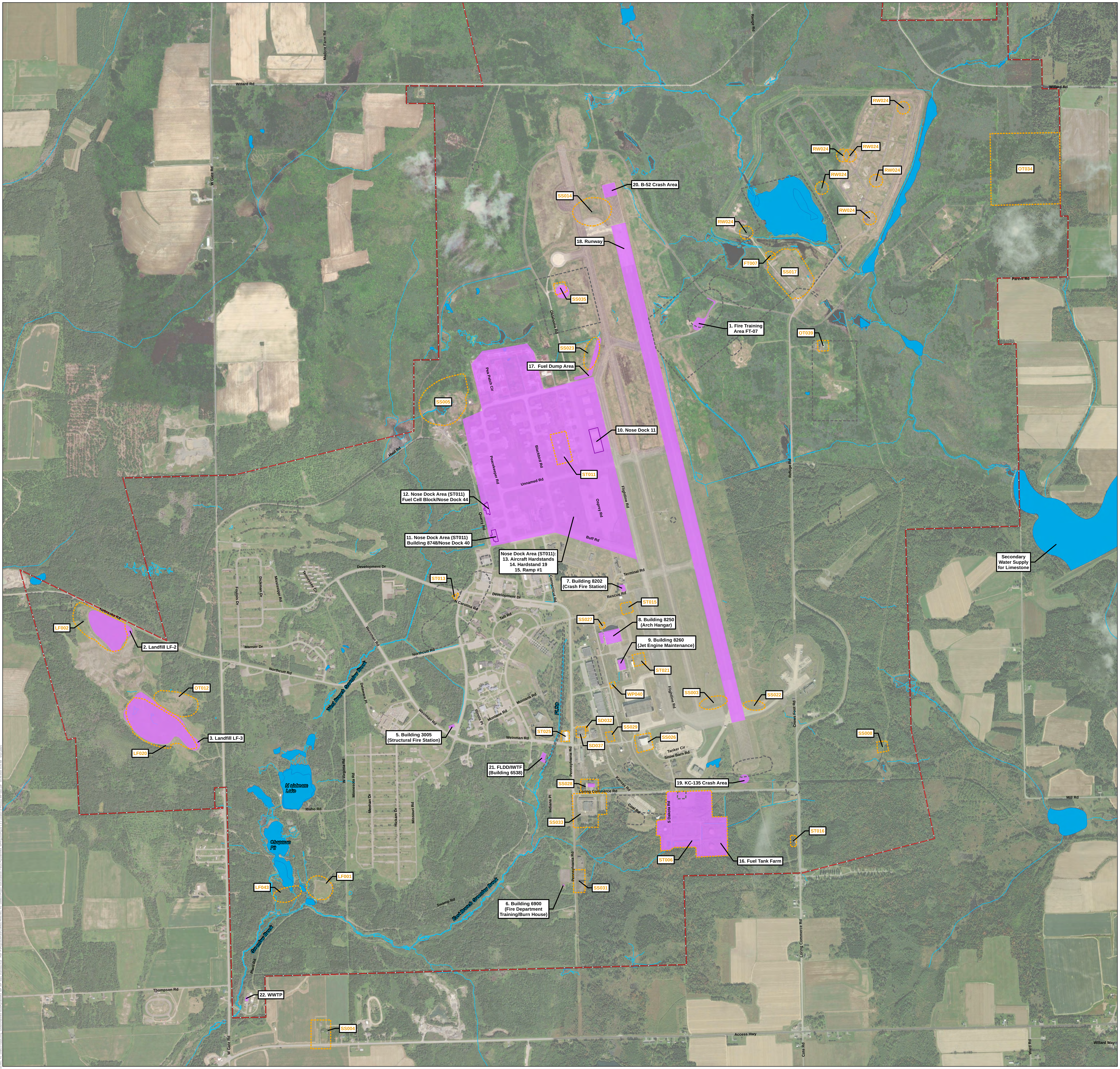

SYMBOL KEY

- IRP Site - Found on Table
- IRP Site - Not Found on Table
- Potential AFFF Release Area
- Potential AFFF Release Area
- Stream
- Surface Water Bodies
- Installation Boundary

Note:
IRP = Air Force Installation Restoration Program

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0 100 200 400 600 800 Meters
0 400 800 1,600 2,400 3,200 Feet

Figure 1.3-1
Location of Previous IRP Sites
Ecological Risk Assessment Work Plan
Former Loring Air Force Base, Limestone, ME

NOTES:
-Aerial Imagery obtained through ESRI Online Services

2022-04-25 | BHHRA_WP_IRP_Sites_Overview
Drawn: BRP | PROJ: 775361701

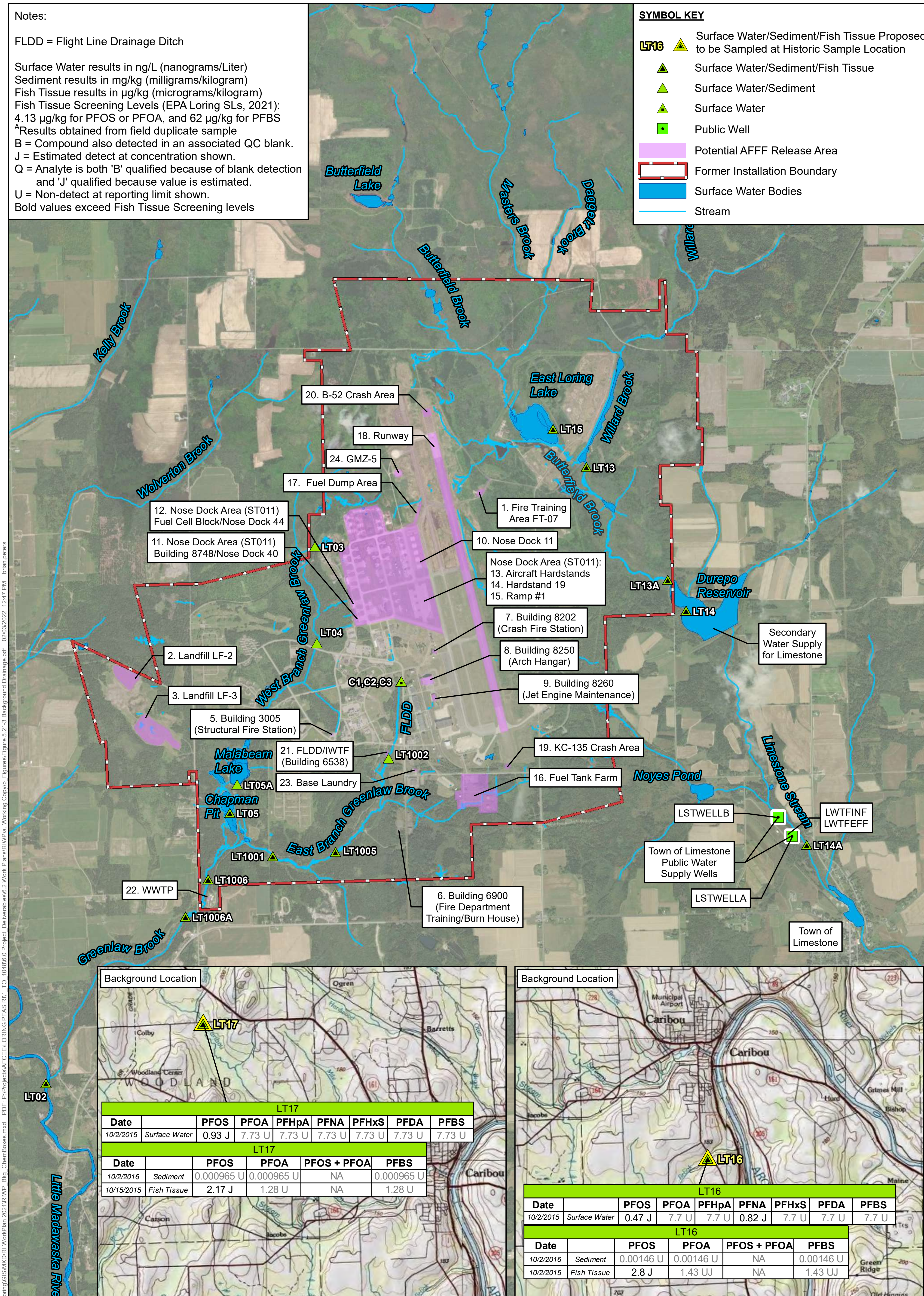
Notes:

FLDD = Flight Line Drainage Ditch

Surface Water results in ng/L (nanograms/Liter)
Sediment results in mg/kg (milligrams/kilogram)
Fish Tissue results in µg/kg (micrograms/kilogram)
Fish Tissue Screening Levels (EPA Loring SLs, 2021):
4.13 µg/kg for PFOS or PFOA, and 62 µg/kg for PFBS
[A]Results obtained from field duplicate sample
B = Compound also detected in an associated QC blank.
J = Estimated detect at concentration shown.
Q = Analyte is both 'B' qualified because of blank detection and 'J' qualified because value is estimated.
U = Non-detect at reporting limit shown.
Bold values exceed Fish Tissue Screening levels

SYMBOL KEY

LT16 Surface Water/Sediment/Fish Tissue Proposed to be Sampled at Historic Sample Location
Surface Water/Sediment/Fish Tissue
Surface Water/Sediment
Surface Water
Public Well
Potential AFFF Release Area
Former Installation Boundary
Surface Water Bodies
Stream



LT17								
Date		PFOS	PFOA	PFHpA	PFNA	PFHxS	PFDA	PFBS
10/2/2015	Surface Water	0.93 J	7.73 U	7.73 U	7.73 U	7.73 U	7.73 U	7.73 U

LT17					
Date		PFOS	PFOA	PFOS + PFOA	PFBS
10/2/2016	Sediment	0.000965 U	0.000965 U	NA	0.000965 U
10/15/2015	Fish Tissue	2.17 J	1.28 U	NA	1.28 U

LT16								
Date		PFOS	PFOA	PFHpA	PFNA	PFHxS	PFDA	PFBS
10/2/2015	Surface Water	0.47 J	7.7 U	7.7 U	0.82 J	7.7 U	7.7 U	7.7 U

LT16					
Date		PFOS	PFOA	PFOS + PFOA	PFBS
10/2/2016	Sediment	0.00146 U	0.00146 U	NA	0.00146 U
10/2/2015	Fish Tissue	2.8 J	1.43 UJ	NA	1.43 UJ

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Figure 3.1-1
Background Drainage – Proposed Sample Locations

Ecological Risk Assessment Work Plan
Former Loring Air Force Base, Limestone, ME

0 500 1,000 2,000 3,000 4,000 Meters
0 1,750 3,500 7,000 10,500 14,000 Feet

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NOTES:
-Aerial Imagery obtained through ESRI Online Services

02/03/2022	Rev:	RIWP_Bkg_ChemBoxes	
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TABLES

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Table 2.1-1
SLERA Assessment & Measurement Endpoints

Ecological Risk Assessment Work Plan
Former Loring Air Force Base
Limestone, Maine

Assessment Endpoint	Measurement Endpoint
Terrestrial Exposure Areas	
1. Protection and maintenance of populations of terrestrial plants typical to the area.	a. Compare chemical concentrations measured in soil to screening benchmarks protective of terrestrial plants.
2. Protection and maintenance of the soil invertebrate community.	a. Compare chemical concentrations measured in soil to screening benchmarks protective of soil invertebrates.
3. Protection and maintenance of populations of herbivorous, invertivorous, and carnivorous birds typical to the area.	a. Compare chemical concentrations measured in soil to screening benchmarks protective of dietary and incidental soil ingestion.
4. Protection and maintenance of populations of herbivorous, invertivorous, and carnivorous mammals typical to the area.	a. Compare chemical concentrations measured in soil to screening benchmarks protective of dietary and incidental soil ingestion.
Aquatic Exposure Areas	
5. Protection and maintenance of the water column aquatic community (plants, invertebrates, fish) typical to the area.	a. Compare chemical concentrations measured in surface water to screening benchmarks protective of aquatic life. b. If groundwater exposure pathway is found to be complete, compare chemical concentrations measured in groundwater to screening benchmarks protective of aquatic life.
6. Protection and maintenance of the benthic community typical to the area.	a. Compare chemical concentrations measured in sediment pore water to screening benchmarks protective of aquatic life.
7. Protection and maintenance of populations of herbivorous, piscivorous, invertivorous, and omnivorous birds typical to the area.	a. Compare chemical concentrations measured in surface water to screening benchmarks protective of dietary and incidental surface water ingestion.
8. Protection and maintenance of populations of herbivorous, invertivorous, piscivorous, and omnivorous mammals typical to the area.	a. Compare chemical concentrations measured in surface water to screening benchmarks protective of dietary and incidental surface water ingestion.

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Table 2.3-1
No Observed Effect Concentration Screening Benchmarks

Ecological Risk Assessment Work Plan
Former Loring Air Force Base
Limestone, Maine

Analyte (mg/kg)	Soil Benchmarks by Receptor				Surface Water/Pore Water Benchmarks by Receptor		
					Freshwater		
	Terrestrial Plants (mg/kg)	Soil Invertebrates (mg/kg)	Terrestrial Birds (mg/kg)	Terrestrial Mammals (mg/kg)	Aquatic Life (µg/L)	Aquatic-dependent Birds (µg/L)	Aquatic-dependent Mammals (µg/L)
PFBA	-	-	-	2.98	64.6	-	8,370
PFHxA	-	-	-	6.20	28.8	-	2,210
PFOA	79.5	22.4	-	3.84	307	-	1,580
PFNA	-	10	-	0.0242	16.4	-	2.08
PFDA	-	-	-	0.0677	2.94	-	0.66
PFBS	-	100	15.8	0.817	400	88,600	5,710
PFHxS	-	10	-	0.0028	65.3	-	5.50
PFOS	40.2	48.1	0.0386	0.0087	22.6	2.57	0.117

Notes:
Source: Grippa et al. (2021) Table ES-3
µg/L = micrograms per Liter
mg/kg = milligrams per kilogram
PFBA = Perfluorobutanoic acid
PFHxA = Perfluorohexanoic acid
PFOA = Perfluorooctanoic acid
PFNA = Perfluorononanoic acid
PFDA = Perfluorodecanoic acid
PFBS = Perfluorobutanesulfonic acid
PFHxS = Perfluorohexanesulfonic acid
PFOS = Perfluorooctanesulfonic acid