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RCRA Facility Investigation/Remedial Investigation Work Plan for the D-Area Groundwater Operable Unit (D-Area Upgradient Sources) (U)

SEMS Number: 63

SRNS-RP-2019-00394

Revision 1

April 2022

SAVANNAH RIVER SITE • AIKEN, SOUTH CAROLINA

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U.S. Department of Energy
and
Savannah River Site Nuclear Solutions, LLC
Aiken, South Carolina

CERTIFICATION

RCRA Facility Investigation / Remedial Investigation Work Plan for the D-Area Groundwater Operable Unit (D-Area Upgradient Sources) (U), SEMS Number: 63

SRNS-RP-2019-00394, Revision 1, April 2022

[REF: 40CFR270.11 (d)(1)]

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as the Co-Operator with the U. S. Department of Energy
Savannah River Operations Office

9/07/22
Date Signed

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EXECUTIVE SUMMARY

This Resource Conservation and Recovery Act Facility Investigation/Remedial Investigation Report Work Plan has been prepared for the D-Area Groundwater Operable Unit, located in D Area at the Savannah River Site in Aiken, South Carolina (Figure ES-1). The groundwater in D Area has been contaminated with tritium, volatile organic compounds, metals, and per-and polyfluoroalkyl substances, also known as PFAS, from previous operations in D Area. The purpose of this document is to present an evaluation of existing unit-source and background data, describe the regulatory framework for the unit investigation, present the evaluations and decision process for further characterization of the groundwater, and describe the scope and objectives of the planned remedial investigation. A unit-specific Sampling and Analysis plan that presents the Data Quality Objectives is included in the Work Plan.

In March 2002, the United States Department of Energy, United States Environmental Protection Agency, and South Carolina Department of Health and Environmental Control created the D-Area Groundwater Operable Unit to monitor groundwater quality until the operational facilities in D Area become inactive, and a final remedial decision is reached. Groundwater in D Area has been monitored since 2004 per the *Monitoring Work Plan for the DAG OU* (WSRC 2004a), and groundwater monitoring reports or data summary letters have been submitted annually to document the monitoring results.

D Area is comprised of the multiple waste units and facilities associated with the former operation of the 484-D Powerhouse and the production and rework of a heavy water moderator for reactor operations (Figure ES-2). The groundwater in D Area has been contaminated from the following surface or facility sources associated with the D-Area Operable Unit and the D-Area Expanded Operable Unit.

- 488-D Ash Basin, D-Area Coal Pile Runoff Basin (489-D), D-Area Rubble Pit (431-2D) (DRP);
- Former D-Area Coal Storage Area (484-17D);
- D-Area Heavy Water Facility (411-D, 412-1D, and 413-D);
- D-Area Heavy Water Rework Facility, also known as the 420-D Concentrator Building;

- Moderator Recovery Facility, also known as the 420-2D Rework Handling Facility;
- 421-2D Moderator Handling and Storage Building;
- Fire Training Area (411-1D/411-3D); and
- Gasoline Station (715-D).

Most of the sources of groundwater contamination associated with the D-Area Expanded Operable Unit and the D-Area Operable Unit have been addressed under remedial and/or removal actions. The remedy selected in the D-Area Expanded Operable Unit Record of Decision (WSRC 2004b) for the 488-D Ash Basin was containment and included the area outside of the basin and along its northern perimeter berm where coal rejects had sloughed from the basin into the D-003 outfall drainage ditch, causing acidification of stormwater runoff in the drainage. The selected remedy for the D-Area Rubble Pit (431-2D) was excavation of waste materials and solids containing coal rejects and consolidation into the 488-D Ash Basin, and removal of a polychlorinated biphenyl hot spot. Groundwater monitoring for metals and pH continues downgradient of the 488-D Ash Basin.

The D-Area Operable Unit consists of the following three main facility areas: the D-Area Heavy Water Facility (Bubble Tower Subunit), the Moderator Processing Facility (Moderator Processing Subunit), and the 484-D Powerhouse (Powerhouse Subunit) in addition to miscellaneous units. Activities within the Bubble Tower Subunit resulted in a previous impact to groundwater from volatile organic carbons. Tritium was a contaminant of concern from previous activities within the Moderator Processing Subunit. Previous coal related operations in the Powerhouse subunit have resulted in metal contamination to groundwater associated with the infiltration of low pH water. The potential for PFAS contamination from the Gasoline Station (715-D) and the Fire Training Area (411-1D/411-3D) also exists.

In 2011, a D-Area Operable Unit Early Action Record of Decision integrated the results of completed removal actions and selected land use controls to prevent unrestricted use as the final action for the Bubble Tower Subunit, Moderator Processing Subunit, northern 25% section of the D-Area Coal Pile Runoff Basin (489-D), D-Area Asbestos Pit, D-Area Process Sewer Lines as Abandoned [inside the facility area fence]), electrical transformers, and miscellaneous buildings.

A non-time critical removal action was completed in 2016 to place excavated ash from the 488-2D Ash Basin into the 488-4D Ash Landfill and apply Class 3 landfill cover over the entire landfill and infiltration basin. Groundwater monitoring for metals is part of the Class Three Landfill requirements. A time critical removal action was submitted in 2014 for the 488-2D Ash Basin to dewater the basin and remove bulk ash. The basin was re-graded, sloped appropriately, and is currently a storm water detention structure. Although not a source of groundwater contamination, the structure is within the footprint of D Area groundwater monitoring for VOCs, tritium, and metals. Ash in the 488-1D Ash Basin was consolidated into the eastern portion of the basin, and a geosynthetic cover and vegetative layer was installed over the ash consolidated area while the western portion of the basin was covered with soil and graded to direct rainfall to the existing ditch at the southwest corner of the basin. The southern 75% section of the D-Area Coal Pile Runoff Basin (489-D) was addressed under a non-time critical removal action in 2017 to remove coal fines and contaminated sediments from the basin. The southern 75% section of the D-Area Coal Pile Runoff Basin (489-D) remains open as a storm water retention structure. In 2020, a second Early Action Record of Decision was issued to incorporate the completed removal actions and select land use controls as the final remedial action for the 488-1D Ash Basin, 488-2D Ash Basin, and 488-4D Ash Landfill. No Action was selected as the final remedial action for the remaining 75% of the D-Area Coal Pile Runoff Basin (489-D) and the Inlet Basins associated with the 488-1D Ash Basin.

In addition to previous removal and remedial actions in D Area, two additional activities to address groundwater contamination were recently initiated. A removal action for the D-Area Coal Storage Area (484-17D) was completed in November 2020. Although a maintenance action in 2012 and 2013 removed essentially all the visible coal from the D-Area Coal Storage Area (484-17D), the long-term coal storage caused the underlying vadose zone soil and groundwater to become acidified (i.e., low pH). Groundwater in D Area has been shown to be contaminated with various metals, and many of the metal plumes coincide with the low-pH area and/or nearby source areas including the D-Area Coal Storage Area (484-17D) and the D-Area Coal Pile Runoff Basin (489-D). The preferred removal action was the addition of soil neutralization amendments

(lime/calcium carbonate) to reduce the acidity in the upper portion of the vadose zone and subsequently reduce the amount of acidic leachate to groundwater.

The presence of a low-pH plume in the groundwater is expected to last for decades under natural groundwater conditions. The low-pH groundwater is currently discharging into the D-Area Effluent Discharge Canal which later converges with Beaver Dam Creek and flows through the Savannah River floodplain to the Savannah River. A treatability study is ongoing to inject potable water into the Upper Three Runs Aquifer upgradient of the low-pH, metals plume to displace the low-pH groundwater and raise the pH in the aquifer to more normal, less acidic conditions. The treatability study design includes the installation of two calcium carbonate (CaCO3) reactive structures in the D-Area Effluent Discharge Canal designed to raise the pH of the surface water to a more neutral condition. Monitoring of water table elevations and pH measurements in surrounding monitoring wells and streams, as well as metal analyses of groundwater and surface water, will be used to determine the impact of the groundwater injections.

Conclusions and Objectives

Groundwater sampling in D Area has identified multiple contaminant plumes with multiple sources (Figure ES-3). The volatile organic carbon plume, primarily trichloroethylene, is approximately 366 acres and extends from the Bubble Tower Subunit southwest across the D-Area Coal Storage Area (484-17D), 488-D Ash Landfill and portions of the D-Area Ash Basins, and westward into the D Area wetlands. The low pH and metals plume extends to the southwest from the D-Area Rubble Pile (431-2D), D-Area Coal Storage Area (484-17D), and D-Area Coal Pile Runoff Basin (489-D). The tritium plume is approximately 132 acres and extends from the Moderator Processing Facility to the southwest towards the 488-D Ash Basin and 488-D Ash Landfill and to the west into the D Area wetlands. In addition, a PFAS plume was identified during a recent investigation brought on by the emerging concerns about PFAS in the environment. The PFAS plume in D Area was first identified in 2020 by sampling existing monitoring wells in the immediate vicinity of known PFAS release sites – specifically the Fire Training Area (411-1D/411-3D) and the 715-D Gasoline Station and will be defined through further investigation.

A significant amount of data already exists for the D-Area Groundwater Operable Unit from historical information, Site Evaluations, previous remedial and interim actions and pre-Work Plan characterization and monitoring activities that have been ongoing since 2004. Because the additional data needed to fully characterize the extent of contamination is not extensive, the Sampling and Analysis Plan to support additional data collection for the D-Area Groundwater Operable Unit is included in this Work Plan.

The D-Area Groundwater Operable Unit investigation will be based on collecting and evaluating historical and real-time analytical data. The four plume areas identified at the D-Area Groundwater Operable Unit have varying needs for additional characterization. Since the groundwater sampling was initiated in 2004, the volatile organic plume has been well characterized for concentration and trend data for the Upper Three Runs Aquifer. However, the horizontal extent of the plume as well as the depth of the plume are not well defined, and there is the potential that contamination has reached the Gordon Aquifer and is expanding vertically. These parameters will be addressed by increasing the number of available wells to sample as well as by installing additional wells into the Gordon Aquifer. The VOC plume is also a candidate for a Monitored Natural Attenuation remedial decision, so pertinent Monitored Natural Attenuation parameters will be incorporated into the sampling plan. Surface water will be initially screened for volatile organic carbons as well.

The pH and metals plume has been well defined in past sampling events and the major sources [i.e., D-Area Coal Pile Runoff Basin (489-D) and D-Area Coal Storage Area (484-17D)] of acidic conditions have been addressed through response actions. The sampling design for this plume will focus on horizontal and vertical geometry of the affected groundwater, as well as trends in concentrations. Additionally, since there is a high likelihood of metals seeping into streams, surface water will be analyzed for metals and compared to their respective maximum contaminant levels or regional screening levels as appropriate.

The tritium source material has been removed and is no longer contributing to the groundwater plume in D Area. Because of this and its relatively short decay half-life (12.3 years), the plume is expected to shrink and degrade with time over the duration of the next several years. Plume

sample design will focus on the trends of the tritium and the geometry of the plume to monitor and support decisions on remedial design, if needed.

As with the other D-Area Groundwater Operable Unit plumes, the concern for PFAS is to establish the vertical and horizontal extent of the plume through the sampling of existing and recently installed groundwater monitoring wells as well as future monitoring wells in the Upper Three Runs Aquifer and Gordon Aquifer. In addition, sediment and surface water sampling will be conducted at collocated points in streams to correlate the possibility of PFAS seeping into stream beds and binding to the sediment in those streams. This strategy will help establish the potential human and environmental risks associated with PFAS from surface water and/or groundwater movement.

Data will be compiled from existing and new monitoring wells and surface water sampling points over the next several years. This strategy of data collection and analysis will increase the understanding of the hydrology and any measurable effects of the actions in the area. This strategy is specifically to assist in the assessment process for the D-Area Groundwater Operable Unit Resource Conservation and Recovery Act Facility Investigation/Remedial Investigation Report/Baseline Risk Assessment (currently scheduled for December 2024) and the development of the Corrective Measures Study/Feasibility Study (currently scheduled for March 2026). A modeling task will be implemented to develop a flow model that will assist in assessing the feasibility and effectiveness of early, interim, or final actions.

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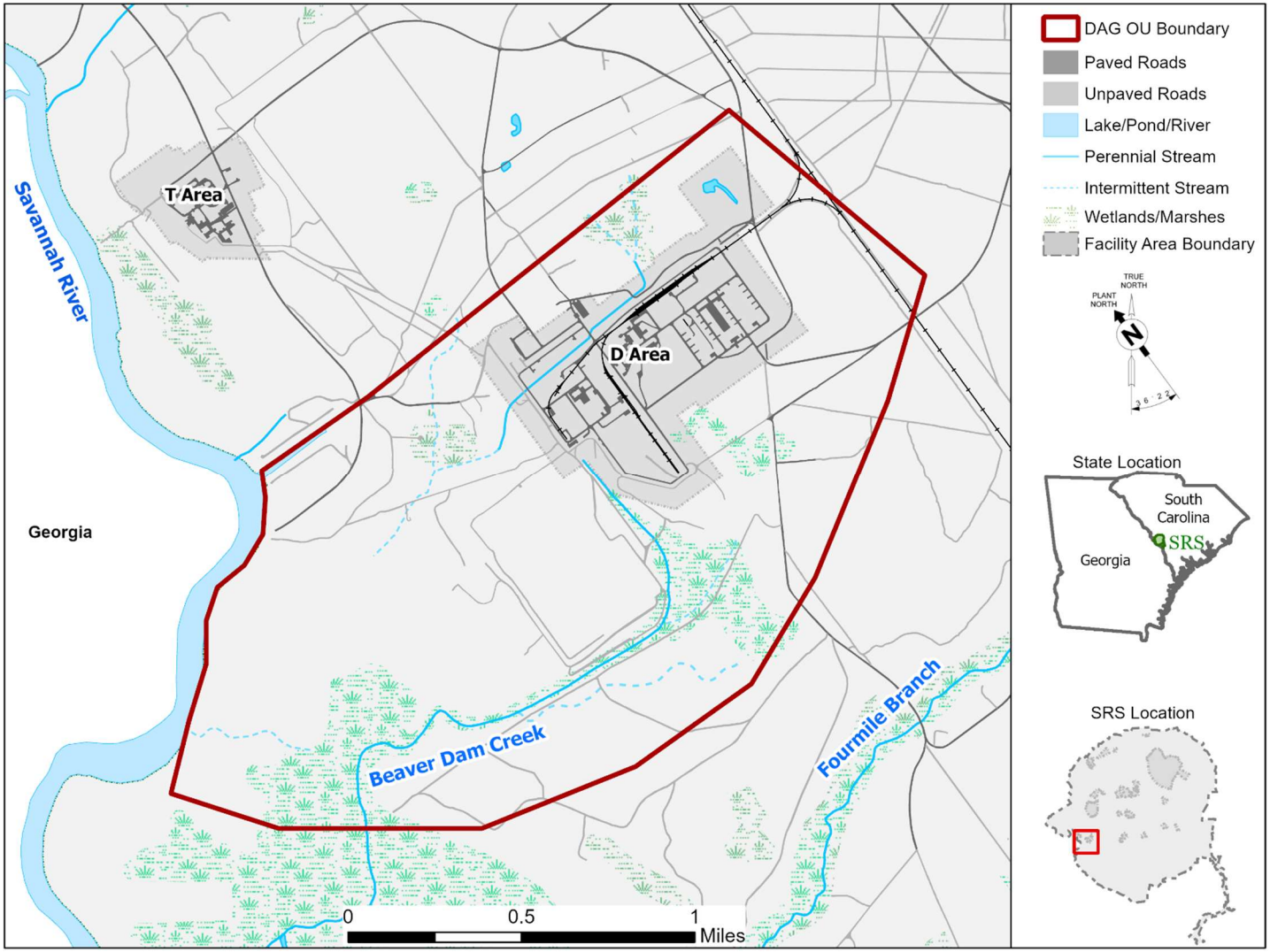

Figure ES-1. Location of D Area at the Savannah River Site

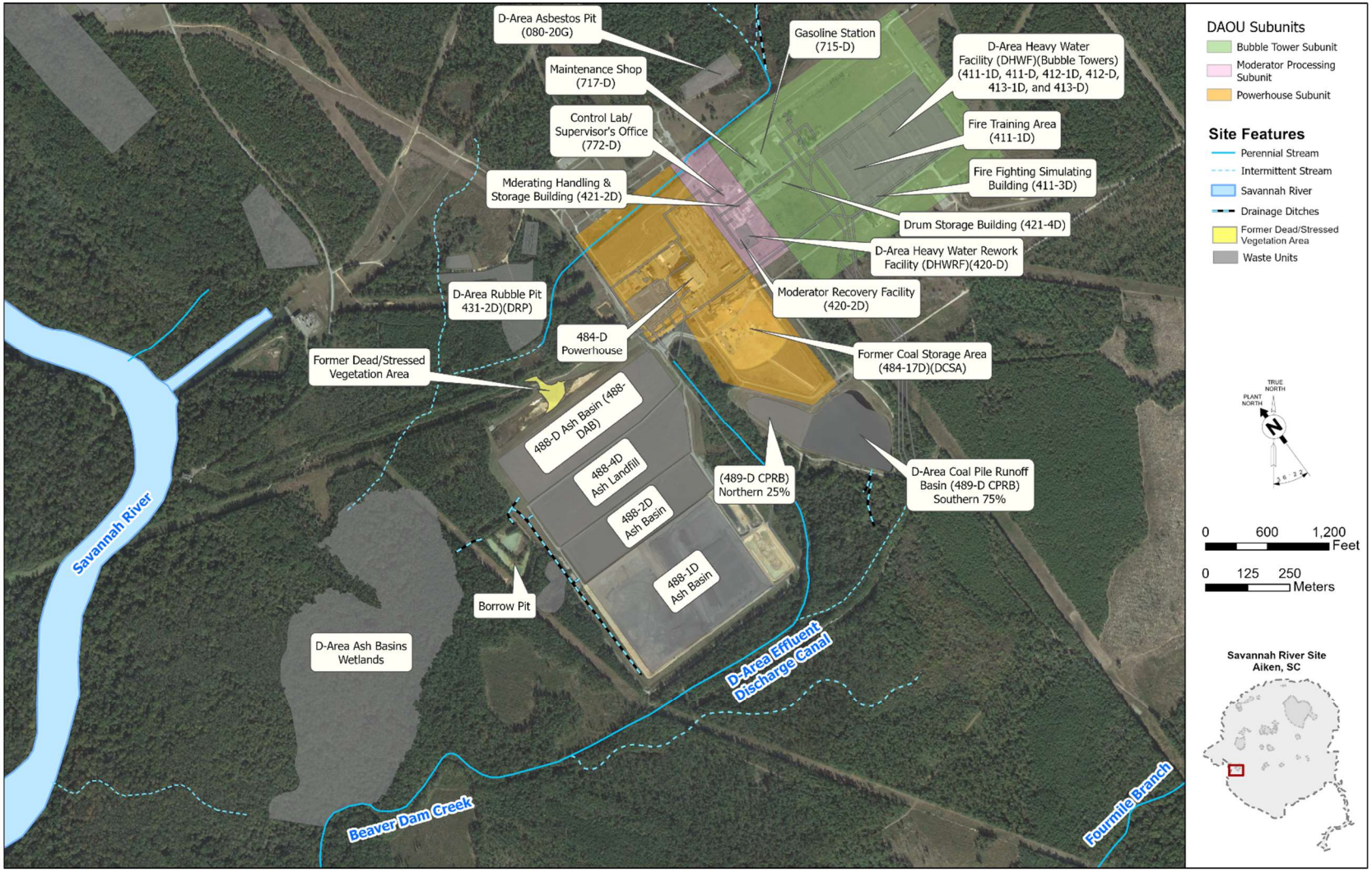

Figure ES-2. D-Area Operable Unit Subunits and Facilities

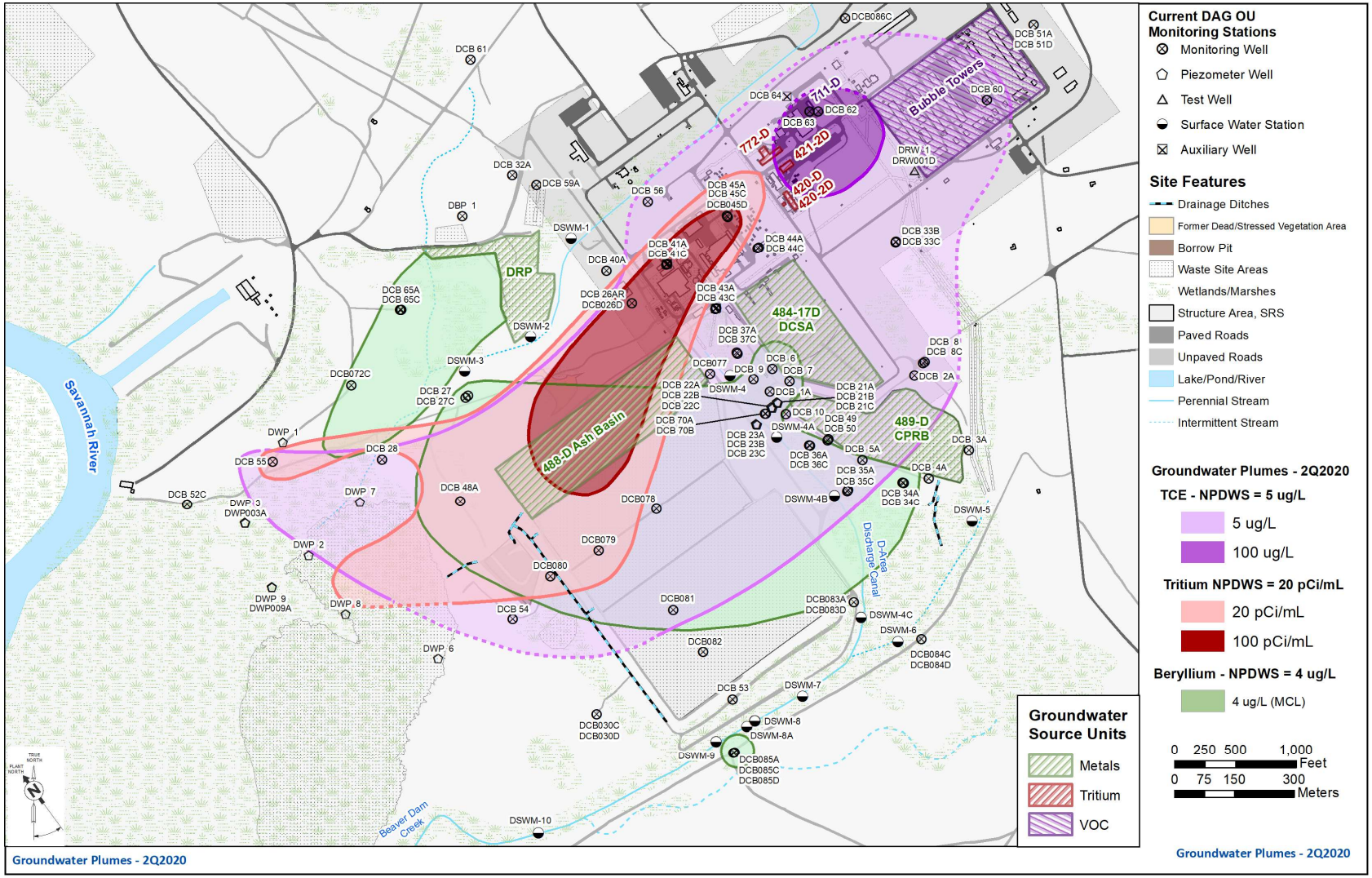

Figure ES-3. Groundwater Plumes – 2Q2020

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LIST OF ABBREVIATIONS AND ACRONYMNS

~	approximate, approximately
>	greater than
<	less than
ac	acre
AFFF	aqueous film-forming foam
ARF	Administrative Record File
ARAR	applicable or relevant and appropriate requirement
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cm	centimeter
CM	contaminant migration
CMS	Corrective Measures Study
CPRB	Coal Pile Runoff Basin
CSM	conceptual site model
D&D	deactivation and decommissioning
DAB	488-D Ash Basin
DAG	D-Area Groundwater
DAOU	D-Area Operable Unit
DEXOU	D-Area Expanded Operable Unit
DHWF	D-Area Heavy Water Facility
DHWRF	D-Area Heavy Water Rework Facility
DPSL	D-Area Process Sewer Lines
DQO	Data Quality Objective
DRP	D-Area Rubble Pit
EAROD	Early Action Record of Decision
EE/CA	Engineering Evaluation/Cost Analysis
ft	feet
FS	Feasibility Study
FFA	Federal Facility Agreement
GA	Gordon Aquifer
gal	gallon
GCU	Gordon Confining Unit
ha	hectare
HSWA	Hazardous and Solid Waste Amendments
in.	inch
IOU	Integrator Operable Unit
km^2	square kilometers
L	liter
LLC	Limited Liability Company
LUC	Land Use Controls
LUCIP	Land Use Control Implementation Plan
µg/L	microgram per liter

LIST OF ABBREVIATIONS AND ACRONYMS *(Continued/End)*

m	meter
MCL	maximum contaminant levels
mi	mile
mi^2	square mile
mg/kg	milligram per kilogram
MNA	Monitored Natural Attenuation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTCR	non-time critical removal
OU	Operable Unit
PCE	tetrachloroethylene
pCi/g	picocuries per gram
pCi/mL	picocuries per milliliter
PFAS	polyfluoroalkyl substances
QA/QC	Quality Assurance/Quality Control
RAO	remedial action objective
RCOC	refined constituent of concern
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Levels
RSER	Removal Site Evaluation Report
SAP	Sample Analysis Plan
SCDHEC	South Carolina Department of Health and Environmental Control
SR	Savannah River Floodplain Swamp
SRNS	Savannah River Site Nuclear Solutions, LLC
SRFS	Savannah River
SRS	Savannah River Site
TBC	to be considered
TCCZ	Tan Clay Confining Zone
TCE	trichloroethylene
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
UST	underground storage tank
UTRA	Upper Three Runs Aquifer
VOC	volatile organic compound
WOF	Waste Oil Facility
WP	Work Plan
WSRC	Washington Savannah River Company, LLC

1.0 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Facility Investigation / Remedial Investigation (RFI/RI) Work Plan (WP) has been prepared for the D-Area Groundwater (DAG) Operable Unit (OU) at the Savannah River Site (SRS). This unit is subject to the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The purpose of this work plan is to present an evaluation of existing unit-source and background data, the regulatory framework for the unit investigation, the evaluations and decision made during the scoping process, and the scope and objectives of the planned RI activities.

Groundwater in D Area has been monitored since 2004 per the *Monitoring Work Plan for the DAG OU* (WSRC 2004a). Groundwater monitoring reports or data summary letters have been submitted annually to the South Carolina Department of Health and Environmental Control (SCDHEC) and U.S. Environmental Protection Agency (USEPA) documenting the monitoring results. Monitoring well data collected for DAG OU indicate that the groundwater is contaminated with tritium, volatile organic compounds (VOCs) (primarily trichloroethylene [TCE]), metals, and per-and polyfluoroalkyl substances (PFAS). This WP presents a characterization investigation designed to determine the nature, vertical and horizontal extent of all groundwater plumes within the DAG OU. The Sampling and Analysis Plan (SAP) to support additional data collection to augment existing information is included in this RFI/RI WP.

1.1 RI Work Plan Organization

This RFI/RI WP is organized into eleven sections. Section 1, Introduction, outlines the regulatory framework, provides a description and history of D Area, and describes a strategy for characterization activities and remediation of any contaminated media. Section 2, Preliminary Unit Evaluation, is a description of the specific regional and environmental settings in which the DAG OU is located, including physiography, climate, geology, ecology, and pedology. Section 2 also summarizes previous investigations, the

unit evaluation conclusions, and potential applicable or relevant and appropriate requirements (ARARs) and "to be considered" (TBC) criteria. Section 3, Data Quality Objectives (DQOs), describes the DQOs, identifies possible receptors, and presents the conceptual site model (CSM). Section 4, Unit Assessment, outlines the proposed environmental sampling at the DAG OU and path forward for this unit. The SAP for additional data collection is incorporated into Sections 5.0 through 7.0 of this RFI/RI WP rather than submitted as a separate SAP report. Section 5.0 describes the design and rational of the unit characterization work proposed for fiscal year 2022. Section 6.0 provides the analytical plan and data quality levels for each type of data collected. Section 7.0 describes the field collection procedures and data management for the planned samples.

The project health and safety plan is addressed in Section 8, Safety, Health, and Emergency Response Plan. Section 9.0 presents the Quality Assurance/Quality Control (QA/QC) Plan. Section 10 includes the proposed schedule for key deliverables and submittal dates. Section 11, References, is a list of references used to prepare this document.

1.2 Regulatory Background

1.2.1 RCRA Facility Investigation Program

The U.S. Department of Energy Savannah River Operations Office (USDOE-SR) manages waste materials that are regulated under RCRA, a comprehensive law that requires the stringent management of hazardous waste. In 1984, the original RCRA requirements were augmented by the Hazardous and Solid Waste Amendments (HSWA).

Certain activities require operation or post-closure permits issued in accordance with RCRA and HSWA. SRS has received a RCRA permit from the SCDHEC. The permit mandates that SRS establish and implement an RFI program to fulfill the requirements of RCRA Section 3004(u). Solid Waste Management Units were identified by the USEPA Region IV through the RCRA Facility Assessment process and are therefore subject to the RFI process.

1.2.2 CERCLA Remedial Investigation Program

On December 21, 1989, SRS was included on the National Priorities List (NPL). A facility included on the NPL is subject to the provisions of CERCLA. In accordance with Section 120 of CERCLA, the USDOE negotiated a Federal Facility Agreement (FFA) (FFA 1993) with the USEPA and SCDHEC to coordinate cleanup activities at SRS as one comprehensive strategy. Public participation requirements are listed in Section 113 and 117 of CERCLA. These requirements include the establishment of an Administrative Record File (ARF) that documents the selection of cleanup alternatives and provides for review and comment by the public on those alternatives. The SRS Public Involvement Plan (USDOE 1994a) is designed to facilitate public participation in the decision-making processes for permitting, closure, and the selection of remedial alternatives. It addresses the requirements of CERCLA, RCRA, and the National Environmental Policy Act.

Unit-specific work plans such as this one will be part of the ARF and will be available to the public. Information repositories have been established at USDOE's Public Reading Room located at the University of South Carolina – Aiken campus in Aiken, South Carolina. A notice will be published in local newspapers when information is being compiled regarding the investigation and cleanup of DAG OU. Additional repositories may be added and/or locations changed to better meet the needs of the public.

1.2.3 Summary of Unit Description

SRS is located principally in Aiken and Barnwell counties near the city of Aiken, South Carolina. D Area is located on an alluvial terrace in the southwest quadrant of the SRS approximately (~)915-m (3,050-ft) east of the Savannah River (Figure 1) at an elevation ~37.5-m (125-ft) above mean sea level. Local topography is relatively flat with a general slope from the northeast to the southwest.

The groundwater in D Area has been contaminated with tritium, VOCs (primarily (TCE), metals, and PFAS from surface or facility sources associated with the D-Area Operable Unit (DAOU) and the D-Area Expanded Operable Unit (DEXOU). The DAOU is

comprised of multiple waste units and facilities associated with the former operation of the 484-D Powerhouse and the production and rework of heavy water moderator for reactor operations. Most of the sources of groundwater contamination associated with the DAOU have been addressed under remedial and/or removal actions. The final action Record of Decision (ROD) issuance date for completion of the DAOU is scheduled in the FFA for January 2046 based on remedial decisions for the remaining DAOU subunits and completion of deactivation and decommissioning (D&D) of facilities in D Area.

In March 2002, the USEPA SCDHEC, and USDOE created the DAG OU to monitor groundwater quality until the operational facilities in D Area become inactive and a final remedial decision is reached for the DAG OU. Groundwater in D Area has been monitored since 2004 per the *Monitoring Work Plan for the DAG OU* (WSRC 2004a). Groundwater monitoring reports or data summary letters have been submitted annually to SCDHEC and USEPA to document the monitoring results. Monitoring well data collected for DAG OU indicate that the groundwater is contaminated with tritium, TCE, metals, and PFAS.

The DAG OU consists of the groundwater impacted by previous operations from the following:

- 488-D Ash Basin (488-DAB), D-Area Coal Pile Runoff Basin (489-D) (CPRB), D-Area Rubble Pit (431-2D) (DRP);
- Former Coal Storage Area (484-17D) (DCSA);
- D-Area Heavy Water Facility (411-1D, 411-D, 412-1D, 412-D, 413-1D. and 413-D) (DHWF);
- D-Area Heavy Water Rework Facility (DHWRF), also known as the 420-D Concentrator Building;
- Moderator Recovery Facility, also known as the 420-2D Rework Handling Facility;
- 421-2D Moderator Handling and Storage Building;
- Control Lab/Supervisor's Office (772-D)
- Fire Training Area (411-1D/411-3D); and
- Gasoline Station (715-D).

1.2.4 D-Area Expanded Operable Unit (DEXOU)

The DEXOU is comprised of the D-Area Rubble Pit (431-2D) (DRP) and the 488-D Ash Basin (488-DAB) (Figure 2). It is assumed that the 488-DAB and the adjacent 488-4D ash basin (now the 488-4D Ash Basin) were placed in operation in 1952 when the 484-D Powerhouse began operating. The ash basins were used to intercept, stabilize, and provide passive treatment of ash-sluice water before it was discharged to local surface streams. In 1978, ash-sluice water was diverted to the newly constructed 488-1D and 488-2D Ash Basins. After 1978, the 488-DAB received only dry ash and coal-reject material until the early mid-1990s.

The DEXOU ROD (WSRC 2004b) selected remedy for the 488-DAB was containment and included the area outside of the basin and along its northern perimeter berm where coal rejects had sloughed from the basin into the D-003 outfall drainage ditch, causing acidification of stormwater runoff in the drainage. The total volume of coal rejects was consolidated into the 488-DAB closure. The 488-DAB Interior selected remedy was containment and included the excavation and consolidation of waste material from the 431-2D DRP into the 488-DAB, consolidation of the 488-DAB exposure areas (DSVA, basin exterior, and DAB drainage) within the 488-DAB; and application of a low permeability geosynthetic cover system, institutional controls, and monitoring. Groundwater monitoring continues downgradient of the closure (metals and pH). Selected remedy for the 431-2D DRP was removal, and included the following components:

- Excavation of waste materials and soils containing coal rejects and consolidation into the 488-DAB;
- removal of a polychlorinated biphenyl (PCB) hot spot and verification to the PCB remedial goal; and
- No groundwater impacts after completion of removal activities.

Additionally, the 488-D Pooled Basin subunit consisted of standing surface water having low pH located in the western portion of the 488-D Ash Basin. A standpipe was used to discharge pooled surface water from the 488-D Pooled Basin into the 488-D Drainage. The

standpipe was plugged in 1998 to eliminate the release of low pH surface water from the 488-D Pooled Basin.

The 488-D Drainage consisted of a small area where a standpipe from the 488-DAB discharged. Sediment and surface water were addressed by the remedial action. The Dead and Stressed Vegetation Area on the northern edge of the 488-DAB was about 0.72 ha (1.8 ac) where vegetation was impacted by acid runoff from the Powerhouse subunit. There are no further groundwater impacts.

1.2.5 D-Area Operable Unit

The DAOU consists of the following three main facility areas: the D-Area Heavy Water Facility (Bubble Tower Subunit), the Moderator Processing Facility (Moderator Processing Subunit), and the 484-D Powerhouse (Powerhouse Subunit) (Figure 2).

The Bubble Tower subunit consists of the 717-D Maintenance Facility, D-Area Heavy Water Facility (DHWF), 715-D Gas Station and a Fire Fighting Training Facility. The Moderator Process Subunit consist of the 420-D Concentrator Building, 420-2D Rework Handling Facility, 421-2D Moderating Handling and Storage Building, 421-D Finishing Building, 421-4D Drum Storage Building, and 772-D Control Laboratory/Supervisor's Office.

The Powerhouse Subunit consists of the 484-D Powerhouse Building, the 484-10D Waste Oil Facility, the 484-17D DCSA and the 489-D CPRB, and associated ancillary facilities for coal and ash storage, runoff, and disposal. The 489-D CPRB previously received runoff from the 484-17D DCSA. A NTCR action was completed for the 489-D CPRB northern 25% section in 2011 and as previously stated, the northern 25% was addressed by an EAROD. The southern 75% section of the 489-D CPRB was addressed under a NTCR action in 2017 to remove coal fines and contaminated sediments from the basin and will remain open as a storm water retention structure. Previous operation of the 489-D CPRB has resulted in a metals plume due to infiltration of low pH water from the basin.

The DAOU also includes miscellaneous units consisting of the 904-50G Outfall and D-Area Asbestos Pit (080-20G). The D-Area Inactive Process Sewer Lines (DIPSL) are located in the Bubble Tower, the Moderator Processing Facility, and the Powerhouse subunits. DAOU also includes electrical transformers and miscellaneous buildings.

An Early Action ROD (EAROD) for DAOU integrated the results of the completed removal actions and selected land use controls (LUCs) as the final action for the Bubble Tower Subunit, Moderator Processing Subunit, miscellaneous units (i.e., D-Area Asbestos Pit and the D-Area Process Sewer Lines as Abandoned [inside the facility area fence]), and selected unrestricted land use for the southern 75% section of the 489-D CPRB (Powerhouse Subunit) (SRNS 2011).

1.2.5.1 DAOU First Early Action ROD

Implemented in 2011, LUCs was chosen for DAOU subunits and facilities where previous removal actions had been completed or where no remedial actions beyond LUCs were needed. Areas addressed by the first EAROD included:

- Bubble Tower Subunit
- Moderator Processing Subunit
- Portions of the Powerhouse Subunit
- Miscellaneous Units

Bubble Tower Subunit – The DHWF and DHWRF were used in the production of heavy water for use in the SRS reactors. The DHWRF was used to purify contaminated heavy water, and the 420-2D Rework Handling Facility was used to empty and fill contaminated heavy water drums. Operation of the Bubble Towers ceased in 1982 with final D&D concluding in 1994. Soil sampling and soil gas surveys identified insignificant concentrations of VOCs in the Bubble Tower area but a high TCE concentration in groundwater area south of the Bubble Towers. Tetrachloroethylene (PCE) exceeded the contaminant migration (CM) refined constituent of concern (RCOC) in vadose zone soils at three locations, and 11 MicroBlowers™ units were installed in 2010 and are still in operation.

The DHWF, the DHWRF, 420-3D Rework Handling Facility, and the 421-2D Moderating Handling and Storage Building have been decommissioned and/or decontaminated and are no longer an ongoing source of tritium contamination to groundwater.

After the shutdown and the dismantling of the DHWF facilities, the area was repurposed into a fire-training area for SRS. This included multiple concrete fire pits where fuels and/or gas tanks were set on fire and aqueous film-forming foam (AFFF) was utilized in training exercises to extinguish the fires. The D-Area Fire Fighting Training Facilities (411-D, 411-1D, and 411-3D) and Building 411-3D concrete pits were used for fuel and fuel mixture burnings and training simulations. These previous exercises have subsequently resulted in a potential source of PFAS contamination to the groundwater.

The 717-D Maintenance Facility was used for general area maintenance, machine shop services, and administrative support. PCE exceeded CM RCOCs in vadose soils east of the 717-D Facility.

The Gasoline Station Area (715-D), including an underground storage tank (UST) (18,927 L [5,000 gal] capacity), was a former refueling station located just east of the 484-D Powerhouse. The UST was removed in 1983 along with about 94 L (25 gal) of pooled product beneath the tank. The fueling station was closed about the same time. With the removal of the UST and the pooled product beneath the tank, the Gas Station Area (715-D) is no longer considered a source of fuel product contamination to the groundwater.

In summary, activities within the Bubble Tower Subunit resulted in previous impact to groundwater from the VOCs and petroleum with potential groundwater influence from PFAS.

Moderator Processing Subunit – After D&D of the 420-D Concentrator Building the 420-2D Rework Handling Facility and 421-2D Moderating Handling and Storage Building, tritium was detected in both concrete and soil samples at concentrations exceeding the CM RCOC threshold. Treatment of the concrete and soil with an on-unit thermal detritiation system was implemented in 2011 under a NTCR action, and is no

longer a source of tritium to groundwater. The 421-4D Drum Storage Building was used for storing drums of tritium contaminated moderator. Investigations showed that there was one known case of a spill of contaminated moderator withing the structure due to a drum leak. The leak was confined by the perimeter containment curbs and was below the free release radiological standard.

Powerhouse Subunit – The 484-D Powerhouse was a coal-fired power plant that began operating in 1952 to produce steam and electricity for several SRS facilities. The 489-D CPRB previously received runoff from the 484-17D DCSA and coal pile located south of the 484-D Powerhouse. Major ancillary facilities associated with the Powerhouse included within the First EA ROD were the 489-D CPRB (Northern 25%), the 484-10D Waste Oil Facility (WOF) and the 483-D Water Treatment Plant. The 484-D Powerhouse was not included in the first EAROD. Arsenic was identified at the 484-10D WOF as a human health RCOC for surface soil. The contaminated surface soil was removed and placed in the northern 25% section of the 489-D Coal Pile Runoff Basin under a removal action with no CM risks identified. The 484-10D is a potential source of groundwater contaminants (metals) warranting further investigation.

The 489-D CPRB was built in 1978 as a catch basin to remove suspended solids from the coal storage area runoff water to minimize discharge to Beaver Dam Creek. Long-term exposure of the coal to the environment has resulted in weathering of the coal and production of a low-pH leachate containing heavy metals. Sediment, soil, and surface water samples were collected within the 489-D CPRB. Arsenic was identified as a human health and ecological RCOC for sediment. 2-Methylnaphthalene and low pH were identified as ecological RCOCs in sediment. Metals, including aluminum, beryllium, cobalt, copper, iron, manganese, and zinc were identified as ecological RCOCs for surface water. Removal of coal and coal fines was done under a maintenance action in 2012 and 2013. Under a Removal Action, the 489-D CPRB was dewatered and additional contaminated media (from the D-006 Outfall and 484-10D WOF) was placed in the northern 25% section of the 489-D CPRB before a soil and topsoil cover was installed.

Runoff from the 484-17D Coal Storage Area was rerouted to the southern 75% section of the 489-D CPRB.

Miscellaneous Units Subunit – These include the D-Area Asbestos Pit (080-20G) which was covered and is currently under LUCs with no groundwater impact, the 904-5G Outfall, which had no RCOCs identified, and the D-006 Outfall (Petroleum Release Site), which was identified in 2001 due to petroleum odor in the soil at the outfall subunit, east of the 431-2D D-Area Rubble Pile. Field screening identified the petroleum as diesel-range organics; however, its source was not identified or known. Sediment and surface water samples were collected along the D-006 Outfall subunit. Arsenic was identified as a human health RCOC in sediment. Metals and pesticides were identified as ecological RCOCs in sediment. The sediment east of the 431-2D D-Area Rubble Pile to the northern end of the D-006 subunit was excavated and placed in the northern 25% section of 489-D CPRB. There were no CM RCOCs identified and the D-006 Outfall is maintained as a wetlands area. There is no groundwater impact from the D-Area Asbestos Pit or the D-006 Outfall.

The electrical transformer substations were located throughout D Area and were often included with facilities during decommissioning activities. As of 1996, SRS had replaced or rendered non-PCB all of the site's transformers and large capacitors that were regulated due to PCB content. No records indicated a spill or release from the transformers while they were operated with PCB oil; therefore, no samples were collected during D&D. Visual inspections of the concrete pads were performed with no evidence of spills on the pads indicating no problems warranting action, therefore it is not a source of groundwater contamination.

D-Area Process Sewer Lines (DPSLs) as Abandoned samples were obtained from within the DPSL manholes and from various locations beneath the DPSLs. No COCs were identified. The manholes associated with the DPSLs were plugged and grouted as an engineering control to restrict access to potentially impacted areas (i.e., residual contaminants in the DPSLs) and for general safety. The DPSLs are not a source of groundwater contamination.

1.2.5.2 DAOU Second Early Action ROD History

Waste units addressed by the second DAOU EAROD include the 488-1D Ash Basin, 488-2D Ash Basin, 488-4D Ash Landfill, and the 489-D CPRB (Southern 75%)

The 488-4D Ash Landfill is a 8.7-ha (21.5-ac) basin that was initially part of the existing SRS wastewater facilities ceasing operations in 1993. It was re-permitted in November 2007 as a Class 2 Solid Waste Landfill to accept ash waste for disposal. A NTC removal action to place excavated ash from 488-2D Ash Basin into the landfill and apply a Class 3 landfill cover over the entire landfill and infiltration basin was completed in August 2016. Groundwater monitoring for metals is part of the Class Three landfill requirements.

488-2D Ash Basin – A time-critical RSER was submitted in 2014 for the 488-2D Ash Basin to dewater and remove bulk ash to maintain the DAOU construction and closure schedule. After dewatering, the ash and contaminated sediment/soils from the basin bottom and embankment along the entire length of the northern berm were excavated and consolidated in the 488-4D Ash Landfill. Approximately 90,800 yd^3 of ash was placed into the 488-4D Ash Landfill including an area of ash west of the 488-4D Ash Landfill Unit (~6.1 ha [15 ac]). The basin was re-graded, sloped appropriately, and is currently a storm water detention structure. Although, not a source of groundwater contamination, the structure is within the footprint of groundwater monitoring for VOCs, tritium, and metals.

488-1D Ash Basin (Including Inlet Basins) – The 488-1D Ash Basin (including the sluice line and Inlet Basins) transported ash slurry from the Powerhouse into one of two Inlet Basins for settling of ash. As the wastewater level increased in the 488-1D Ash Basin, the water flowed into the 488-2D Ash Basin. After dewatering and vegetation removal, the ash in the 488-1D Ash Basin was consolidated into the eastern portion of the basin and a new berm installed along the western side interface. A geosynthetic cover and vegetative layer was installed over the ash consolidated area (~7.9 ha [19.4 ac]) as a Class 3 cover system while the western portion of the basin (~6.5 ha [16 ac]) was covered with soil and graded to direct rainfall to the existing ditch at the southwest corner of the 488-1D Ash

Basin. Groundwater monitoring for the 488-1D Ash Basin cover system is part of the final remedy.

489-D CPRB (Southern 75%) – Since the Powerhouse was still active when the removal action field start began in 2011, a revised Action Memorandum was issued in August 2010 to segment the 489-D CPRB into northern and southern sections. The removal action for the 489-D CPRB (Northern 25%) was completed in 2011. The 489-D CPRB (Southern 75%) remained active during Powerhouse operations. The second phase of the removal action begin in September 2015 once Powerhouse operations ceased and runoff was no longer received from the active 484-17D DCSA.

After dewatering, coal fines and contaminated sediments from the 489-D CPRB (Southern 75%) were excavated and consolidated in the eastern end of the 488-1D Ash Basin. Once sufficient removal was confirmed, clean soil was placed in the 75% southern section and the area was contoured and re-graded to design elevations. The remediated basin serves as a storm water retention structure as its end-state condition. Historical groundwater impacts from the 489-D CPRB include low pH and leaching of metals.

2.0 PRELIMINARY UNIT EVALUATION

This section describes the preliminary unit evaluation of the RFI/RI WP for the DAG OU and presents the results of a unit reconnaissance, and groundwater well monitoring and sampling data.

The available information for the DAG OU was reviewed and evaluated to determine the nature of contaminants that may have potentially migrated into the groundwater at the DAG OU as well as the probability of secondary source contamination. Based upon this review, a preliminary list of ARARs and TBC factors was developed to establish preliminary objectives.

2.1 Unit Characteristics

The DAG OU encompasses all the groundwater below D Area, west and southwest toward the Savannah River, and east and south toward Beaver Dam Creek and the D-Area Discharge Canal (Figure 1). The groundwater unit has been separated from the surface units located in D Area to provide a more comprehensive evaluation of the groundwater in this area. The surface OUs, DEXOU and DAOU, were previously investigated as contaminant source areas.

The following sections present known unit characteristics, including unit history and waste composition, physical setting, demography and land use, climate, ecological setting, unit soils, geology, hydrogeology, and hydrology.

2.1.1 Physical Setting

D Area is located on an alluvial terrace in the southwest quadrant of the SRS ~915-m (3,050-ft) east of the Savannah River (Figure 1) at an elevation ~37.5-m (125-ft) above mean sea level. Local topography is relatively flat with a general slope from the northeast to southwest. The D-Area Effluent Discharge Canal discharges into Beaver Dam Creek which then extends ~3.2 km (2 mi.) to the southwest and south which discharges into the Savannah River.

The Savannah River provides the western boundary of the SRS. Two of the five major streams systems that feed into the Savannah River could potentially influence D Area: Upper Three Runs (upgradient of D Area) and Fourmile Branch (downgradient of D Area) (Figure 1). During non-flood river stages, Fourmile Branch flows through the Savannah River Swamp prior to entering the river at well-defined breaches in the natural levee. In high water conditions, the water from Fourmile Branch flows through the swamp parallel to the river on the inside of the levee and discharges to the Savannah River near Steel Creek.

2.1.2 Demography and Land Use

SRS is located ~32.2km (20-mi) south of Aiken, South Carolina, and ~40.2-km (25-mi) southeast of Augusta, Georgia. Currently, no industrial activity is being performed.

Most of the urbanized development outside of the SRS boundary has occurred in and around the cities of Augusta, Georgia, and Aiken, South Carolina. Within SRS, less than 5% of the total area is urbanized and/or developed. All the facilities engaged in the production of special nuclear materials are located within a fraction of this area. Reservoirs and ponds comprise ~12.9 km^2 (5 mi^2) of SRS. The remainder of the more than 777 km^2 (300 mi^2) is composed of natural vegetation and pine plantations.

DAG OU is located within an industrial use area. Land use will be controlled consistent with the *SRS Land Use Control Assurance Plan* (WSRC 1999) to prevent the use of groundwater that exceeds maximum contaminant levels (MCLs), Regional Screening Levels (RSLs), and/or USEPA drinking water health advisory limits. The Upper Three Runs Aquifer (UTRA) and Gordon Aquifer (GA), which are the targets of this investigation, are not currently used regionally as a drinking water source.

2.1.3 Climate

The average regional annual temperature is 18.3ºC (65ºF) at SRS. In general, the SRS region has a temperate climate with relatively short, mild winters and long, hot, humid summers. Summer average low and high temperatures are ~21.1ºC (70ºF) and 33.3ºC (92ºF), respectively. The SRS region is subject to continental influences but is protected from relatively sever winters by the Appalachian Mountains to the north and northwest. Often influenced by warm, moist, maritime air masses throughout the year, less than one-third of the winter days have a minimum temperature below freezing.

Rainfall at SRS tends to be evenly distributed throughout the year, on average spring and fall are drier and summers wetter. The average annual precipitation at SRS for the 30-year period between 1990-2020 is 120.4 cm (47.4 in.), and the greatest observed rainfall for a

24-hour period was ~49.8 cm (19.6 in.) in October 1990. The evaporation rate is ~76.2 cm (30 in.) per year.

In general, seasonal prevailing winds are as follows: winter, northwest to southeast; spring, west to east; summer, southwest to northeast, and autumn, toward the southwest and southeast.

2.1.4 Habitats and Ecological Setting

SRS supports a variety of diverse habitat types that support terrestrial and semiaquatic wildlife species (WSRC 2006). These populations include urban wildlife, several commercially and recreationally important species, and a few threatened and endangered species. The DAG OU consists of subsurface groundwater, which discharges to a wetland area west of D Area or surface water. The wetland area is part of the Savannah River Floodplain Swamp Integrator Operable Unit (SRFS IOU). The SRFS IOU is primarily a mixed bottomland hardwood forest floodplain and contains cypress/tupelo swamp habitat.

SRS also supports abundant herpetofauna because of its temperate climate and diverse habitats as well as avifauna resources which include migrant, seasonal, and permanent residents (WSRC 2006).

2.1.5 Unit Soils

D Area is predominantly an urban land complex consisting of Udorthent soils (USDA 1990). Udorthent soils are gently sloping and are affected by major land shaping or grading intermingled with streets, sidewalks, buildings, and parking lots and areas of undisturbed soils. The soil is ~50 percent Udorthent, 30 percent urban land, and 20 percent undisturbed soils. Blanton, Troup, and Wagram soils are in the undisturbed areas. Individual areas of urban land and undisturbed soils are too small or to intermingled to be distinguished separately; therefore, the entire urban complex is mapped as Udorthent. The Udorthents occur as friable, loamy layers deposited in the process of grading and shaping large areas of land. The soil of the higher ground between the D-Area Ash Basins and the

wetland area to the west is mapped as Smithboro Loam. Fluvaquens and Chastain Clay, found in frequently flooded areas, occur in the wetland area.

2.1.6 Geology

SRS is situated on the Atlantic Coastal Plain, a seaward-thickening wedge of unconsolidated and semi-consolidated sediments. The sediments range in age from Late Cretaceous to recent and are ~270-m (900-ft) thick at SRS (Aadland Gellici, and Thayer 1995, Fallaw and Price 1995). The Late Cretaceous sediments rest on the underlying Triassic sediments and crystallin Precambrian/Paleozoic basement rocks (Aadland, Gellici, and Thayer 1995, Fallaw and Price 1995, Stieve and Stephenson 1995).

Savannah River deposits exist at D Area, with more extensive reworking of the shallow material west of 488-DAB near the current Savannah River. The transition between Eocene sediment underlying D Area and Quarternary fluvial deposits from the ancestral Savannah River is presented in cross-sectional views for each individual plume map.

A generalized lithostratigraphic column for the central SRS is shown in Figure 3. The column illustrates the current stratigraphic nomenclature used at SRS and the geological ages of the lithology. The stratigraphy beneath the DAOU is typical of the central third of the SRS. The pertinent stratigraphy beneath D Area, in ascending order, is the Snapp, Fourmile Branch, Congaree, Warley Hill, and Tinker/Santee Formations. Over most of SRS, these units are overlain by the sands, clayey sands, and lesser clay lenses of the Dry Branch Formation, Tobacco Road San, and Altahama Formation ("Upland" Unit). However, in D Area, west of the ash basins, these three shallowest units have been eroded by the ancestral Savannah River and locally replaced with a veneer of Quarternary stream terrace deposits.

D Area lies on sediments of the Santee Formation, which is lithologically heterogenous, where clay beds, sandy clay to clayey sand beds, and sand beds interfinger and are truncated over short distances. The underlying Warley Hill Formation generally consists of very clayey sands and sandy clays to clays. The unit becomes increasingly clayey

towards the base of the formation. The laterally continuous clayey sands to clays in the Warley Hill and in the uppermost part of the underlying Congaree Formation constitute the Gordon Confining Unit (GCU) (Figure 3).

The Congaree often consists of clayey sands and clays, and the upper portion of the formation is often included in the GCU. The underlying Fourmile Formation generally consists of moderately-sorted sands that constitute the main portion of the GA. The Snapp Formation constitutes the top of the Crouch Branch Confining Unit in the area.

The occurrence and flow of groundwater are influenced by the surface physiography and by the texture, composition, and bedding characteristics of the described sedimentary sequence.

2.1.7 Hydrogeology

2.1.7.1 Regional Hydrogeology

SRS is located within the Southeastern Coastal Plain hydrogeological province in west-central South Carolina. The hydrogeological province comprises a multi-layered hydraulic complex in which retarding beds are interspersed with more permeable beds. The hydrogeologic differences do not always correspond with boundaries between stratigraphic units. Therefore, geologic formations remain implicit in the hydrostratigraphy (Aadland, Gellici, and Thayer 1995). A generalized correlation between stratigraphic and hydrostratigraphy units is provided in Figure 3.

In the central and southern portions of SRS, the uppermost (water table) aquifer is part of the UTRA of the Floridan aquifer system. Confining zones locally separate the UTRA into the upper and lower aquifer zones of the UTRA. The confining zones vary in thickness and lateral continuity and are often difficult or impossible to correlate from one area to another. One of the more laterally continuous confining zones is located near the base of the Dry Branch Formation; this confining zone is the Tan Clay Confining Zone (TCCZ) or "tan clay" of various SRS reports.

The lower aquifer zone of the UTRA includes the water-bearing sediment from the base of the TCCZ to the top of the GCU. Lithologic variations within the lower aquifer zone commonly result in significant vertical variations in transmissivity (Aadland, Gellici, and Thayer 1995).

The GCU separates the UTRA from the GA across much of the SRS region (Figure 3). The GCU consists of an interval of clayey sand and/or clay. In the central and southern portions of SRS, the GCU is laterally continuous and significantly inhibits the flow of water between the UTRA and GA (Aadland, Gellici, and Thayer 1995). Groundwater from the GA discharges into the various site streams and into the SRFS IOU. A downward hydraulic gradient typically exists between the UTRA and the GA; however, in D-Area this vertical gradient is minimal.

2.1.7.2 Local Hydrogeology

Two main aquifer systems are present beneath D Area: a deep aquifer system and a shallow aquifer system. The deep aquifer system comprises a 135-m (450-ft) thick sequence of sands and clays confined beneath a thick sequence of interbedded silts and clays known as the Meyers Branch Confining Unit. The shallow aquifer system lies above the Meyers Branch Confining Unit and includes a semi-confined and an unconfined aquifer system. The semi-confined GA is a 15-m (50-ft) thick sequence of fine to medium-grained sand that is overlain by the GCU, a 3-m (10-ft) thick clay layer. The GCU is overlain by the UTRA, which is an unconfined series of interbedded and laterally discontinuous sand, silt, and clay beds ranging in thickness from 12-m (40-ft) to 18-m (60-ft) beneath D Area. A schematic of the lithostratigraphy and hydrostratigraphy generally observed at SRS is provided in Figure 3. The water table is encountered at a depth of ~3-m (10-ft) below ground surface. West of D Area, the UTRA and GCU are incised by 13.7-m (45-ft) thick sequence of Quarternary deposits consisting of fluvial clay, silt, and sand.

The shallow groundwater system generally flows to the west-southwest near D Area and discharges to the floodplain and wetlands as well as the Savannah River (Figure 4). Groundwater flow in the GA is to the southwest (Figure 5).

2.1.8 Surface Water

D Area is situated within the floodplain of the Savannah River. Former National Pollutant Discharge Elimination System (NPDES) outfalls in the area affected the local surface hydrology by providing base flow and directing surface water runoff during storm events. The only remaining active outfall in D area is the D-02 (Figure 6).

Some of the surface water features associated with D Area are the D-003 Outfall drainage ditch, the groundwater seeps, and D-001 Outfall. To the northwest, the D-003 Outfall drainage ditch flows along the margin edge of the 488-DAB, into the wetland, and then into the Savannah River (Figure 6). To the west, groundwater seeps into the D-003 Outfall drainage ditch (now a wetland area located west of the ash basins) and flows into the wetland area at the Savannah River. To the southeast, the D-001 outfall flows southwest from the 489-D CPRB and 488-DAB into the D-Area Effluent Discharge Canal which later flows into Beaver Dam Creek, and then drains to the Savannah River. The surface water features define the boundary of the 488-DAB an adjacent ash basin, which form a topographic high in an area of generally low relief.

The D-003 Outfall drainage ditch receives runoff from D Area and forms the source for an unnamed tributary flowing along an access road built adjacent to the 488-DAB berm (Figure 6). The DWOF is included as a source to the D-003 Outfall drainage ditch. During periods of high flow, water from this drainage inundates the wetland area immediately adjacent to the outfall and 488-DAB. On the northern side of the unnamed tributary, surface water sources include the D-006 outfall (runoff from D Area), groundwater influenced by the closed D-Area Cinder Disposal Pit, 431-2D DRP, and D-Area Burning/Rubble Pit (431-D) (431-D DBRP), and a stream that flows adjacent to the 431-D DBRP (Figure 6). On the south side of the drainage, the primary source is from the 488-DAB; this includes surface water runoff, surface water flow via the dead and stressed vegetation area (Figure 6), and groundwater. From D-003 Outfall drainage ditch, the stream flows along the southern side of the access road for 325 m (1,065 ft). At this point, it mixes with an unnamed tributary from the north side of the road and the combined stream

flows southwest into the wetland that is 915-m (1,000-yd) west of the 488-DAB. Site records indicate that the flow was previously diverted under the access road through a culvert 135 m (147 yd) from the D-003 drainage.

The wetland located between the ash basins and the Savannah River receives surface water from the unnamed tributary, groundwater seeps from the 488-DAB, and the borrow pit located west of the 488-DAB (Figure 6). The borrow pit in turn receives water from a drainage gully associated with the 488-DAB and the other ash basins (488-1D, 488-2D) and landfill (488-4D). Pooled water in the southwest end of the 488-DAB was discharged to a drainage gully on the west side of the basin via a standpipe. The pipe extends from the surface to the base of the waste, then runs horizontally along the basin bottom and exits the west basin wall. The standpipe was filled with cement in autumn 1998 to eliminate release of low pH leachate from the 488-DAB. Effluent from the 488-DAB converges with runoff from the D-Area Ash Basins (488-1D and 488-2D) and D-Area Ash Landfill (488-4D) ~76 m (83 yd) west of the basin. The combined runoff flows into the borrow pit and then into the wetland west of the ash basins.

The surface water channel that runs to the former D-001 outfall forms a drainage gully located between the ash basins and the 489-D CPRB (Figure 6). This drainage receives effluent from D Area and surface water discharges from the 488-2D Ash Basin through the D-003 Outfall drainage ditch (Figure 6). Near the 488-1D Ash Basin, the drainage turns southwest and coalesces with a drainage gully south of the 489-D CPRB that receives effluent and surface water runoff from D Area through a network of process sewer lines and drainage ditches. The merged channel discharges into Beaver Dam Creek, which flows into a swamp on the southwest side of the unit and then into the Savannah River.

Surface water runoff from the DRP is to the south-southwest towards the unnamed tributary associated with the D-003 Outfall drainage ditch, as described above. Surface water runoff associated with this unit occurs only during rainfall events and is through a poorly defined gully. It is not permitted under the NPDES.

The D-Area Effluent Discharge Canal is a subunit of the "SRFS IOU [Including Beaver Dam Creek, D-Area Discharge Canal, and Ash Area Adjacent to and Easterly of D-Area Ash Basins 488-1D and 488-2D])". As noted in the FFA, although the D-Area Effluent Discharge Canal is not a subunit of the DAG OU, a separate schedule for the "D-Area Effluent Discharge Canal and Ash Area Adjacent to and Easterly of D-Area Ash Basins 488-1D and 488-2D" may be developed pending the results of the DAG OU remedial investigation process. This engineered canal received discharges from the powerhouse when it was active. With the shuttering of the powerhouse, the canal gains water from discharging groundwater and eventually intersects with Beaver Dam Creek downstream of the closed ash basins.

2.1.8.1 Streams

The Savannah River provides the western boundary of the SRS. Five major SRS stream systems feed into the Savanah River: Upper Three Runs (immediately north of D Area), Fourmile Branch (immediately south of D Area), Pen Branch, Steel Creek, and Lower Three Runs (Figure 6). Beaver Dam Creek originating on the south side of the 488-1D Ash Basin flows through the Savannah River Swamp for ~3.2 km (2 mi) before discharging to the Savannah River, north of Fourmile Branch. During non-flood river stages, Beaver Dam Creek, Fourmile Branch, Pen Branch and Steel Creek flow through the Savannah River Swamp prior to entering the river at well-defined breaches in the natural levee. In high water conditions, the water from these streams flow through the swamp parallel to the river on the inside of the levee and discharge into the Savannah River near Steel Creek. The SRFS IOU has been defined as the Savannah River, Savannah River Swamp, and associated contiguous wetlands within the 100-year floodplain from the northern boundary of SRS near Jackson, South Carolina, south-eastward to the U.S. Highway 301 bridge, an ~72-km (45-mi) long stretch along the Savannah River. The 488-DAB wetlands, D-006 Petroleum Release Site, and Beaver Dam Creek, located in or within the vicinity of the DAG OU, are administratively part of the SRFS IOU.

2.2 Existing/Previous Investigations

In 2002, a flow and transport groundwater model was developed to support the DEXOU, provide a baseline for D Area groundwater understanding, and to evaluate the nature and extent of existing groundwater plumes in the event of no remedial action (associated with low pH and metals). The model was also used to support the development of the *Monitoring Work Plan for the DAG OU (U)* (WSRC 2004a) which prescribed annual and semiannual monitoring of wells and surface water stations.

2.2.1 NTCR Action for the 484-17D Coal Storage Area (DCSA)

The 484-17D DCSA was an ~6-hectare (ha [15-acre {ac}]) coal storage area for the 484-D Powerhouse. Coal was stockpiled at the 484-17D DCSA for 59 years which allowed infiltration of rainwater through the coal and degradation of iron sulfide (pyrite), commonly found in coal, to sulfuric acid when mixed with rainwater. Although a maintenance action in 2012 and 2013 removed essentially all the visible coal from the 484-17D DCSA, the long-term coal storage caused the underlying vadose zone soil and groundwater to become acidified (i.e., low pH). Groundwater in D-Area has been shown to be contaminated with various metals, and many of the metal plumes coincide with the low-pH area and/or nearby source areas including the 484-17D DCSA and the 489-D CPRB (Figure 7). The vadose zone soils were expected to be a long-term source of acidity to groundwater in D-Area if not addressed.

The preferred action documented in the RSER/EE/CA for the 484-17D DCSA (SRNS 2019a) was a NTCR action to add soil neutralization amendments to reduce the acidity in the upper portion of the vadose zone and subsequently reduce the amount of acidic leachate to groundwater. Addressing the acidic vadose zone soils will eventually improve groundwater conditions by mixing neutralization amendments (lime/calcium carbonate) into the vadose zone soils at the 484-17D DCSA to raise the soil pH of the vadose zone to more natural background levels (approximate pH of 5.5). This removal action is specific for the 484-17D DCSA vadose zone soils and will complement the DAG OU treatability study for the treatment of acidic groundwater and surface water in the

vicinity of the 484-17D DCSA and the 489-D CPRB. The removal action started in May 2020 and was completed in November 2020. Post-action pH soil sampling will be collected in 2022.

The 484-17D DCSA is currently listed on FFA Appendix K.1: D&D Facilities to be Decommissioned. The final action for the 484-17D DCSA will be addressed by the final DAOU ROD scheduled for issuance in January 2046.

2.2.2 Treatability Study for Groundwater Injection and Effluent Discharge Canal Treatment

The presence of a low-pH plume in the groundwater is expected to last for decades under natural groundwater conditions. The low-pH groundwater is currently discharging into the D-Area Effluent Discharge Canal which later converges with Beaver Dam Creek and flows through the Savannah River floodplain to the Savannah River (Figure 6). If the pH of the aquifer can be raised to more normal, less acidic conditions, the groundwater and surface water conditions in the D-Area Discharge Canal would improve.

A treatability study is being enacted to inject potable water into the UTRA upgradient of the low-pH, metals plume to create a hydraulic head and displace the low-pH groundwater in the aquifer (SRNS 2019b). Artesian groundwater will be piped to the 484-17D DCSA and the 489-D CPRB and injected into the UTRA water table with a series of injection wells (Figure 8). Although the water table is expected to rise ~1.5 m (5 ft) into the vadose zone, the groundwater injection is not intended to be a major treatment for the vadose zone and will not remove all the acidity from the vadose zone. As previously discussed, the NTCR action for the 484-17D DCSA to add neutralization amendments to the vadose zone soils is intended to reduce the acidic vadose zone source that has contributed to groundwater contamination. The lower vadose zone is not expected to be neutralized or have much change in pH as a result of the groundwater injection treatability study but will eventually see the buffering effects of the upper vadose zone amendments through infiltration. The combined (or synergistic) effects of the two actions have not been estimated or considered but will be apparent from the measurements using the parameters

described in the treatability study, the 484-17D DCSA Removal Action Report, and the DAG OU groundwater and surface water monitoring.

An increase in the amount of acidic groundwater discharge to the D-Area Effluent Discharge Canal is expected to occur as the low-pH groundwater is displaced in the aquifer. The treatability study design includes the installation of two calcium carbonate (CaCO3) reactive structures in the D-Area Effluent Discharge Canal designed to raise the pH of the surface water to a more neutral condition. Monitoring of water table elevations and pH measurements in surrounding monitoring wells and streams, as well as metal analyses of groundwater and surface water, will be used to determine the impact of the groundwater injections. Monitoring of stream pH will be conducted upgradient, between, and downgradient of the two $CaCO_3$ reactive structures. The field start date for the treatability study is in 2021 and it has an anticipated duration of three years of groundwater injection. The treatability study results will be used to support the development of the DAG OU Corrective Measures Study/Feasibility Study (CMS/FS).

2.3 Unit Evaluation Conclusions

Based on previously completed groundwater sampling at D Area, multiple contaminant plumes with multiple sources are present in the DAG OU. Contamination is prominent in the UTRA with minor detectable concentrations found in one GA monitoring well. The results of the sampling indicate that the groundwater in D Area is contaminated with VOCs (primarily trichloroethylene [TCE]), tritium, low pH/metals, and PFAS. Additionally, the data indicates that little contamination has been detected in the GA with TCE exceeding MCLs in one GA well (DRW001D), and PFAS contamination detected in two GA wells (DRW001D and DCB 33D). This suggests that groundwater contamination is mainly migrating horizontally, which is supported by elevated levels of contamination in the UTRA.

TCE, tritium, low pH/metals, and the emerging PFAS contaminants are the principal groundwater contaminants to be analyzed. Based on available data, the primary sources of the groundwater contamination include the 488-DAB, 489-D CPRB, 431-2D DRP,

484-17D DCSA, DHWF (411-D, 412-1D, and 413-D), DHWRF (420-D Concentrator Building), 420-2D Rework Handling Facility, 421-2D Moderator Handling and Storage Building, Gasoline Station (715-D), and the 411-1D/411-3D Fire Training Area.

The four plume areas at the DAG OU have been identified and have varying needs for additional characterization (Figures 9 through 17). A description of each plume area follows.

2.3.1 DAG OU VOC Plume

The DAG OU VOC Plume in the UTRA, which primarily consists of TCE (Figure 9), extends from the Bubble Towers Subunit southwest across the 484-17D DCSA, 488-4D Ash Landfill and portions of the D-Area Ash Basins, and westward into the D Area wetlands. The VOC Plume consists of an area of ~148 ha (366 ac). The maximum TCE concentration in 2020 was 128 µg/L at monitoring well DCB 62, exceeding the 5 µg/L MCL. Concentrations downgradient of DCB 62 are less than 100 µg/L. The plume area estimated at or above 100 µg/L is about 5.7 ha (14 ac). Concentrations farther downgradient into the D Area wetlands decrease to levels ranging from non-detect to above the MCL. The maximum TCE concentration in the wetlands area in 2020 was 23.1 µg/L at well DCB 55. The GA has a limited TCE plume (Figure 10). A cross-sectional view of the TCE plume is provided in Figure 11. Surface water concentrations within the DAOU footprint are generally non-detect with occasional detections less than the MCL (5 µg/L).

Overall, VOC (TCE and PCE) concentrations are decreasing slightly, with plume attenuation primarily based on advection and dispersion. As indicated in the D-Area Groundwater Annual Report (SRNS 2021a), data indicates a general decline in concentrations of TCE. PCE is detected above MCLs in a small portion of the groundwater monitoring wells. However, PCE concentrations are much lower than TCE concentrations with a 2020 maximum PCE concentration of 7.56 µg/L at well DCB080. VOC degradation products are minimal to non-existent, and detected concentrations remain below respective MCLs. Most concentrations of TCE in the UTRA source area are decreasing, indicating depletion of the source and degradation of the TCE plume. Increases in concentration at

well DCB 26AR are most likely due to plume migration from the higher concentrations upgradient. Intermediate wells (DCB 27C and DCB 28) show decreasing concentrations indicating the plume is not expanding. Downgradient wells exhibit steady or decreasing concentration trends, which also supports the lack of plume expansions and not posing an immediate threat to surface water or the D Area wetlands. Surface water VOC concentrations are generally non-detect with occasional detections less than the MCL (5 µg/L).

2.3.2 DAG OU Low pH and Metals Plume

The DAG OU low pH and metals plume extends to the southwest from the 431-2D DRP, 484-17D DCSA, and 489-D CPRB. Exposure of coal to rainwater for 59 years caused the dissolution of iron sulfide (pyrite; a mineral commonly found in coal), leading to the creation of sulfuric acid. As a result, the soils beneath the 484-17D DCSA, associated stormwater runoff in the 489-D CPRB, and groundwater underlying the area have been acidified. The groundwater downgradient of the 431-2D DRP, 484-17D DCSA, and the 489-D CPRB has historical pH levels less than 4.5 with some areas as low as 3 to 3.5 (Figure 12), which is drastically lower than the background groundwater in D Area (pH ~5.2). This acidification has resulted in leaching of metals from both the coal and the natural minerals in the underlying soils, leading to a metal groundwater plume in the UTRA. Measurements of pH and metal concentrations are shown in the D-Area Groundwater Annual Report (SRNS 2021a) which indicate an acidic condition and the likely consequence of lingering metal trends.

Most of the coal has been removed (DCSA) or capped (DRP) and the acidic runoff water and coal material in the 489-D CPRB has been removed. In addition, a recently completed removal action to raise the vadose zone pH to more acceptable levels in the DCSA footprint, has incorporated calcium carbonate into the top four feet of the vadose zone. The underlying soils are expected to remain acidified and continue to contribute to the low pH and metals groundwater plume for several more years. Metals, including aluminum, beryllium, cadmium, chromium, cobalt, iron, lead, manganese, nickel, and uranium,

generally exceed their respective MCLs or RSLs. As depicted on Figure 12, the beryllium plume correlates with the low pH plume. The maximum beryllium concentration during 2020 was 132 µg/L at well DCB 23C, above the 4 µg/L MCL. The beryllium plume covers an area of ~75.7 ha (187 ac). In general, the highest beryllium concentrations, as well as other metal concentrations, are located directly downgradient of the source areas.

Metal trends show lingering contaminant concentrations are likely due to ongoing low (acidic) pH levels in the vadose zone and in the groundwater. Some wells show increasing concentrations due to some plume migration vertically or horizontally, although the overall plume footprints have only minimally changed.

Current GA wells show that the GA is minimally impacted by the pH and metals contamination (Figure 13).

Figure 14 shows cross-sectional views of the beryllium plume. Surface water downgradient of the 484-17D DCSA in the D-Area Effluent Discharge Canal displays low pH levels (pH <4) and elevated metals concentrations. An effort to control the discharge of low pH surface water from the canal into Beaver Dam Creek has been initiated where a $CaCO_3$ check dam system has been installed within the canal to enhance the discharging stream pH levels. Another part of the of the study will include an injection system that will help buffer water table conditions and displace low-pH shallow groundwater directly under the 484-17D DCSA and 489-D CPRB.

2.3.3 DAG OU Tritium Plume

The DAG OU tritium plume extends from the Moderator Processing Facility to the southwest towards the 488-D Ash Basin and 488-4D Ash Landfill and to the west into the D Area wetlands. The tritium plume consists of an area of ~53.4 ha (132 ac) (Figure 15). In 2020, the maximum concentration was 174 pCi/mL at well DCB 26AR, exceeding the 20 pCi/mL MCL. The highest concentration area (≥100 pCi/mL) comprises an area of ~49.4 ha (121 ac) near the source area and downgradient towards the 488-D Ash Basin. Concentrations of tritium located downgradient of D Area into the wetlands drop to levels

ranging from non-detects to slightly above the MCL, the maximum concentration in this area in 2020 was 19.1 pCi/mL at well DWP8. A cross-sectional view of the tritium plume is provided in Figure 16.

Historical monitoring well data shows tritium maximum concentrations were above 1,400 pCi/mL during 2001. In 2011, the tritium source in the vadose zone at the Moderator Processing Subunit was remediated by detritiation of concrete and soil under a removal action, thus tritium concentrations in groundwater have been declining near the source and are expected to continue this downward trend. Tritium concentrations above MCLs are only present in the UTRA; concentrations at GA wells are either non-detect or less than the MCL (20 pCi/mL). Overall tritium concentrations are decreasing. Surface water samples remain either non-detect or at levels far below the MCL (20 pCi/L).

2.3.4 DAG OU PFAS Plume

The DAG OU PFAS plume has been identified during a recent investigation brought on by the emerging concerns about PFAS in the environment. The PFAS plume in D Area was first identified in 2020 by sampling existing monitoring wells in the immediate vicinity of known PFAS release sites – specifically the Fire Training Area at 411-1D and 411-3D and the 715-D Gasoline Station.

Using carefully executed protocols for sampling and analysis, a multi-step process was used to ensure samples were obtained in a manner to avoid any cross contamination from various media (e.g., clothing, lotions, sampling materials, etc.) used during the sample collection process. Nineteen monitoring wells in D Area were analyzed for 14 PFAS constituents. The highest concentration found of the fourteen PFAS constituents analyzed was perfluorononanoic acid (PFNA) at a concentration of 1,910 nanograms per liter (ng/L) at well DCB 62 located downgradient of the 715-D Gas Station (Figure 17). PFNA is associated with legacy fluorinated AFFF. The PFAS constituents perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) were also detected above the current USEPA Health Advisory limit of 70 ng/L with maximum concentrations of 607 ng/L (well DCB 62 for PFOS) and 113 ng/L (well DRW 1 for PFOA).

Characterization of the PFAS plume is currently ongoing. The PFAS plume is expected to have an aerial extent of at least 28 ha (70 ac).

Since the initial sampling events, an evolving decision process has been used to further define the horizontal and vertical dimensions of the PFAS contaminant plume, as well as, current concentrations to which additional trend data will be added for incorporation into the DAG OU RFI/RI/Baseline Risk Assessment (BRA).

2.4 Operable Unit Strategy

The DAG OU investigation will be based on collecting and evaluating historical and real-time analytical data. Table 1 lists all current and proposed wells and new surface water stations. These new wells include one in the UTRA and three in the GA (refer to Table 1).

The treatability study for groundwater injection and discharge canal treatment was started in October 2019 with installation of a $CaCO_3$ reactive structure in the D-Area Effluent Discharge Canal. The second $CaCO_3$ reactive structure has since been installed and the completion of the injection system piping (utilizing 11 injection wells) is scheduled to be installed by December 2021 with injections starting shortly afterwards. The vadose zone and groundwater beneath the 484-17D DCSA and the 489-D CPRB are impacted by low pH conditions (pH<4) from ~60 years of coal-fed power plant operations. The presence of a low-pH plume in the groundwater is expected to last for decades under natural groundwater conditions. The treatability study will determine whether: 1) injecting potable water into the aquifer upgradient of the low pH and metals plumes will create a hydraulic head and displace the low pH groundwater in the aquifer; and 2) treating the low pH surface water in the D-Area Effluent Discharge Canal with $CaCO_3$ reactive structure(s) will increase the pH.

Data from the 484-17D DCSA Removal Action Report and the groundwater injection treatability study will be collected and analyzed to support the evaluation of remedial alternatives in the DAG OU CMS/FS. Since these processes are slow in developing results, this data will be compiled from existing and new monitoring wells and surface water

sampling points over the next several years. This strategy of data collection and analysis will increase the understanding of the hydrology and any measurable effects of the actions in the area. This strategy will specifically assist in the assessment process for the DAG OU RFI/RI/BRA and the development of the CMS/FS.

An RFI/RI/BRA will be developed and is currently scheduled for submission to the regulators for review and comment in December 2024. The RFI/RI/BRA will evaluate and document the results of the groundwater investigation, and to document the appropriate groundwater remedial action objectives (RAOs). MCLs, or Regional Screening Levels (RSL) in the absence of MCLs, as well as USEPA drinking water lifetime health advisory limits (i.e., for PFAS) will be used as a point of comparison for defining the problem(s) and scope of the problem(s). A baseline flow and fate and transport model will be developed in conjunction with the RFI/RI/BRA. The CMS/FS will be developed and submitted (currently scheduled for March 2026), including groundwater modeling of alternatives.

A characterization effort is being planned per this RFI/RI Work Plan and SAP to collect groundwater data from existing wells and new groundwater investigation sampling points, install additional groundwater wells, and collect surface water samples from the D-Area Effluent Discharge Canal.

2.5 Potential ARARs and TBC Criteria

A preliminary list of potential ARARs and TBC criteria for the DAG OU is presented in Table 2. Development of ARARs and TBC criteria is an iterative process performed throughout the assessment and corrective action of the DAG OU. This list of potential ARARs is expected to be modified and refined as more data are collected. ARARs may be location-, chemical-, or action-specific.

Because groundwater monitoring data indicate that groundwater in the DAG OU is contaminated, the USEPA Primary Drinking Water Standards of the Safe Drinking Water Act and South Carolina Drinking Regulations are potential ARARs. The Atomic Energy

Act is likely to be applicable since radioactive material are thought to be associated with disposal activities at DAG OU. Certain other requirements may be applicable depending on specific remedial actions implemented at the unit. RCRA and South Carolina Hazardous Waste Management Regulations may be considered ARARs if waste material is removed from the unit. If groundwater extraction wells or monitoring wells are required for remedial action, then the South Carolina Well Standards would be considered an action-specific ARAR.

Certain potential ARARs can be identified as inappropriate based on existing information available about DAG OU. No critical habitats for endangered species are associated with groundwater; therefore, the Endangered Species Act is not applicable. No archeological or historic sites are located at or near the DAG OU; therefore, the National Archeological and Historic Preservation Act is not included as an ARAR.

2.6 Potential Corrective Measures Study/Feasibility Study Options

2.6.1 Standard Remedial Technologies

Historical groundwater data indicate that groundwater may require remediation. Likely Response Actions are identified early in the life cycle of the project to ensure that the planning for data collection will support the response action alternative selection process. Based on available data, the Likely Response Actions for the DAG OU for evaluation in the CMS/FS include Monitored Natural Attenuation (MNA) with LUCs, pH adjustment (for metals), bioremediation (for VOCs), phytoremediation (for tritium), and carbon treatment, resin encapsulation, or other emerging remediation technologies for PFAS as appropriate.

2.6.2 Innovative Remedial Technologies

Although standard remedial technologies and process options should provide appropriate protection to human health and the environment, innovative technologies will be considered and evaluated for the DAG OU in the CMS/FS stage of development.

2.7 Potential Early and/or Interim Remedial Actions

Characterization data will be evaluated with the USDOE, USEPA, and SCDHEC to cooperatively develop the best strategy for implementing early actions at the DAG OU, if warranted. A modeling task will be developed to implement a flow and transport model that will assist in assessing the feasibility and effectiveness of early, interim, or final actions.

3.0 DATA QUALITY OBJECTIVES (DQO)

The data quality objective (DQO) process was developed by USEPA as guidance for data collection activities (USEPA 2006). The DQOs are developed using an interactive and iterative process approach to decision-making based on seven steps outlined by USEPA guidance: 1) state the problem, 2) identify the goal(s), 3) identify the information inputs, 4) define the boundaries of the study, 5) develop the analytic approach, 6) specify performance or acceptance criteria, and 7) develop the plan for obtaining data.

DQOs are useful in identifying data gaps and in developing SAPs that describe the procedure for collecting sufficient data of known and defensible quality. These data are used to define the nature, magnitude, and extent of contamination and to define human health risks. In turn, these finding will facilitate development of sound decisions concerning remedial response activities. DQOs also assist in determining appropriate detection limits, analytical methods, and sampling and handling procedures/ requirements.

The focus of the DQO development process is efficient planning for data collection. This process is participatory, encouraging input and consensus from all data users, thus facilitating the understanding and acceptance of project goals. The DQO process applies to the entire planning team, including management, regulators, and technical personnel. The DQO process is a series of planning steps based on the scientific methods (Section 3.1.2 through 3.1.8 of this document) detailed in *Guidance of Systematic Planning Using Data Quality Objectives Process* (USEPA 2006). This process provides a systematic, flexible approach to decision-making. Although the steps are described

sequentially, the DQO process is iterative. The results of the DQO process are a set of data specifications and an efficient, cost-effective SAP. Thus, major benefits of the DQO process are as follows:

- Promotes efficient, cost-effective, and timely data collection;
- Provides a thorough, systematic approach to relate data collection specifications to the end needs of the data users;
- Involves the decision-makers and the assessment technical team in a establishing definitive plan with objective criteria;
- Aids in communicating and understanding the levels of risk and the basis for decisions; and
- Encourages critical thinking about data gathering and interpretation.

3.1 DQO Evaluation

3.1.1 Conceptual Site Model (CSM)

USEPA guidance for CERCLA RIs stresses the need and utility of conceptual representation of the unit under consideration. Such a representation provides an objective framework around which existing information can be organized and synthesized, data gaps can be identified, and sampling programs can be designed to address critical data needs identified in the DQO process.

The conceptual site model (CSM) follows USEPA guidance for conceptual representation. It depicts the preliminary understanding of the site and focuses on identifying potential CM from the sources to potential receptors. The CSM for DAG OU is presented in Figure 18. The CSM identifies potential sources of contamination, release mechanisms, media of concern, exposure routes, and potential receptors. Each of these components is described below.

3.1.1.1 Exposure/Physical Attributes

The primary sources to the DAG OU are contaminant releases and process spills or leaks from subunits associated with the DEXOU and DAOU. These primary sources include the 488-DAB, 489-D CPRB, 432-2D DRP, 484-17D DCSA, DHWF (411-D, 412-1D, and 413-D), DHWRF (420-D Concentrator Building), 420-2D Rework Handling Facility, 421-2D Moderator Handling and Storage Building, Fire Training Area (411-1D/411-3D) and the Gasoline Station (715-D).

3.1.1.2 Primary Release Mechanisms

Contaminants may have been released from the primary sources by the following primary release mechanisms:

- Operation of facilities;
- Spills and leaks from process-related activities and maintenance;
- Runoff and deposition from the surface units; and
- Infiltration/percolation/seepage from the surface units.

3.1.1.3 Secondary Sources of Contamination

Secondary sources of contamination at the DAG OU include surface soil (0 to 0.3 m [0 to 1 ft]) and subsurface/deep soil (0.3 m [1 ft] to water table depth) in areas where the primary sources may have been released through infiltration, seepage, surface runoff, and/or discharge.

3.1.1.4 Secondary Release Mechanisms

The secondary sources may release contamination to other media through infiltration/ percolation and leaching of contaminants from soils (all depths) to groundwater.

3.1.1.5 Exposure Pathways (Media)

Contact with contaminated environmental media creates pathways for human and ecological receptors. The exposure pathway (media) at the DAG OU is groundwater (human receptors only).

3.1.1.6 Exposure Routes

The final element in the CSM that links the primary sources to the potential receptors are the exposure routes. Exposure routes for human receptors may including ingestion of contaminated groundwater and showering (includes dermal contact and inhalation).

A quantitative risk assessment is not planned to be conducted for the DAG OU, but rather contaminant concentrations in the groundwater (and surface water) will be compared to MCLs, tap water RSL in the absence of a MCL, and USEPA drinking water health advisory limits (PFAS only) to determine exceedances. Formal human health and ecological risk assessments for the surface water and sediment media will be performed under the SRFS IOU.

3.1.1.7 Receptors

A hypothetical future resident receptor scenario will be used to evaluate exposure to the groundwater media for the DAG OU. Both human health and ecological risk assessment to surface water and sediment will be evaluated as part of the SRFS IOU.

3.1.2 State the Problem

The initial step in the DQO process is to define the problem for the DAG OU so that the focus of the investigation will be clear and disciplined. This step entails summarizing and evaluating data from previous investigations (Section 2). A CSM is then developed (Section 3.1.1), and potential exposure pathways are identified.

Previous characterization and monitoring activities indicate the presence of VOCs, tritium, low pH/metals, and PFAS in the groundwater. Although groundwater investigations have

shown the groundwater is contaminated, the extent of contamination has not been completely defined. Data are required to define the extent of contamination and plume geometry and to develop the appropriate RAOs.

VOCs (primarily TCE), tritium, low pH/metals, and PFAS are the primary contaminants and exceed MCLs (or RSLs as appropriate) and/or drinking water health advisory limits (PFAS) in groundwater. The resultant groundwater plume discharges to the southwest to the D-Area Effluent Discharge Canal and Beaver Dam Creek and into the D Area wetlands. Surface waters in the D-Area Effluent Discharge Canal and Beaver Dam Creek exhibit low pH and metal concentrations that exceed respective MCLs and RSLs.

3.1.3 Identify the Decisions

The purpose of this DQO step is to identify the decisions that must be supported with the collected data to address the problem. This step helps define the objectives of the field investigation.

Figures 9 through 17 show the locations of the plumes in DAG OU. The following are decisions that need to be addressed for the groundwater under this RFI/RI Work Plan:

- Complete groundwater characterization of the plume boundaries and determine current groundwater flow direction;
- Install and/or augment existing groundwater monitoring well network to monitor groundwater quality and movement of the groundwater plumes; and
- Collect applicable suite of analytes from selected monitoring wells.

The following are decisions that need to be addressed for surface water under this work plan:

- Collect surface water to monitor impact to receiving streams from groundwater plume movement.

Environmental measurements are necessary to adequately characterize the data gaps. Resources available to resolve the problem include water sampling, sample collection, and the installation of monitoring wells, as well as, limited sediment sampling.

Unit screening data will be compiled and evaluated as part of this investigation in accordance with USEPA guidance (USEPA 2006). In conjunction with existing data, the new data will be used to address the decisions listed above and to determine whether the contaminants exceed ARAR criteria, MCLs or RSLs (as appropriate), USEPA drinking water lifetime health advisory limits (PFAS), or background concentrations. Unit-specific stratigraphic and hydrostratigraphic data will support the design and implementation of remedial actions. A strategy for determining potential remedial alternatives is discussed in Section 2.5.

3.1.4 Identify the Inputs to the Decisions

The purpose of this step is to identify the information needed to support the decisions presented in Section 3.1.3 and to specify which inputs require new environmental measurements. Existing data that supports the decisions are also addressed. Each of the following inputs requires new environmental measurements:

Groundwater

- Definitive-level analytical data for groundwater media to determine if MCLs or in the absence of MCLs, RSLs and USEPA drinking water lifetime health advisory limits are exceeded;
- Hydrostratigraphic and groundwater hydrologic characteristics to provide inputs into contaminant fate and transport analyses; and
- Definitive- and screening-level groundwater data from the UTRA, and if necessary GA, to determine plume extent and geometry and to perform groundwater modeling.

Surface Water

- Screening-level data from the D-Area Effluent Discharge Canal and other surface water features as appropriate to monitor groundwater discharges for impact to surface water.

3.1.5 Define the Boundaries of the Study

The purpose of this step is to identify the spatial limits of the affected media and to determine the discrete area affected by the remedial decisions. This step also investigates temporal changes in the plumes over time. This work plan is using the guidance of monitoring stations that have been previously installed and established for years and provide a benchmark for the spatial boundaries of the individual contaminant plumes of concern. A planned comprehensive sampling event will commence after the installation of additional monitoring points and is expected in early 2023. The generalized plume areas are depicted on Figures 9 through 17.

The primary goal of the RFI/RI Work Plan is to determine the extent of groundwater plume boundaries in the DAG OU. These boundaries will determine the populations at risk and will affect the selection of the preferred remedial alternative.

3.1.6 Develop Decision Rules

The purpose of this step is to integrate the output from the previous steps of the DQO process to form a statement that defines the conditions of the OU so that the decision maker can chose among the appropriate alternative actions. These actions encompass the entire CERCLA process. Figure 7 depicts the location of the monitoring points that require additional data confirmation, as well as the location of new borings and monitoring wells to assess the extent of VOC and PFAS contamination. It is expected that the extent of contamination will be adequately defined after completion of these work plan activities.

MCLs will be the primary point of comparison for groundwater constituent concentrations according to the protocols established in the FFA (FFA 1993). In the absence of an MCL for a constituent, the USEPA tap water RSL will be the primary point of comparison for

an Action Level. PFAS water concentrations will also be compared to the USEPA drinking water health advisory limits. PFAS soil concentrations will be used to determine if future potential impacts to groundwater exist.

Completion of the comprehensive sampling analysis will lead to the presentation and analysis of sampling results for potential continued characterization of contamination extent, determination of COCs, and evaluation of remedial alternatives with the support of groundwater modeling.

3.1.7 Specify the Limits on Decision Errors

This section presents guidelines for the decision maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data. Due to the inherent uncertainty introduced by heterogeneity and error in sampling, storing, transporting, and analyzing environmental media, it is important to specify the acceptable decision error rates. Potential errors resulting from field sampling modifications implemented will be minimized by using standardized sampling and analytical procedures. SRNS developed specific technical instructions for collecting samples for PFAS analysis that minimize the risk of anthropogenic PFAS contamination.

All constituents will be analyzed at levels that allow comparison against established MCLs or RSLs or risk-based concentrations (RBCs). The analytical method chosen must be capable of achieving a Practical Quantitation Limit (PQL) below the established MCL, RSL, or RBC. The project will use the results to determine COCs and support a remedial decision that can be agreed to by the USDOE, USEPA and SCDHEC.

Existing groundwater data are summarized in Section 2.3 and provide a baseline for comparison to data obtained under this proposed work plan. Over 20 years of results have been obtained at the DAG OU, which provide a high level of confidence in the data quality and allow for the easy identification of any data anomalies.

3.1.8 Optimize Design for Obtaining Data

This section discusses the most effective sampling and analysis design for generating the data that are expected to satisfy the DQO process needs by reviewing all existing data, performing a characterization, and interpreting the results in a time frame that allows for timely completion of the RFI/RI/BRA.

The final step in the DQO process is development of a SAP that takes into account the problems key decisions, environmental variables, and method for identifying the spatial and temporal boundaries of the contamination and populations at risk. SAP content is provided in Sections 5.0 through 7.0.

3.2 Summary of DQO Evaluation

This section discusses the unit characterization objectives as they address the CSM and meet the DQO needs. The data needs developed under the DQO process are summarized in Tables 3 through 6.

Groundwater samples will be collected from the UTRA and GA to monitor for VOCs, low pH/metals, tritium and PFAS. Surface water samples will be collected from Beaver Dam Creek and the D-Area Effluent Discharge Canal to monitor the discharge of, if any, contaminated groundwater. This information will be coordinated for evaluation with the SRFS IOU. Results will be compared to the appropriate MCLs or RSLs as well as USEPA drinking water lifetime health advisory limits for PFAS.

4.0 UNIT ASSESSMENT

The unit assessment for the DAG OU makes use of existing datasets developed from historical data and groundwater monitoring. These data have been used to identify remaining data needs, streamline characterization efforts, eliminate unnecessary sampling, and provide sufficient data to make decisions at various points in the environmental assessment process. The data will be used to support fate and transport analysis, support a comparison of groundwater concentrations to ARARs, MCLs or RSLs (as appropriate) and

USEPA drinking water lifetime health advisory limits (PFAS) to satisfy the CERCLA requirements and identify problems warranting response action, and evaluate RAOs for the DAG OU. The process to qualify the risk to human health and ecological receptors in the Savannah River and other surface water features in D Area is being addressed by the SRFS IOU. Any surface water and sediment sampling/results conducted by the DAG OU work plan will be coordinated with the SRS IOU program.

4.1 Objectives

This section presents the unit characterization objectives as they address the conceptual site model (CSM) and meet the DQO process needs. The following data needs were identified as an outcome of reviews conducted on the DAG OU characterization and monitoring datasets:

- Delineate the vertical and horizontal extent of contamination at the DAG OU;
- Continue surface water monitoring in the D-Area Effluent Discharge Canal on an annual basis;
- Install new monitoring well(s) and sample for VOCs, pH, metals, tritium and PFAS as necessary;
- Sample existing monitoring wells for VOCs, pH, metals, tritium and PFAS as necessary;
- Collect surface water and sediment in co-located points upstream and downstream of potential PFAS contaminated groundwater discharge(s); and
- Collect enhanced attenuation parameters for appropriateness of monitored natural attenuation.

The primary objective of the additional characterization sampling for the DAG OU is to address data needs identified by the USDOE, USEPA, and SCDHEC that concern groundwater conditions within the DAG OU that exceed MCLs (or tap water RSLs in the absence of an MCL), as well as USEPA drinking water lifetime health advisory limits

(PFAS) and that may warrant action. This additional information, in conjunction with existing characterization data, will be used to develop an RFI/RI/BRA.

All groundwater samples will be analyzed by SCDHEC-certified laboratories. Groundwater samples will be definitive-level data and will be analyzed for VOCs, metals, tritium and PFAS.

The field investigation will be conducted in compliance with SRS Manual 3Q1, *Hydrogeological Data Collection (U)* (SRS 2019b).

During groundwater unit assessment, field quality control (QC) samples consisting of duplicates, splits, rinsate blanks, field blanks, and trip blanks, will be collected, with samples designated for screening-level analyses. Duplicates and splits will be analyzed for the same parameters as the associated samples. Rinsates will be collected at the rate of one per 40 samples and will only be analyzed for TCL VOCs. Field blanks will be collected at 10% of the sampling locations. Trip blanks will be collected and shipped. If contamination is detected in any field QC blank, contamination of associated samples will be assumed.

4.2 Primary Source Characterization

The following were previously identified to be the sources of groundwater contamination in the DAG OU:

- 484-17D DCSA;
- 488-D Ash Basin;
- 489-D CPRB;
- DHWRF (primarily 420-2D Concentrator Building);
- 420-2D Rework Handling Facility;
- D-Area Heavy Water Facility (411-1D, 411-D, 412-1D, 412-D, 413-1D. and 413-D);
- 431-2D D-Area Rubble Pit;
- 421-2D Moderator Handling and Storage Building;
- Fire Training Area (411-1D and 411-3D); and
- Gasoline Station (715-D).

All of these sources of groundwater contamination have been removed or remediated under separate actions and do not present continuing sources of groundwater contamination.

4.3 Secondary Source Characterization

Secondary sources include impacted soils in and around the facilities as listed in Section 4.2. Soil sampling will be conducted at boring/well locations near the 411-D Fire Training Area and 715-D Gasoline Station during drilling for the analysis of PFAS constituents.

Some limited sediment sampling will be conducted in conjunction with surface water collection to access possible relationships between PFAS contaminated groundwater discharging to the D Area surface water features (i.e., discharge canal, streams).

4.3.1 Boring Investigations

Soil borings will be drilled at two locations within the 411-D Fire Training Area to further characterize PFAS contamination (Figure 7). This will include soil sampling at multiple depths throughout the vadose zone, UTRA and into the GA at both locations.

4.4 Exposure Media Characterization

Groundwater is the primary exposure media at the DAG OU as presented in the CSM (Figure 18) and in Section 3. Groundwater samples will be collected from existing and new groundwater monitoring wells. This data will be used to determine the extent of the PFAS plume, and provide current baseline conditions for the VOC, low pH/metals, and tritium plumes that will be input into a groundwater model. Surface water samples will also be collected to assess the discharge of contaminated groundwater into the D-Area Effluent Discharge Canal and other surface water features.

4.4.1 Existing Groundwater Monitoring Wells

Groundwater samples will be collected from the monitoring wells that comprise the DAG OU monitoring network (Table 1). Nineteen additional monitoring wells were recently installed throughout D-Area in the UTRA and GA during 2020 and 2021 to further supplement the DAG OU monitoring network. This includes ten (10) UTRA wells and nine (9) GA wells (Figure 7). Existing groundwater monitoring wells will be sampled for VOCs, pH, metals, tritium and PFAS to provide data for the assessment of plume movement and outcropping to Beaver Dam Creek, the D-Area Effluent Discharge Canal, and other surface water features in D Area.

Groundwater samples will also be collected from nine existing wells (DAP 2, DCB 20A, DCB20B, DCB 20C, DCB 20D, DCB 43A, DBC 43C, DCB 64, and DUT001) that are currently not part of the DAG OU monitoring network (Figure 7).

4.4.2 New Groundwater Monitoring Wells

Four (4) new monitoring wells will be installed to further characterize PFAS and VOC groundwater contamination (Table 1, Figure 7). This includes one UTRA well and three GA wells.

Groundwater samples obtained from the new groundwater monitoring wells will be analyzed for VOCs, pH, metals, tritium and PFAS as necessary to provide data for the assessment of plume extent, movement, and outcropping to the D-Area Effluent Discharge Canal, Beaver Dam Creek, and other surface water features.

4.4.3 Surface Water Sampling

Surface water sampling will be conducted annually within the D-Area Effluent Discharge Canal, Beaver Dam Creek, and other surface water features. Surface water sample locations DSWM-1 through DSWM-4 will continue to be sampled for VOCs and tritium. Surface water sample locations DSWM-4 though DSWM-10 will continue to be sampled for pH and metals. Surface water stations (DSWM-1 through DSWM-10) were also

installed to support the DAG OU Treatability Study and/or further supplement the DAG OU monitoring network (Figure 7).

In addition, locations will be selected (pending field observations) for monitoring of surface water with a single corresponding sediment sample in co-located points upstream and downstream of potential PFAS contaminated groundwater discharge(s).

4.5 Physical Characteristics

Geologic descriptions of the soil cores collected as part of the Fire Training Pit soil borings and well installations will be conducted. The physical and lithologic descriptions will be used to enhance the hydrogeologic CSM at those locations.

5.0 SAMPLING DESIGN AND RATIONALE

Implementation of the SAP to obtain decision-quality data for each subunit/media is documented in the remaining sections of this sampling and analysis plan. The following section describes how the plan is implemented to collect the physical data to meet the criteria developed during the DQO process. Table 7 lists the laboratory analytical specifications for the samples as described below.

5.1 VOC Plume

Since the groundwater sampling was initiated in 2004, the VOC plume has been well characterized for concentration and trend data for the UTRA. However, the horizontal extent of the plume as well as the depth of the plume are not well defined, there is the potential that contamination has reached the GA and is expanding vertically. These parameters will be addressed by increasing the number of available wells to sample as well as by installing additional wells into the GA. The VOC plume is also a candidate for an MNA remedial decision, so MNA parameters will be incorporated into the early sampling events to obtain baseline values for pertinent MNA parameters. Surface water will be initially screened for VOCs as well.

5.2 pH and Metals Plume

Since the pH and metals plume has been well defined in past sampling events and the major sources (CPRB and DCSA) of acidic conditions have been addressed through response actions, the sampling design for this plume will focus on horizontal and vertical geometry of the affected groundwater, as well as trends in concentrations. Additionally, since there is a high likelihood of metals seeping into streams, surface water will be analyzed for metals and compared to their respective MCLs or RSLs. Refer to Table 7 for the list of metal analysis to be performed.

5.3 Tritium Plume

The tritium source material has been removed and is no longer contributing to the groundwater plume in D Area. Because of this and its relatively short decay half-life (12.3 years), the plume is expected to shrink and degrade with time over the duration of the next several years. Plume sample design will focus on the trends of the tritium and the geometry of the plume to monitor and support decisions on remedial design, if needed.

5.4 PFAS Plume

The PFAS plume had been initially sampled in 2019 and has many evolving analytical considerations as an emerging contaminant. The current sampling protocol is a rigorous routine to avoid cross contamination and utilizes specialized equipment that has no suspected means of cross contaminating the groundwater samples. Tables 7 and 8 list the PFAS constituents that will be analyzed for in the samples collected in the suspected PFAS plume, and the collocated surface water and sediment collection points.

As with the other DAG OU plumes, the concern for PFAS is to establish the vertical and horizontal extent of the plume through the sampling of existing and recently installed groundwater monitoring wells as well as future monitoring wells in the UTRA and GA. In addition, sediment and surface water sampling will be conducted at collocated points in streams to correlate the possibility of PFAS seeping into stream beds and binding to the sediment in those streams. This strategy will help establish the potential human and

environmental risks associated with PFAS from surface water and/or groundwater movement.

PFAS sampling was conducted in 4Q21 at existing groundwater wells, surface water stations, and sediment locations to further delineate the DAG OU PFAS plume. New soil borings/sampling and monitoring water stations as outlined in Table 1 will be investigated and installed during 2022.

6.0 ANALYTICAL PLAN

This section describes the data quality levels for each type of data being collected. All data collected under this SAP will follow the Area Completion Projects (ACP) Quality Assurance Program Plan (QAPP) for Environmental Data Collection and Management (SRS 2019a). The data quality level is determined by the intended use of the data.

6.1 Data Quality Levels for DAG OU

The data quality level for the permanent wells and surface water stations will be Verified and Validated (V&V) data level. Requirements for V&V data are listed in Table 8. Water samples may be analyzed using USEPA approved methods for constituent analysis or screening methods to determine field results (i.e., dissolved oxygen, pH, turbidity, etc. Data will be qualified by the SRNS auto-validation software module for the following aspects of USEPA Functional Guideline Criteria to achieve the V&V quality level: Quantitation Limits, surrogate or tracer recoveries, blanks (method/lab/prep, trip, field, rinsate), lab control sample recoveries, matrix spike recoveries/duplicates, lab replicates, field duplicates, cooler temperatures, chemical preservation, holding times. The laboratory will provide an electronic data deliverable and case narrative and respond to inquiries about the analytical data package for SRNS to run the auto-validation software. All fatal errors, data errors, and warnings will be fixed during the verification process, and the data set will be reviewed for completeness. The auto-validation routines will be conducted, and the

data qualified accordingly. Data usability will be assessed using the following PARCC parameters:

1. **Precision** is the mutual agreement between individual measurements of the same property under similar conditions. Precision is determined from the field and laboratory duplicate analyses and indicates the consistency of field and laboratory techniques.

2. **Accuracy** is determined from the laboratory control samples; matrix spikes; serial dilutions; surrogates/tracers; internal standards/carriers; and the results of the method, field, trip, and equipment rinsate blanks. Accuracy indicates the ability of the field and laboratory process to generate correct results. Blank results specifically monitor for any contamination from sample processing. Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. For this project, representative data will be obtained through careful selection of sampling locations and analytical parameters, Representative data will also be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

3. **Representativeness** of data will also be ensured through consistent application of established field and laboratory procedures. Laboratory, field, and trip blank samples will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined to be nonrepresentative, by comparison with existing data, will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

4. **Completeness** is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with sampling matrix table and QC procedures outlined in this document, and none of the QC criteria that affect data usability are exceeded. When all data validation is completed, the percent completeness value will be calculated by dividing the number

of useable sample results by the total number of sample results planned for this investigation.

5. **Comparability** expresses the confidence with which one data set can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data. Field procedures are standardized, and field operations will adhere to SOPs to ensure comparability. The comparability of laboratory data will be assured by use of established and approved analytical methods and by certified laboratories, consistency in the basis of analysis (wet weight, volume, or similar units), and consistency in reporting units (ppm, pCi/mL, etc.). Comparability will be determined from split and duplicate sample comparisons or screening level and definitive level comparisons. Comparability is an indicator of both precision and accuracy.

Table 9 lists the preservatives, holding times and bottle requirements for groundwater and surface water to meet the data qualities necessary to meet the DQOs.

6.2 Field Analytical Sampling Quality Assurance/Quality Control

QC samples will consist of field duplicates, rinsate/equipment blanks, trip blanks and split samples. Field quality assurance/quality control (QA/QC) will be maintained through the use of QA/QC samples and methods as described below.

1. Field Duplicate (co-located) Samples: Two or more independent samples collected from side by-side locations at the same point in time and space so as to be considered identical. These separate samples are intended to represent the same population and are carried through all steps of the sampling and analytical procedures in an identical manner. These samples are used to assess precision of the total method, including sampling, analysis, and site heterogeneity. Field duplicate samples are planned at a combined minimum rate of 5% according to ER-SOP-043, or typically 1 per 20 samples and analyzed for the same parameters as the associated samples.

2. Equipment Blank: A sample of water free of measurable contaminants poured over or through decontaminated field sampling equipment that is considered ready to collect or process an additional sample. The purpose of this blank is to assess the adequacy of the decontamination process. Also called rinse blank or rinsate blank. Equipment blanks are typically planned at a rate of 1 blank per 40 samples.

3. Trip Blank: A clean sample of water free of measurable contaminants that is taken to the sampling site and transported to the laboratory for analysis without having been exposed to sampling procedures. Trip blanks are analyzed to assess whether contamination was introduced during sample shipment (typically analyzed for VOCs only). A blank consists of distilled-deionized water provided by the laboratory to be placed in every cooler with VOC samples typically at the rate of 1 trip blank per cooler.

4. Split Samples: Two or more representative portions from a sample in the field, analyzed by at least two different laboratories and/or methods. Prior to splitting, a sample is mixed (except volatiles, oil and grease, or when otherwise determined) to minimize sample heterogeneity. These are quality control samples used to assess precision, variability, and data comparability between laboratories. Split samples are planned at a combined minimum rate of 5% or typically 1 per 20 samples and analyzed for the same parameters as the associated samples.

Table 9 lists the preservatives, holding times and containers required for the sampling plan.

6.3 Sample Matrix Table

Table 1 includes the detailed information for all locations where samples are to be collected. The number of duplicate, split, trip and blank samples will meet or exceed the requirements of Table 8 and will be based on field conditions and sample collection protocols (SRNS 2012 and SRNS 2019b).

6.4 Sample Location Map

Figure 7 illustrates the existing and proposed locations of samples to be collected for groundwater as well as surface water samples.

7.0 FIELD IMPLEMENTATION

The following sections outline the field implementation procedures and processes for the DAG OU RFI/RI Work Plan characterization effort. Additional implementing documents such as the environmental evaluation checklist, automated hazard analysis, and site-specific health and safety plan are internal to SRS, and detail day-to-day sampling operations and safety requirements.

7.1 Sample Collection Procedures and Processes

The DAG OU characterization effort will include groundwater and surface water as part of this SAP. The following specific procedures will be followed:

- Technical Oversight (TO) Requirements for Groundwater Monitoring Wells and Soil Borings, SRNS Manual 3Q1, Section 9004
- Sampling Groundwater Monitoring Wells, Tanks/Vessels (Sample Ports or Spigots) and Surface Water, SRNS Manual 3Q1, Section 9015
- Liquid Effluent and Surface Water Surveillance Sampling, SRNS Manual 3Q1, Section 3001

These procedures are consistent with the *USEPA Region 4 Field Branches Quality System and Technical Procedures* sampling procedures. Prior to beginning all field activities, all field crews will be required to read the procedures listed above and the TO will have had experience with those activities.

As described earlier, PFAS sampling involves a rigorous routine to avoid cross contamination. As of issuance of this SAP, the sampling regime is described in the

technical report *SRS Sample Collection Guidelines for Per- and Polyfluoroalkyl Substances (PFAS)* **(**SRNS 2021b).

7.2 Equipment and Decontamination Procedures

The following equipment will be required to sample groundwater and surface water:

- Camera for photo documentation;
- Field Logbook and/or Field Data Recorder with backup batteries;
- Global positioning system unit and backup batteries;
- Personal Protective Equipment;
- KIJ5 radio, Cell phone, and pager;
- All sample bottles with preservatives;
- PFAS compliant pumps and tubing; and
- Cooler and frozen blue ice or equivalent for packing samples in the field.

Equipment needs will vary from day to day based on sampling requirements and field conditions. Specific needs will be addressed at plan-of-the-day meetings by the TO, industrial hygiene personnel, and safety personnel. Decontamination of field sampling equipment will be done in accordance to the 3Q1 Manual Procedure 9016, Section 5.4. Disposal of IDW will follow the job specific waste management plan.

7.3 Sample Documentation

Overall documentation will be done in accordance with *Area Completion Projects Quality Assurance Project Plan for Environmental Data Collection and Management* (SRNS 2012). Sample documentation will be conducted according to Manual C3, ER-SOP-043, standard operating procedure for *Obtaining and Managing Environmental Data for Environmental Compliance & Area Completion Projects*, which provides the general requirements and guidelines that are necessary for the documentation, record keeping, mobilization, collection, processing, reporting and storage of environmental data. Data Management Plan Q-DMP-B-00001, Environmental Restoration Data Management System, requires sampling information, such as barcoded dates, times, sample

identifications, weather, etc., to be recorded and maintained in logbooks and chain-of-custody documents included in the sampling package delivered to the project. Sampling documentation is tracked through a series of documents including:

- Mobilization Report;
- Chain-of-Custody Forms;
- Field Log Books;
- Analytical Data Packages; and
- SCDHEC and SRS required logs and forms.

A logbook for recording sample collection activities will be kept for this project. The subcontractor will ensure the logbook is correctly filled out and returned within two weeks after completion of sampling. Essential field information is: sample name, date of collection, time of collection, and sampler's name. Space should be provided for any field observations or comments relating to the quality or representativeness of the sample. Information on the parent sample of each field duplicate should be recorded.

7.4 Chain-of-Custody

Chain-of-Custody procedures establish requirements for sample custody and documenting custody from the time of collection through laboratory analysis. Chain-of-Custody demonstrates that samples obtained in the field have been securely collected and transported and have reached the analytical laboratory without alteration. Chain-of-Custody requirements are established by SRNS Manual 3Q1, Procedure 1001, *Chain-of-Custody Procedure*. At a minimum, Chain-of-Custody documents will include the following information which is compliant with USEPA requirements:

- Project name – i.e., monitoring well name, stream name, RFI/RI project name, etc.;
- Sample identification;
- Number of sample containers/bottles;
- Time of sample collection;
- Sample identifiers (bar-coded labels);
- Sample description;
- Whether a sample is persevered or unpreserved;

- Sampler's signature for each sample, the sampler indicates;
- Date of sample collection;
- Whether a sample is filtered or unfiltered; and
- Analyses to be performed.

A Chain-of-Custody record is used as physical and legal evidence of sample custody to trace the sample from collection through delivery to the analyzing laboratory and where the samples were stored. The Chain-of-Custody record must originate with the responsible organization or the person collecting the sample. Every sample is assigned a unique identification number that is entered on the Chain-of-Custody document. The Chain-of-Custody records each transfer of custody of the samples by a relinquishing party to a receiving organization whose name and identifying contact information is located on the form.

7.5 Sample Management and Shipping

Samples will be collected in accordance with SRNS Manual 3Q1, Section 9000, *Hydrogeologic Data Collection Procedures and Specifications* (SRS 2019b). Sample management for analytical laboratories and intra-SRS facilities is primarily controlled by SRNS Quality Assurance Manual 1Q, Procedure 13-1, *Packaging, Handling, Shipping, Storage and Receiving*. The purpose of this procedure is to define the requirements and specify the responsible parties and their roles for the packaging, handling, shipping, storage, and receiving of items to ensure that they are properly controlled to prevent damage or loss and to minimize their deterioration. Sample shipment is also regulated by SRNS Manual 19Q, Procedure 1.02, *General Transportation Requirements for Radioactive and Non-Radioactive Hazardous Materials*. These manuals provide specific requirements to sampler personnel for the required packaging, labeling, record-keeping, selection of appropriate transportation carrier, and appropriate transport container based on the analytically pre-tested nature of a sample. Samples associated with this RFI/RI Work Plan are non-hazardous and non-radiological as they represent environmental media rather than waste materials.

Samples will be stored in coolers with blue ice, if applicable, in the custody of the sampler, or designee, until delivered to the ACP Sample Packaging personnel in B-Area. If samples need to be stored over-night prior to delivery to the B Area sample-packaging group, then they will be stored in a locked facility with the Chain-of-Custody record, and in a refrigerator (4°C + 2°C) if required for sample preservation. ACP Sample Packaging personnel in B Area will manage, package, and ship samples to the laboratories in accordance with Manual C3, Volume IX Procedure ER-SOP-803B, *Packaging of Non-Department of Transportation (DOT) Samples for On-Site Transfers/Off-Site Shipments*. Table 9 lists proper preservatives, holding times, and sample containers for samples collected in the field, stored, and transported to the analytical laboratories.

7.6 Data Validation and Data Management

Requirements for data validation/verification and data management procedures are found in SRNS Procedures and Standard Operating Procedures, the USEPA Functional Guidelines, and two USDOE National Policies and Procedures:

- SRNS Manual C1, ER-AP-305 – Use of Field-Generated Blanks;
- SRNS Manual C1, ER-AP-306 – Laboratory Data Records Review;
- SRNS Manual C3, Volume X, ER-SOP-033 – Analytical Data Qualification;
- SRNS Manual C3, Volume X, ER-SOP-043 – Obtaining and Managing Environmental Data for Environmental Compliance & Area Completion Projects;
- Data Management Plan, Q-DMP-B-00001, Environmental Restoration Data Management System;
- Department of Energy Consolidated Audit Program, Policies and Practices, Procedure AD-1, Revision 2, November 10, 2009; and
- Quality Systems for Analytical Services, Revision 2.5, Department of Energy, November 9, 2009.

In addition, SRS procedures incorporate the criteria found in the USEPA National Functional Guidelines to verify, validate, and qualify analytical data to assess its usability

for risk and remedial management decisions. Adherence to this complex list of procedures and guidelines establishes: (a) if data meets the specific technical and QC criteria established by the DQOs and laboratory QAPPs; and (b) the usability of any data not meeting the specific technical and QC criteria. All data is qualified for usability using USEPA Functional Guidelines. Adherence to the guideline requirements and the USDOE Audit Program for analytical laboratories allows the data to be qualified based upon a set of nationally established functional guideline qualifiers for uniformity.

Depending upon the PQOs, data will be verified and/or validated according to the following criteria:

- Verification – Confirmation by examination and provision of objective evidence that the specified analytical requirements have been met. This is to be an electronic data deliverable completeness check for all required fields. Data verification consists of a completeness check to confirm that all sampling data and data fields requested from the laboratory have been received and comply with specified requirements.

- Validation – Confirmation by manual examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Data validation consists of any analyte and sample specific process for evaluating compliance of the laboratory data received with methods, procedures, or contract requirements.

The ACP Data Management group will enter sample collection and laboratory data into the Environment Restoration Data Management System (ERDMS) in accordance with Procedure ER-SOP-43. Properly completed and qualified data is entered into the ERDMS Database. Data records are updated, re-qualified, and continuously corrected for usability based on the results of electronic verification and manual validation evaluations as corrective actions are resolved with the analytical laboratories. A data usability report will be prepared that will accompany the RFI/RI/BRA and CMS/FS reports.

7.7 Investigation-Derived Waste Identification, Generation, and Management

Sampling activities associated with the DAG OU may generate aqueous investigation-derived waste (IDW). These materials will be managed in accordance with the IDW Management Plan (WSRC 2007). Aqueous IDW may consist of decontamination rinsates or monitoring well purge water, which may contain listed waste. Additional IDW-specific information will be documented in an IDW Management Strategy, which will be maintained in the project record file.

8.0 SAFETY, HEALTH, AND EMERGENCY RESPONSE PLAN

A unit-specific health and safety plan (HASP) (if required) will be prepared in accordance with 29 Code of Federal Regulations 1910.120 and approved prior to field investigations. This plan will meet Occupational Safety and Health Administration requirements and follow Savannah River Site safety, health, and emergency response plan guidance (WSRC 1996). All personnel involved in the performance of the work shall be familiar with the provisions of the HASP.

9.0 QUALITY ASSURANCE / QUALITY CONTROL PLAN

Precision, accuracy, completeness, representativeness, comparability, and documentation of the characterization are specified in the Savannah River Site site-level quality assurance manuals listed below:

- WSRC-RP-96-234, Revision 1, Savannah River Site RCRA Facility Investigation / Remedial Investigation Work Plan Safety, Health, and Emergency Response Plan, Quality Assurance / Quality Control, and Data Management Requirements (WSRC 1996)
- SRS Procedure Manual 1Q, *Quality Assurance Manual (U)* (SRS 2019a)
- SRS Procedure Manual 3Q1, Section 9000, Hydrogeological Data Collection Procedures and Specifications (U) (SRS 2019b)

Table 8 shows the QA/QC requirements of the sampling plan.

10.0 SCHEDULE

This section includes the proposed schedule of field activities, documents, and report submittals for the DAG OU. This schedule is subject to regulatory review timetables.

The estimated completion date for field activities is December 2030.

A summary of key deliverables and submittal dates are as follows:

Deliverable	Submittal Date
RFI/RI Work Plan /SAP	06/14/2021
Revision 0 RFI/RI Report with Baseline Risk Assessment	12/10/2024
Revision 0 Corrective Measures Study /Feasibility Study	03/10/2026
Revision 0 Statement of Basis / Proposed Plan	11/10/2026
Record of Decision	07/15/2027
Record of Decision Issuance	03/28/2028
Remedial Action Start	06/21/2029

The review schedule for these documents is shown in Figure 19, which also shows the schedule for preparation and review associated with regulatory documents.

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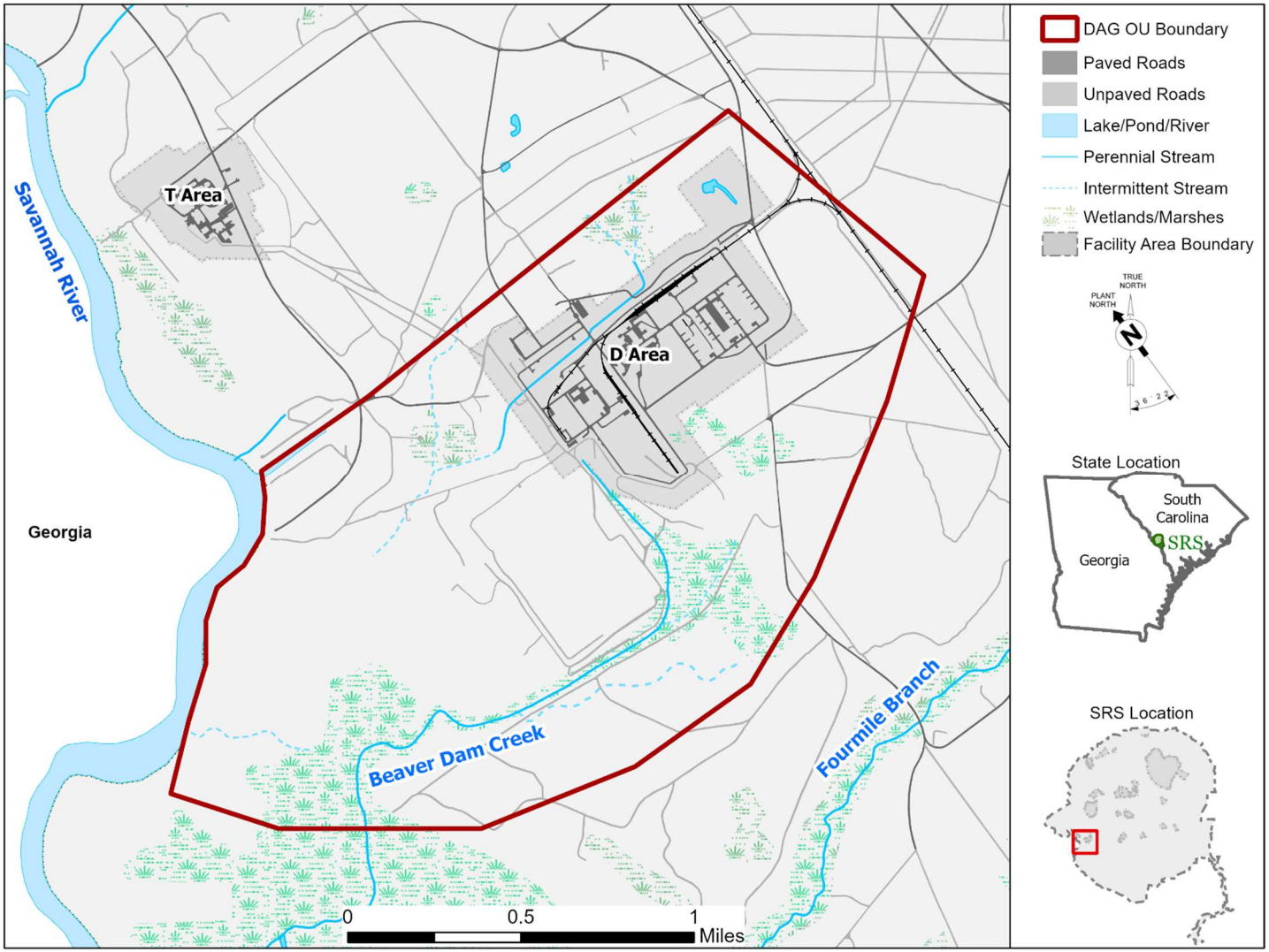

Figure 1. Location of D Area at the Savannah River Site

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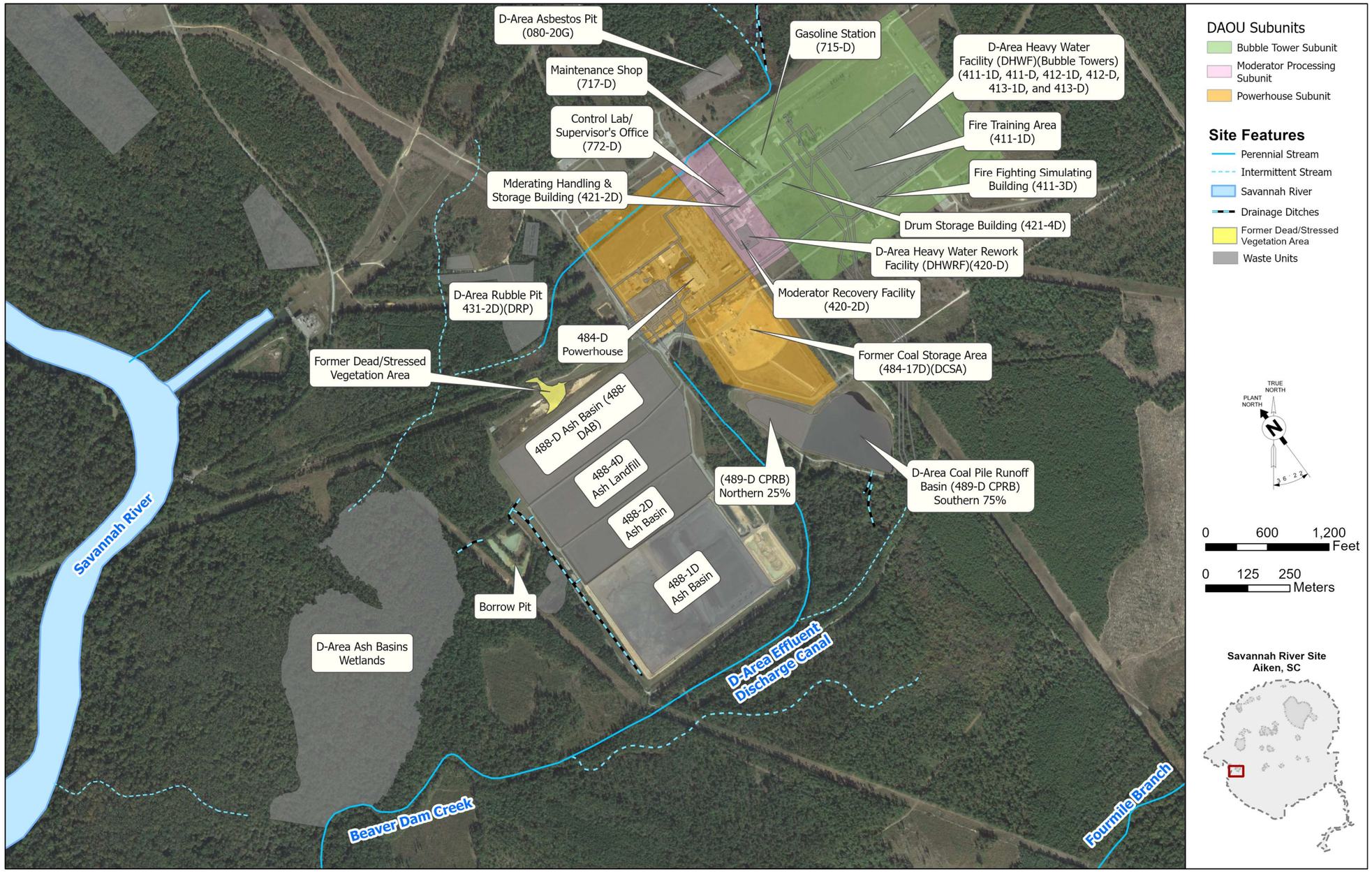

Figure 2. DAOU Subunits and Facilities

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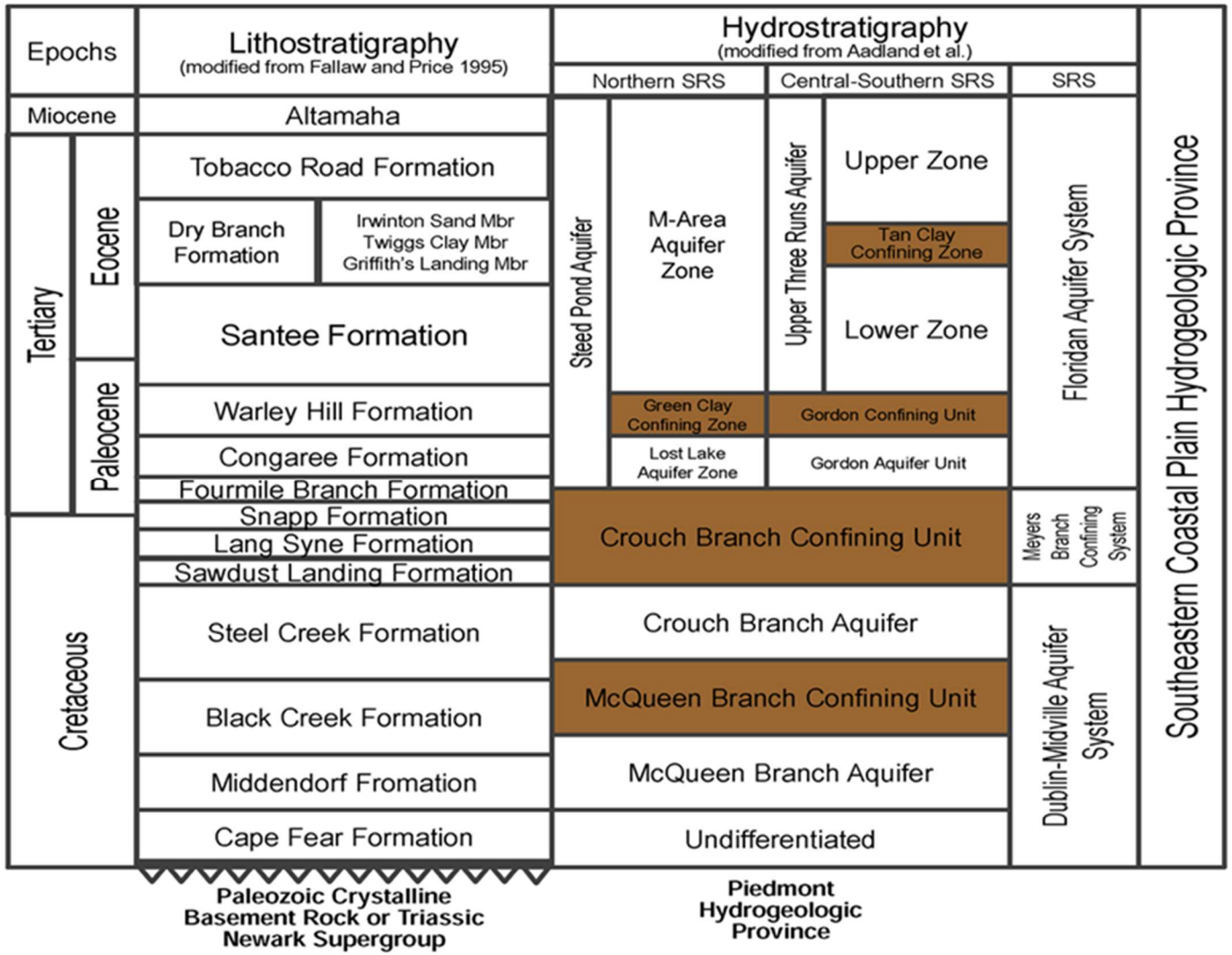

Figure 3. Lithostratigraphy and Hydrostratigraphy of the DAG OU (Central Southern SRS)

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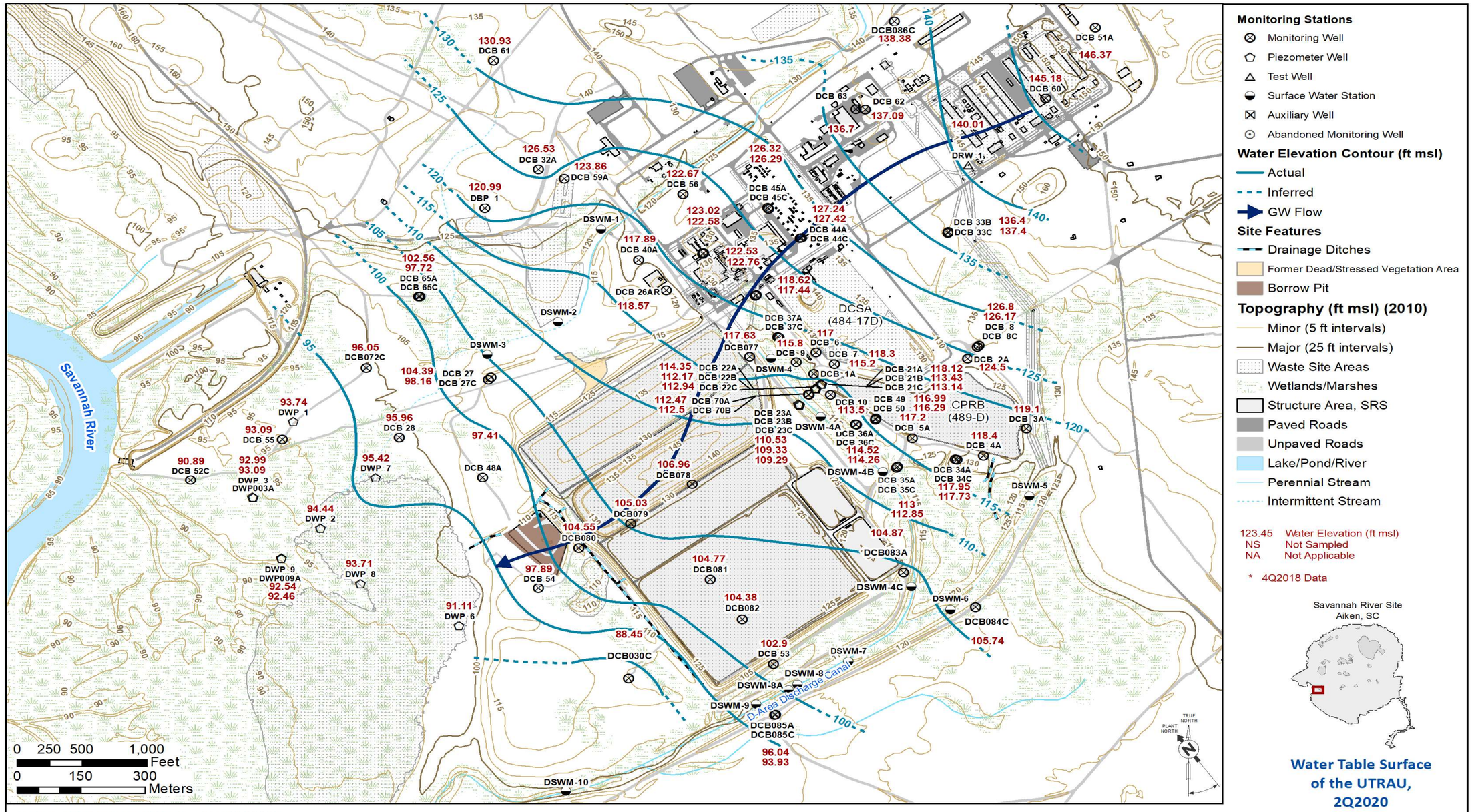

Water Table Surface of the UTRAU, 2Q2020

Figure 4. DAG OU Upper Three Runs Aquifer Groundwater Flow Direction (2Q2020)

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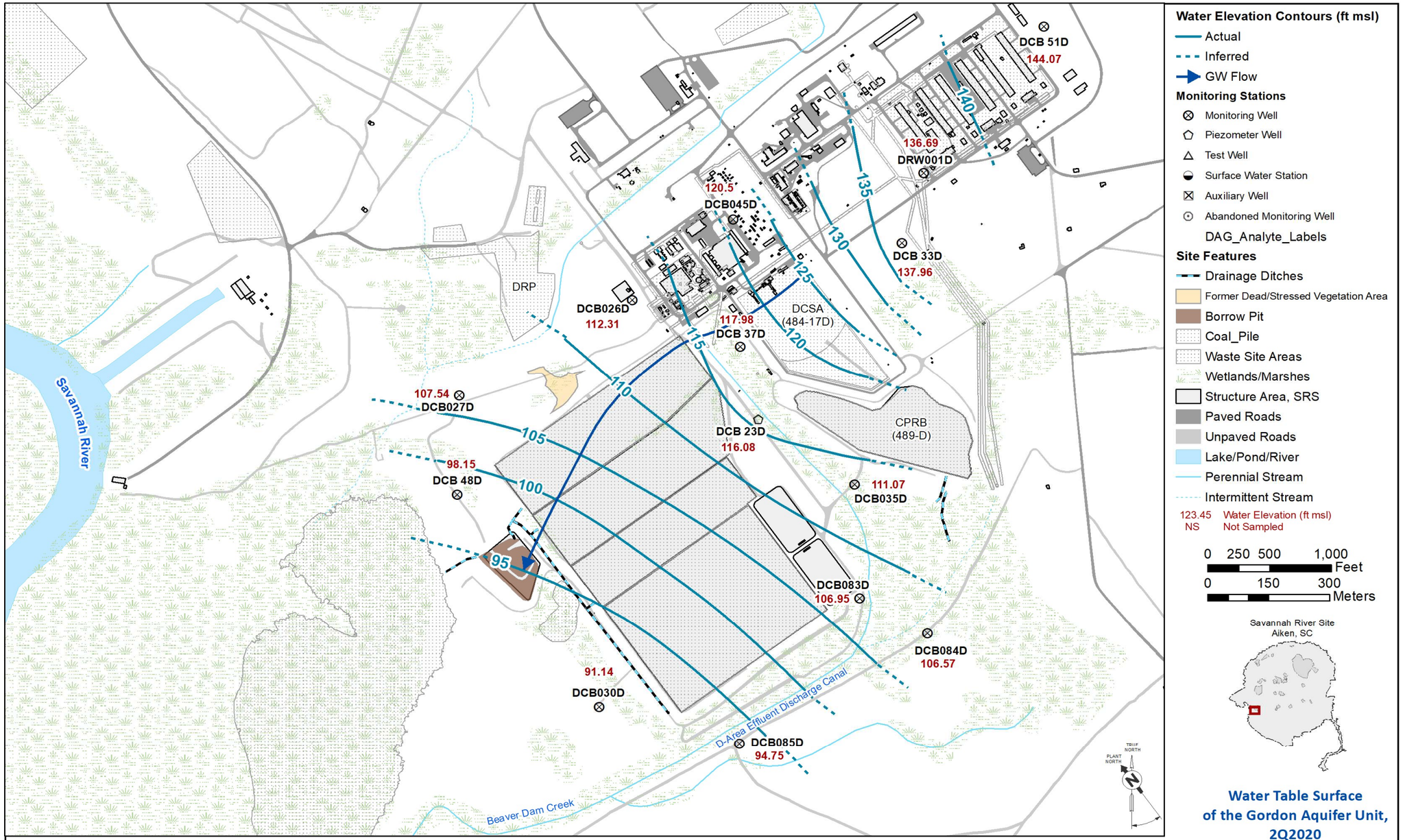

Figure 5. DAG OU Gordon Aquifer Groundwater Flow Direction (2Q2020)

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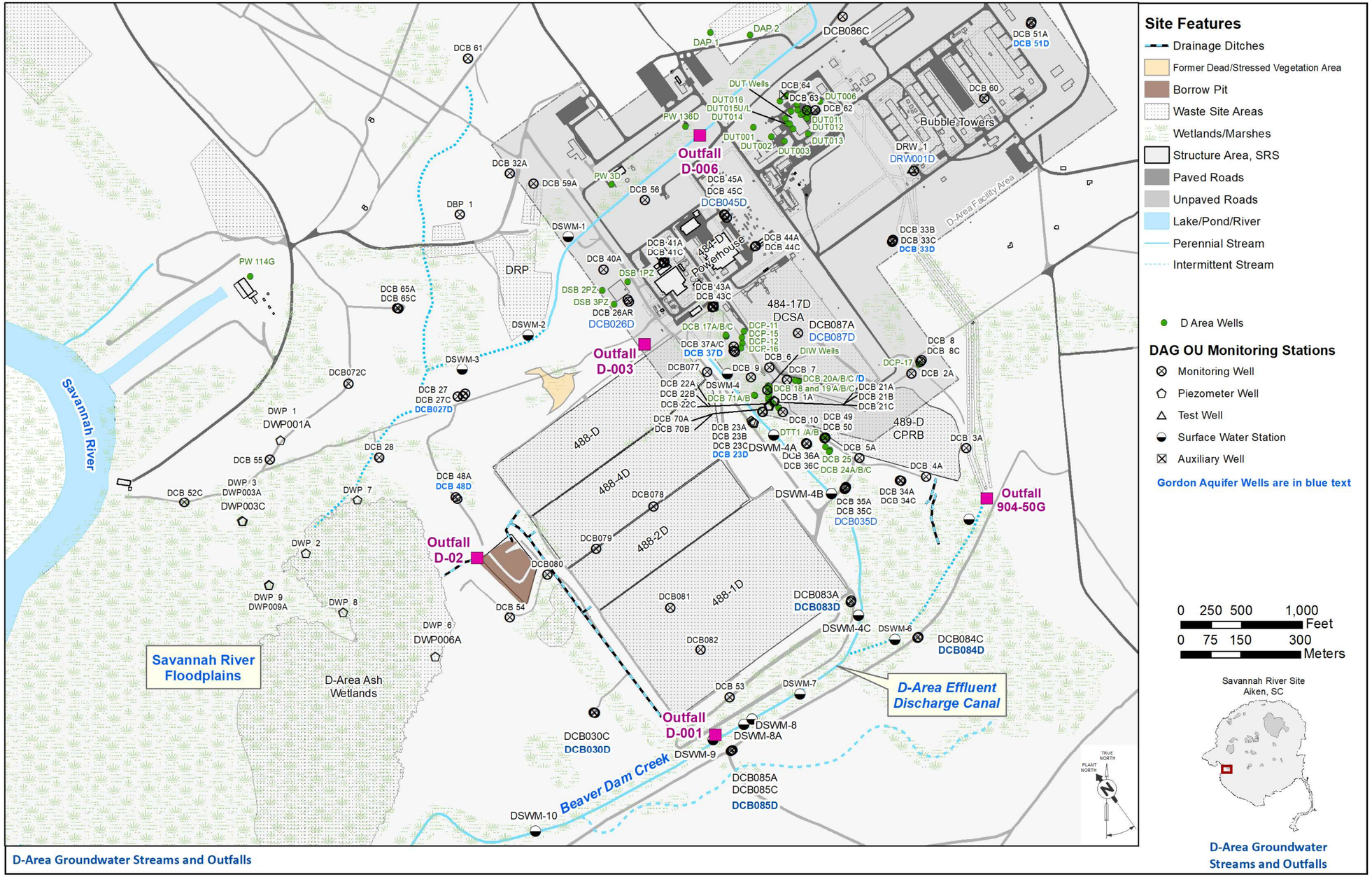

Figure 6. DAG OU Streams and Outfalls

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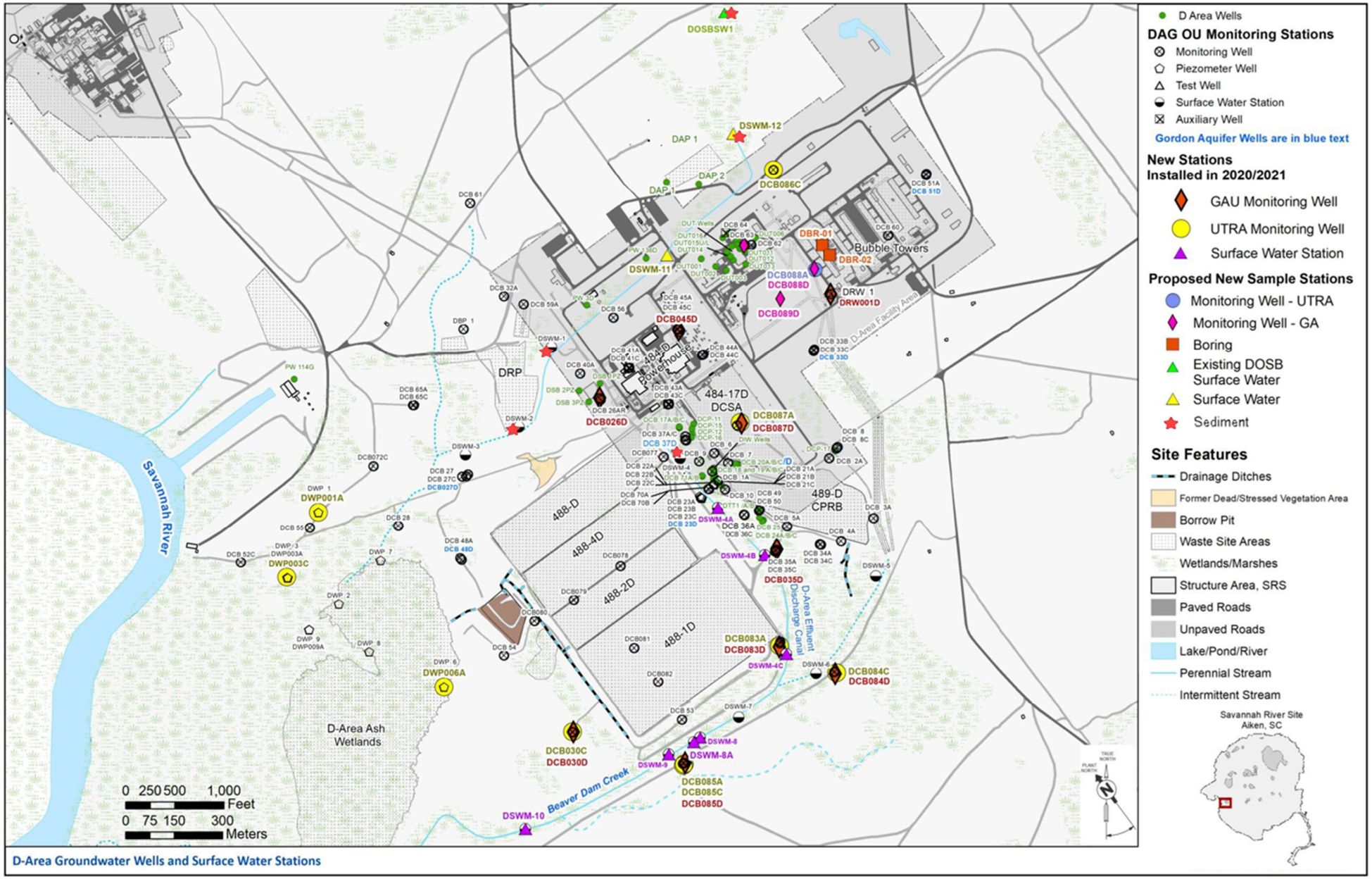

Figure 7. DAG OU Monitoring Well and Surface Water Stations

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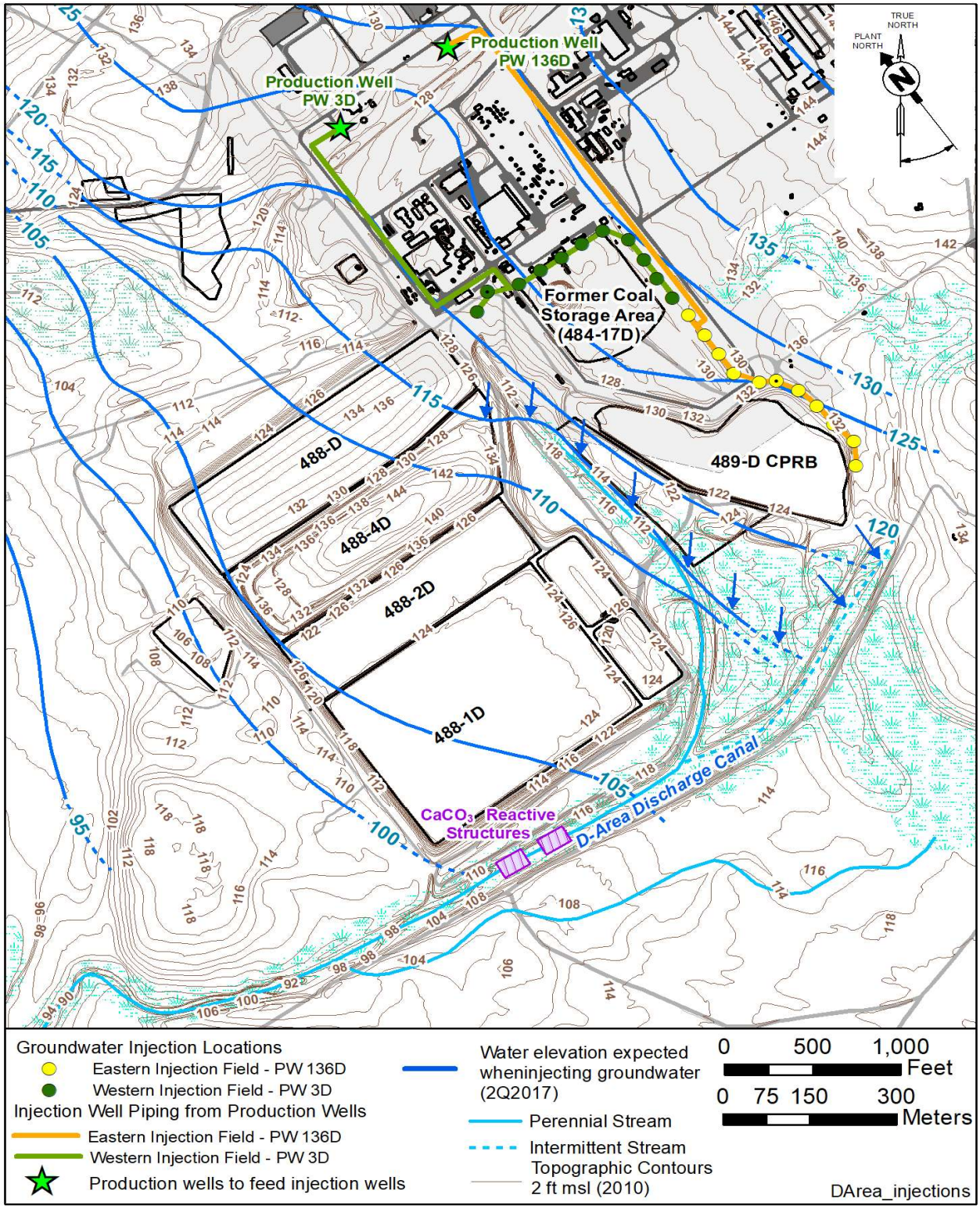

Figure 8. DAG OU Treatability Study Injection Well System

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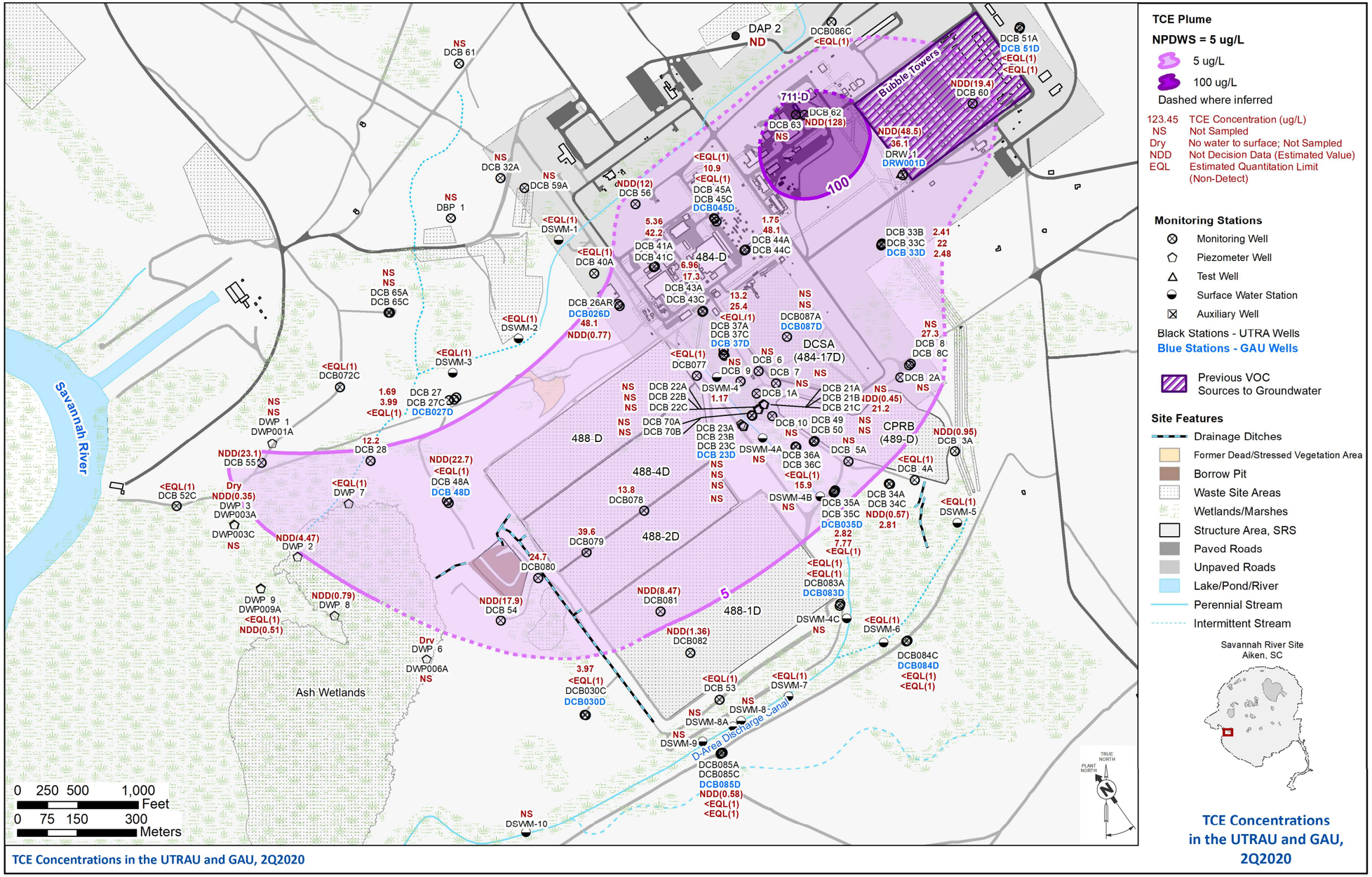

Figure 9. DAG OU VOC Plume (2Q2020)

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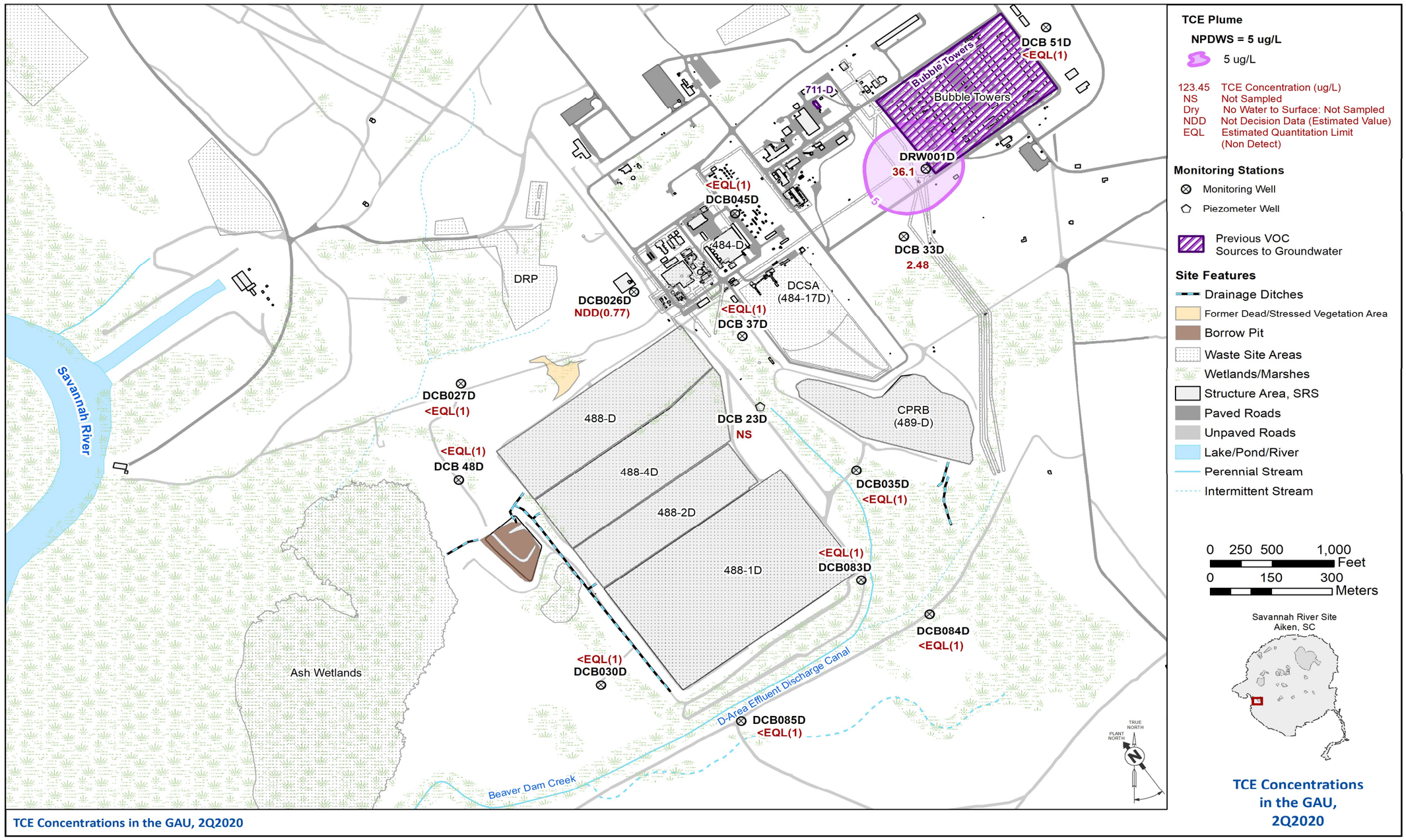

Figure 10. DAG OU Gordon Aquifer TCE Plume (2Q2020)

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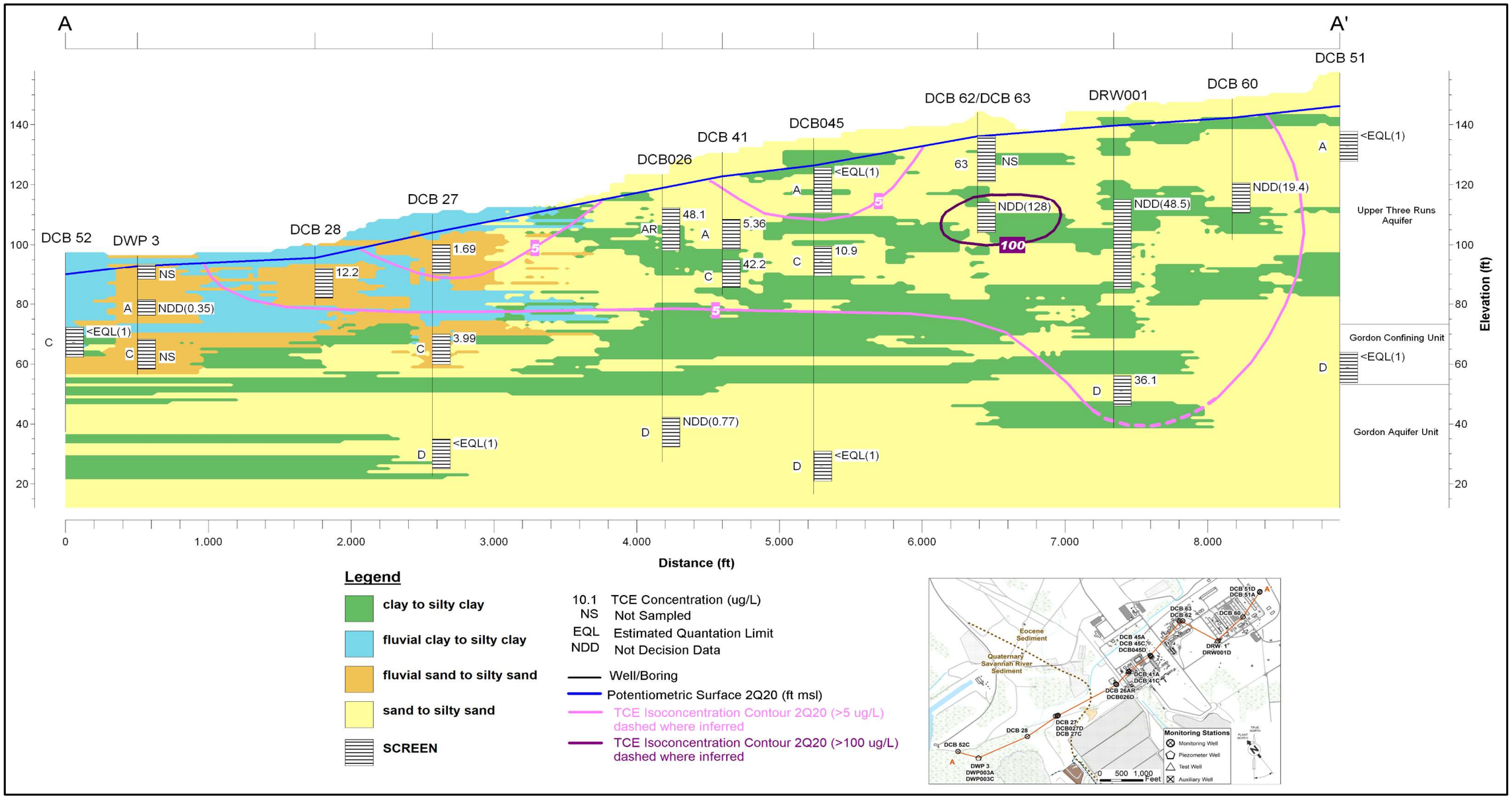

Figure 11. DAG OU VOC Cross Section (2Q2020)

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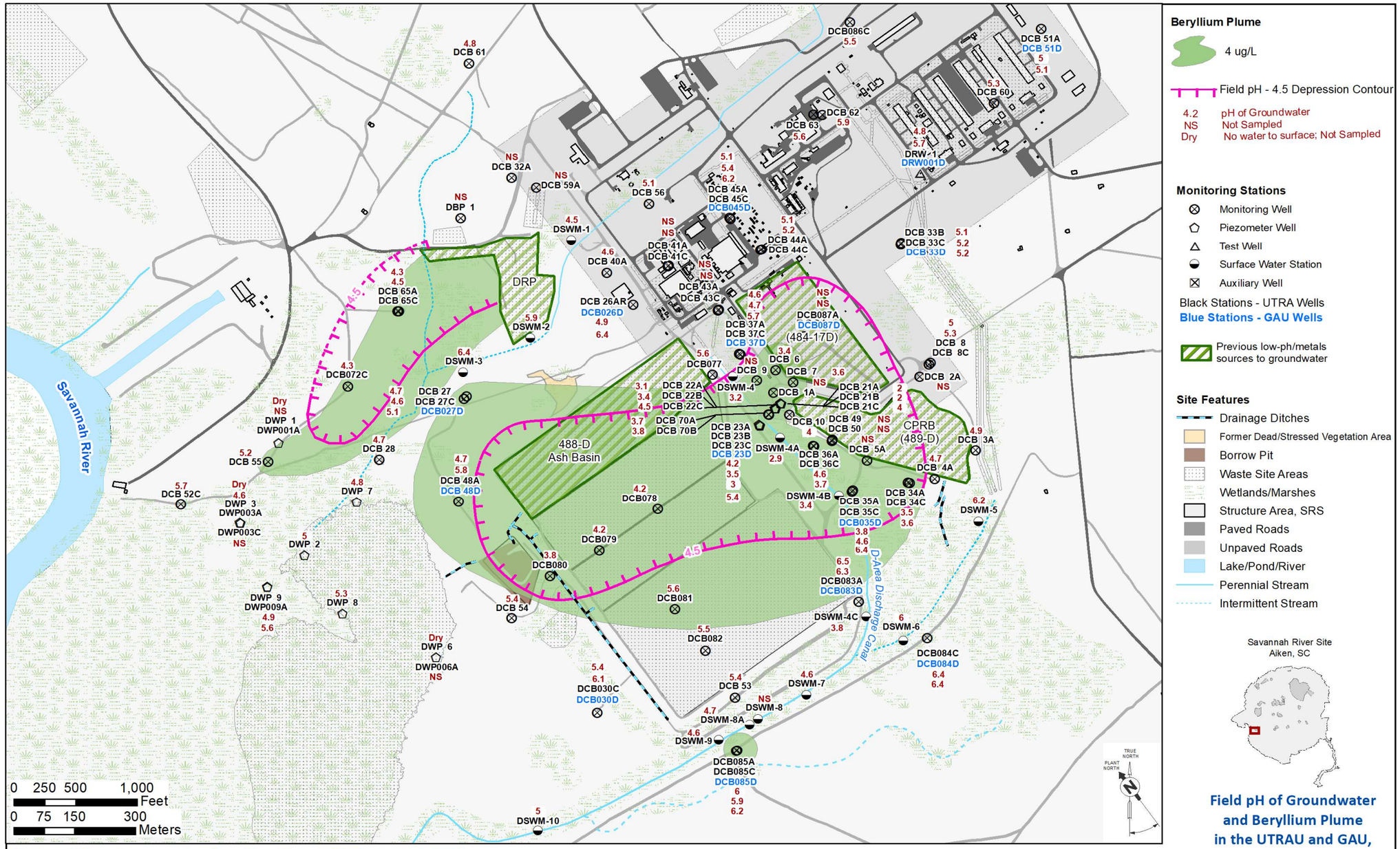

Figure 12. DAG OU UTRA pH and Metals (Beryllium) Plume (2Q2020)

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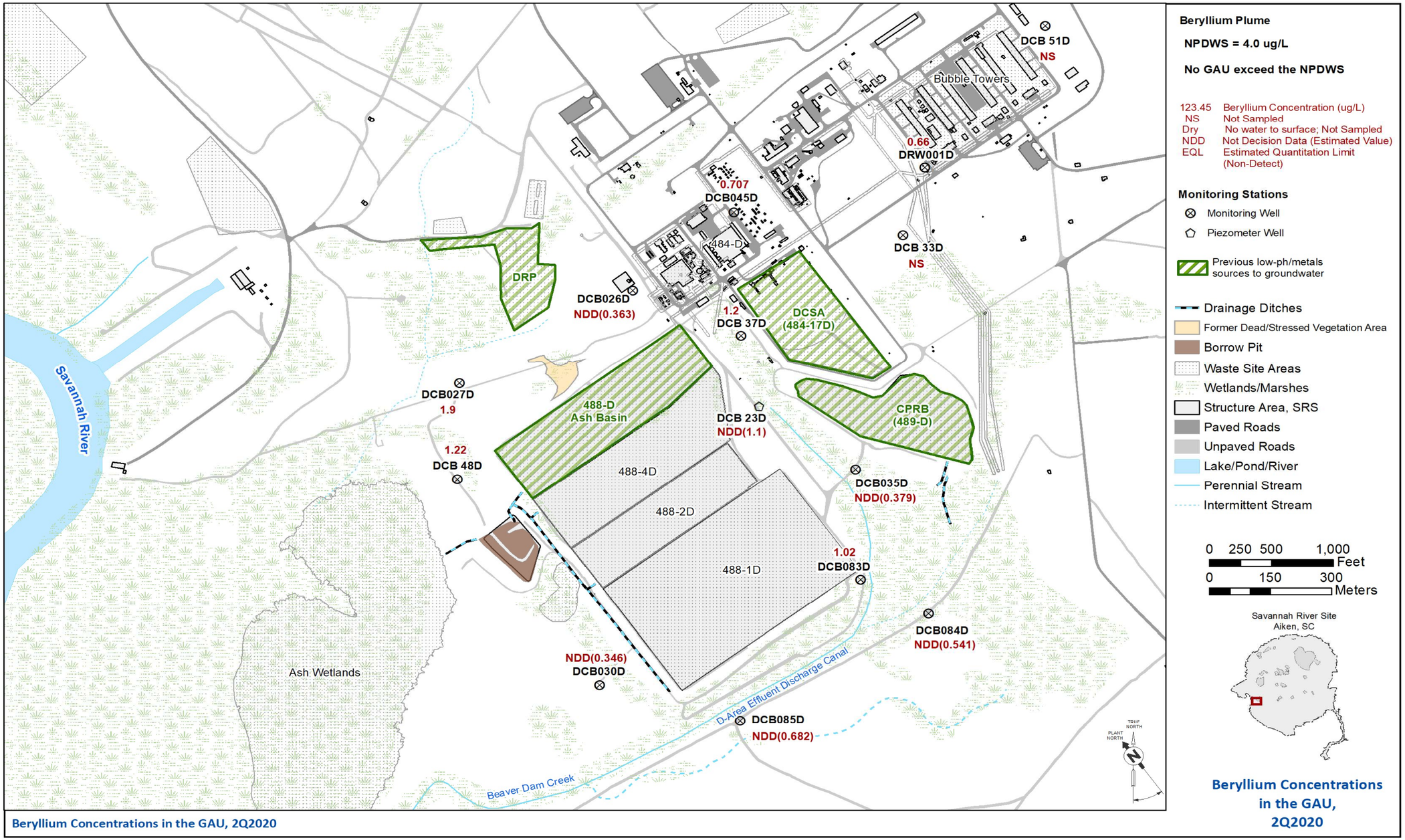

Figure 13. DAG OU Gordon Aquifer pH and Metals (Beryllium) Plume

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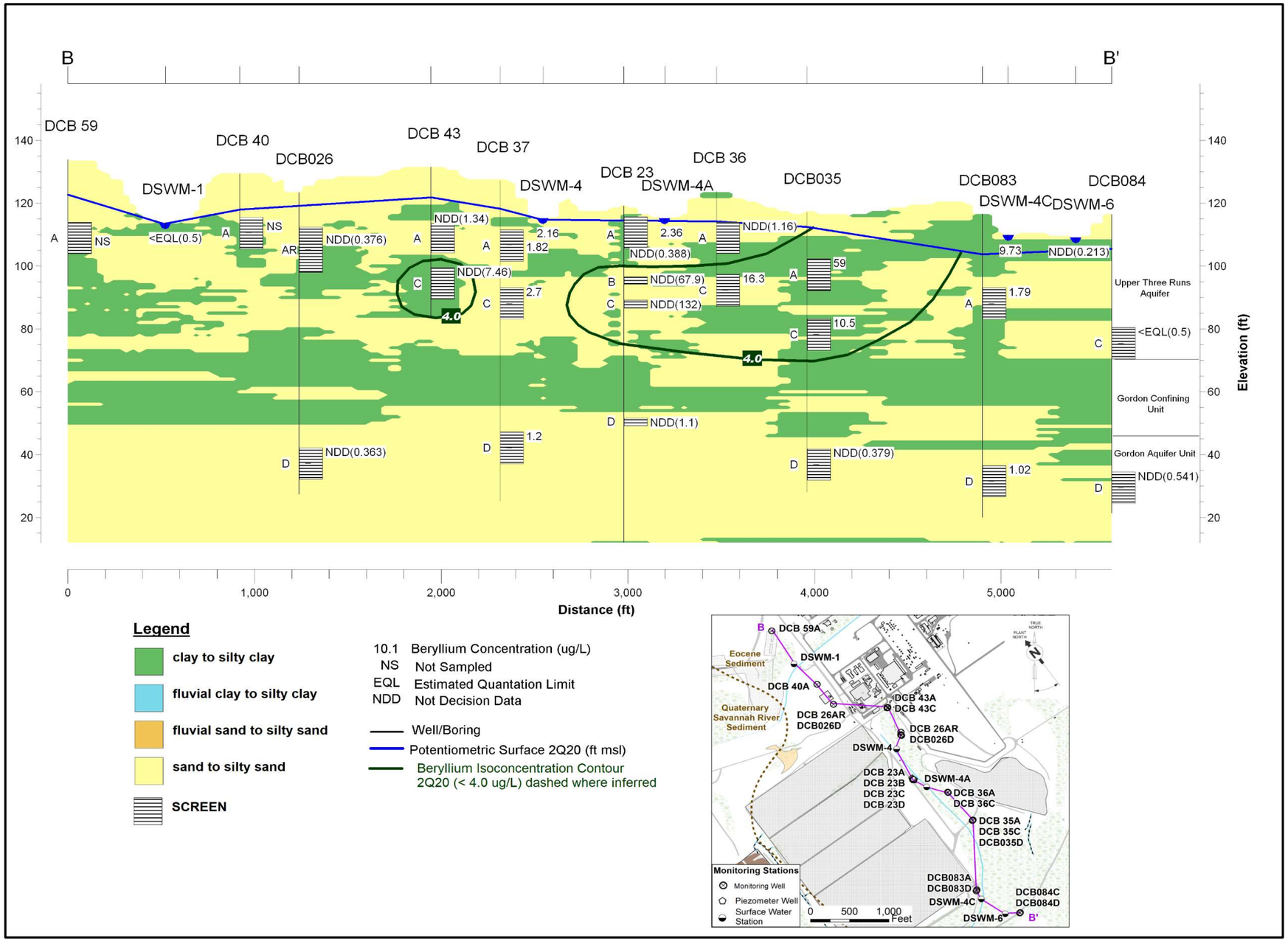

Figure 14. DAG OU pH and Metals Cross Section (2Q2020)

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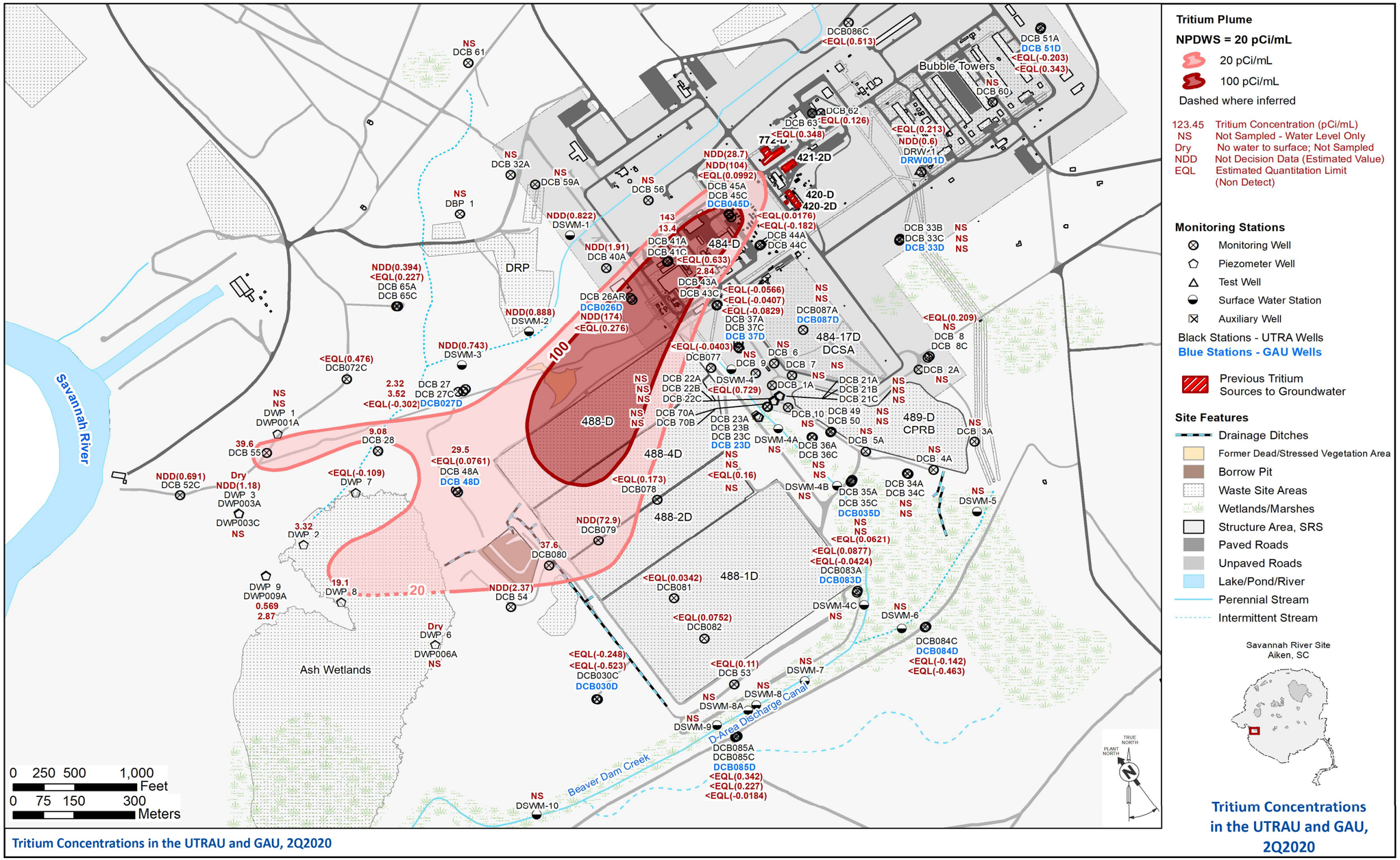

Figure 15. DAG OU Tritium Plume (2Q2020)

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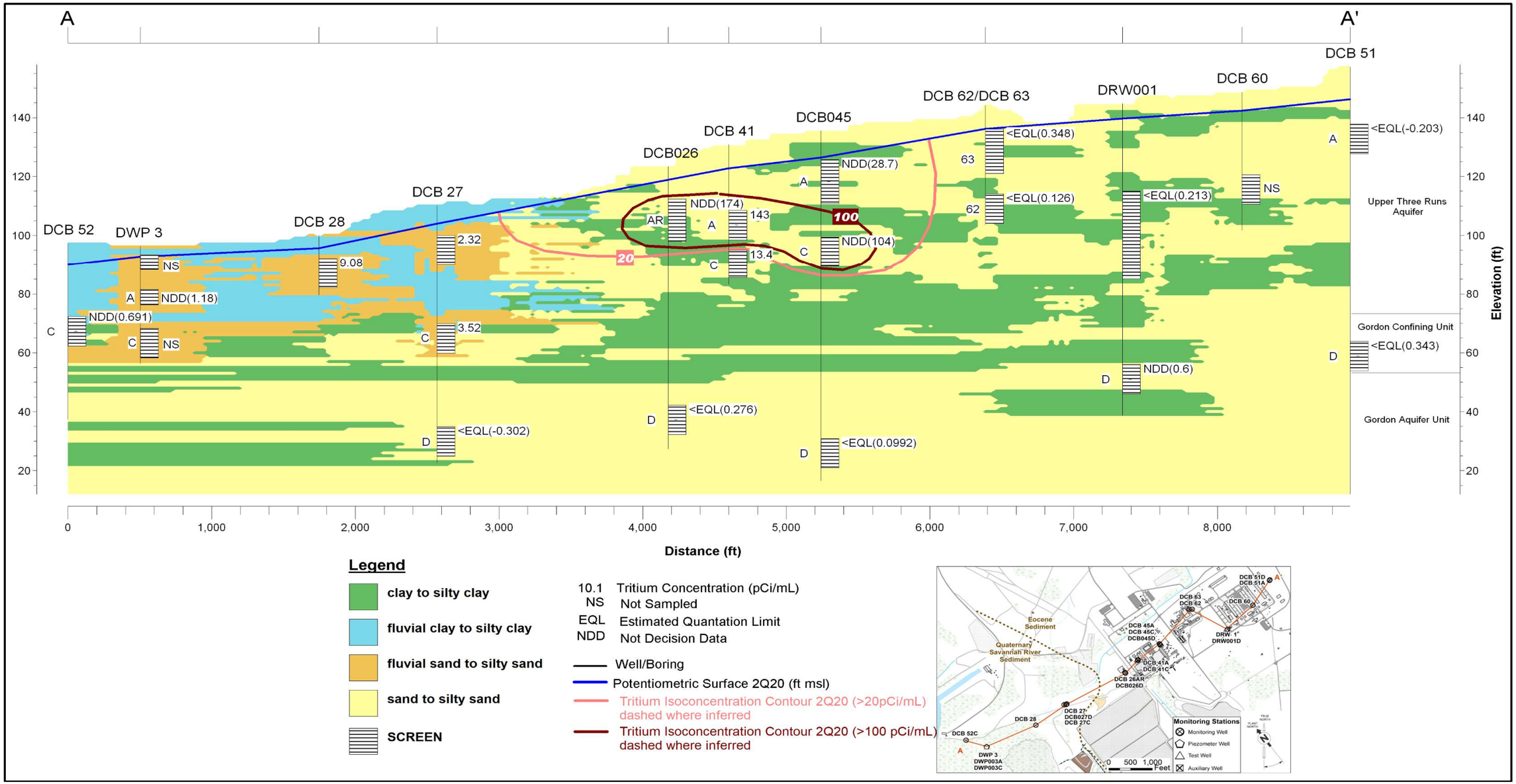

Figure 16. DAG OU Tritium Plume Cross Section (2Q2020)

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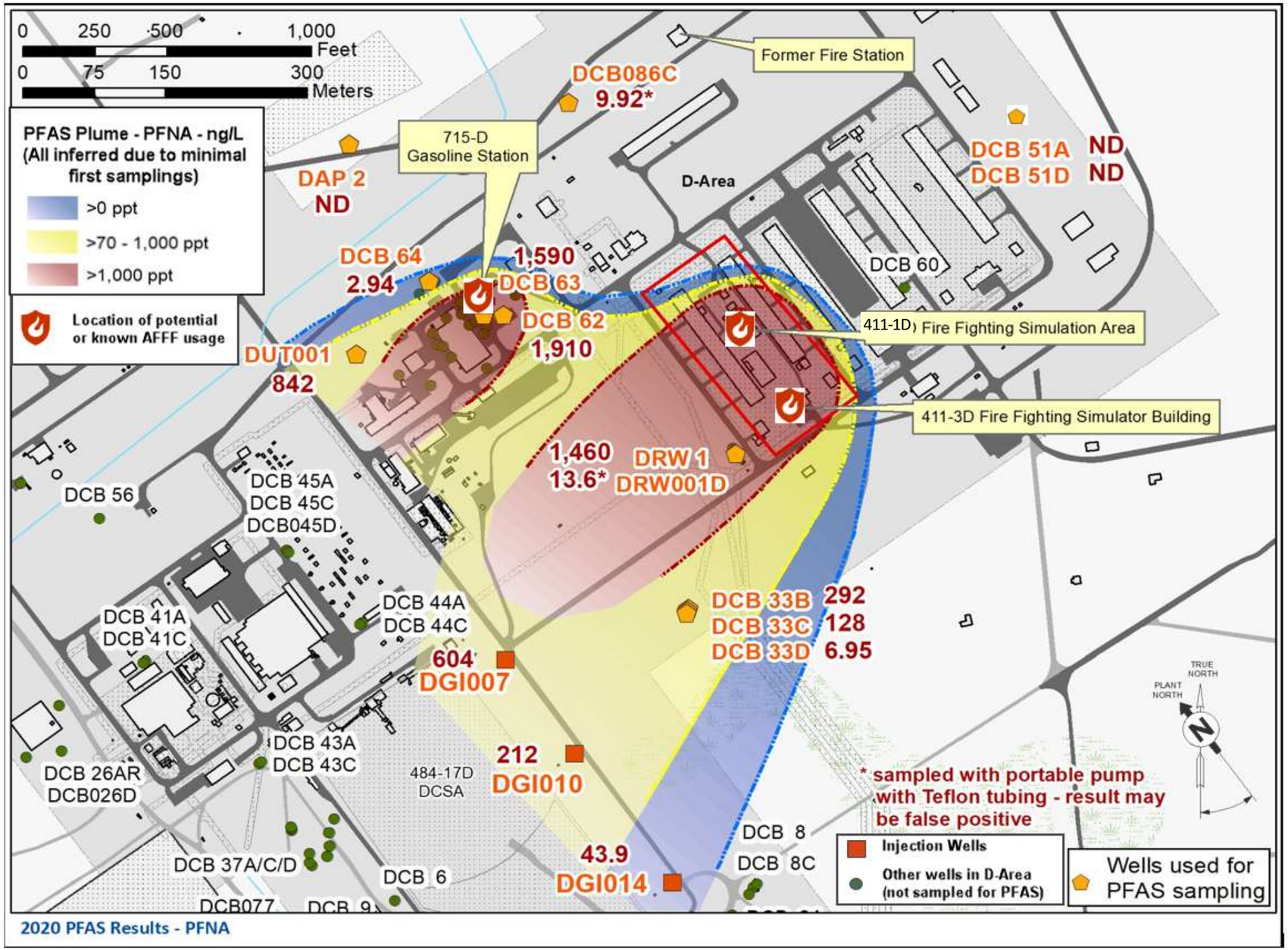

Figure 17. DAG OU PFAS Plume (2Q2020)

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Preliminary Conceptual Site Model for the D-Area Groundwater Operable Unit

Primary Source	Primary Release Mechanisms	Secondary Source	Secondary Release Mechanism	Exposure Media	Exposure Route	Potential Receptors: Human: Industrial Worker	Potential Receptors: Human: Resident	Potential Receptors: Ecological: Terrestrial	Potential Receptors: Ecological: Aquatic	COC[3]
D Area Facility Operations (includes DEXOU and DAOU)[1]	Operations// Spills/ Leaks/ Runoff/ Deposition/ Infiltration	Soil (all depths)[2]	Infiltration/ Leaching	Groundwater	Ingestion	—	○	—	—	GW plumes include 1) VOCs (i .e., PCE and TCE); 2) Tritium; 3) Metals (low pH) and; 4) PFAS
					Showering	—	○	—	—	
				Surface Water/ Sediment[4]		TBD	TBD	TBD	TBD	TBD

→	Pathways: current, historic, and/or future.
○	Complete exposure pathway for qualitative evaluation, (i.e., comparison to MCLs).
—	Incomplete exposure pathway.
1	Groundwater has been impacted by multiple sources within D Area, including subunits associated with the D-Area Expanded Operable Unit (DEXOU) and the D-Area Operable Unit (DAOU). Primary sources include 488-D Ash Basin, D-Area Coal Storage Area (484-17D), D- Area Coal Pile Runoff Basin (489-D), D-Area Rubble Pit (431-2D), D-Area Heavy Water Facility (411-D, 412-D and 413-D), 420-2D Heavy Water Rework Facility, 421-2D Moderator Handling and Storage Building, Fire Training Area (411-1D/411-3D) and the Gasoline Station (715-D).
2	Surface, subsurface and deep soils either have been or will be addressed as subunits of the DEXOU and/or the DAOU and are not part of the DAG OU. Detailed CSMs are provided in the appropriate OU documentation.
3	Although a formal RFI/RI/BRA has not been performed, four distinct groundwater plumes have been identified for the DAG OU.
4	Surface water and/or sediment data to be formally evaluated in the Savannah River and Floodplain Swamp IOU.
TBD	To Be Determined

Figure 18. Conceptual Site Model

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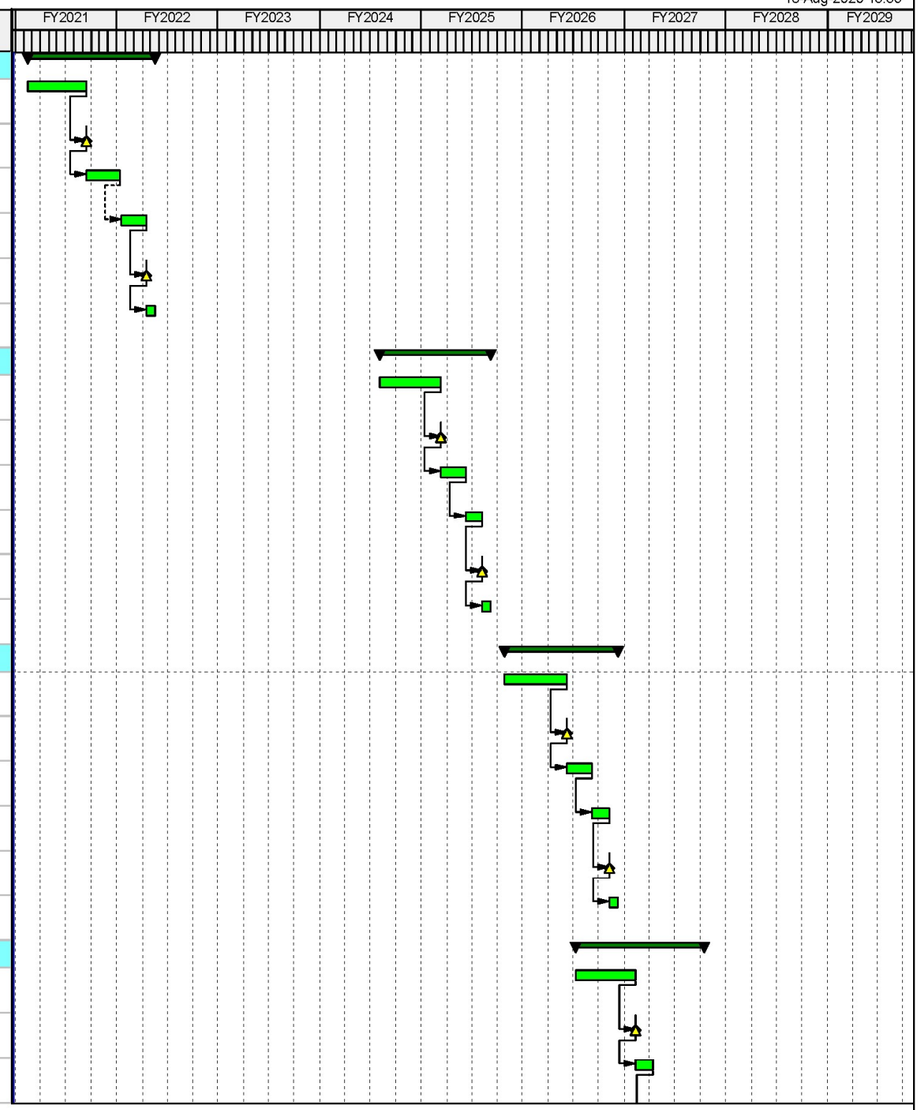
18-Aug-2020 13:36

#	Activity ID	Activity Name	Original Duration	Start	Finish
1	**1- Workplan Development**		245d	17-Nov-2020	16-Feb-2022
2	WRKPLND10	Develop D-Area Groundwater OU Revision 0 SAP / RFI / RI Work Plan	111d	17-Nov-2020*	14-Jun-2021
3	WRKPLND20	D-Area Groundwater OU Revision 0 SAP / RFI / RI Work Plan Submittal	0d		14-Jun-2021
4	WRKPLND30	EPA/SCDHEC Review Revision 0 SAP / RFI / RI Work Plan	123d	15-Jun-2021	15-Oct-2021
5	WRKPLND40	SRS Incorporate EPA/SCDHEC Comments	92d	18-Oct-2021*	17-Jan-2022
6	WRKPLND50	SRS Submit Rev. 1 SAP / RFI / RI Work Plan	0d		17-Jan-2022
7	WRKPLND60	EPA/SCDHEC Final Review & Approval of Rev. 1 SAP / RFI / RI Work	30d	18-Jan-2022	16-Feb-2022
8	**3 - RFI / RI / BRA Report**		216d	07-May-2024	09-Jun-2025
9	RFIRI200	Develop D-Area Groundwater OU Revision 0 RFI/RI / BRA	120d	07-May-2024*	10-Dec-2024
10	RFIRI300	D-Area Groundwater OU Revision 0 RFI / RI / BRA Submittal	0d		10-Dec-2024
11	RFIRI400	EPA/SCDHEC Review Revision 0 RFI / RI / BRA	90d	11-Dec-2024	10-Mar-2025
12	RFIRI500	SRS Incorporate EPA/SCDHEC Comments	60d	11-Mar-2025	09-May-2025
13	RFIRI600	SRS Submit Rev. 1 RFI / RI / BRA	0d		09-May-2025
14	RFIRI700	EPA/SCDHEC Final Review & Approval of Rev. 1 RFI / RI / BRA	31d	10-May-2025	09-Jun-2025
15	**4- CMS / FS Report**		220d	30-Jul-2025	08-Sep-2026
16	CMSFS100	Develop D-Area Groundwater OU Revision 0 CMS/FS	120d	30-Jul-2025*	10-Mar-2026
17	CMSFS200	D-Area Groundwater OU Revision 0 CMS/FS Submittal	0d		10-Mar-2026
18	CMSFS300	EPA/SCDHEC Review Revision 0 CMS/FS	90d	11-Mar-2026	08-Jun-2026
19	CMSFS400	SRS Incorporate EPA/SCDHEC Comments	60d	09-Jun-2026	07-Aug-2026
20	CMSFS500	SRS Submit Rev. 1 CMS/FS	0d		07-Aug-2026
21	CMSFS600	EPA/SCDHEC Final Review & Approval of Rev. 1 CMS/FS	30d	10-Aug-2026	08-Sep-2026
22	**5 - Statement of Basis/Proposed Plan (SB/PP)**		252d	09-Apr-2026	15-Jul-2027
23	SBPP100	Develop D-Area Groundwater OU Revision 0 SB/PP	120d	09-Apr-2026*	10-Nov-2026
24	SBPP200	D-Area Groundwater OU Revision 0 SB/PP Submittal	0d		10-Nov-2026
25	SBPP300	EPA/SCDHEC Review Revision 0 SB/PP	62d	11-Nov-2026	11-Jan-2027



Remaining Level of Effort
Actual Level of Effort
Actual Work
Actual Work Crit
Milestone
Remaining Work
% Complete
Baseline Milestone
Summary

D - Area Groundwater OU Implementation Schedule 8_17_2020

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Figure 19. Implementation Schedule for the DAG OU

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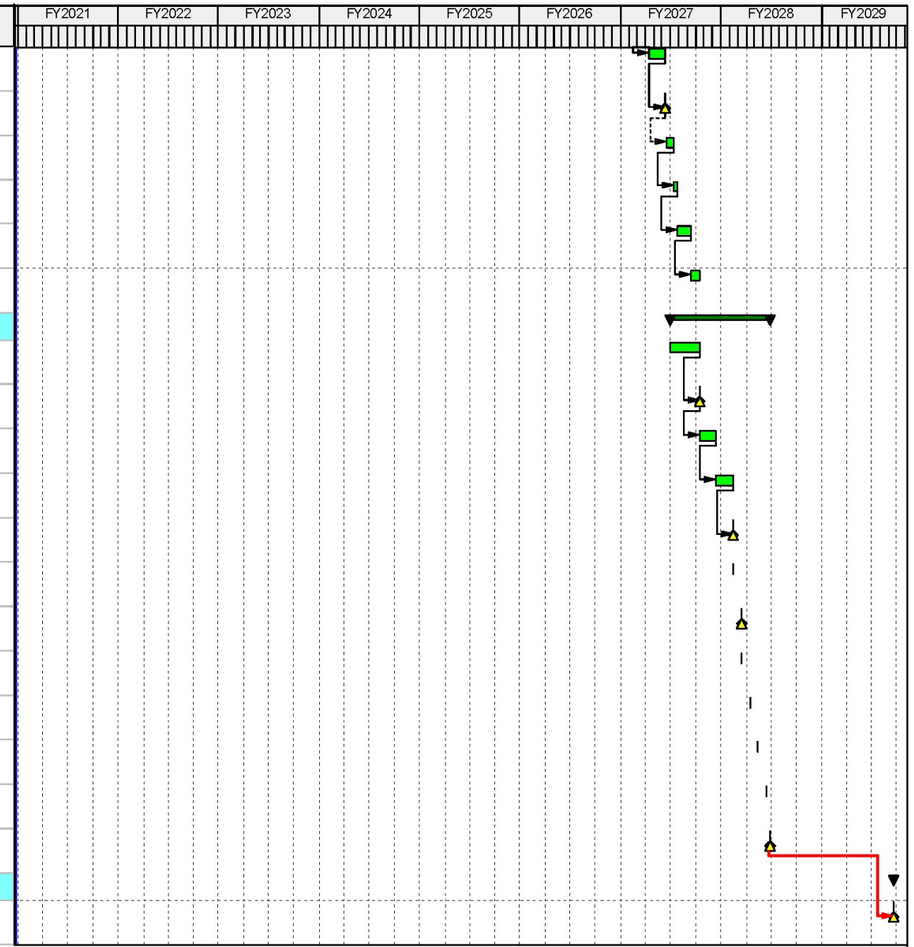
#	Activity ID	Activity Name	Original Duration	Start	Finish
26	SBPP400	SRS Incorporate EPA/SCDHEC Comments	60d	12-Jan-2027	12-Mar-2027
27	SBPP500	SRS Submit Rev. 1 SB/PP	0d		12-Mar-2027
28	SBPP600	EPA/SCDHEC Final Review & Approval of Rev. 1 SB/PP	30d	15-Mar-2027*	13-Apr-2027
29	SBPP700	Notification of Public Comment Proposed Plan	14d	14-Apr-2027	27-Apr-2027
30	SBPP800	Public Comment Period	48d	28-Apr-2027	14-Jun-2027
31	SBPP900	Develop Responsiveness Summary	29d	17-Jun-2027	15-Jul-2027
32	**6- ROD**		198d	31-Mar-2027	28-Mar-2028
33	RODDARA10	Develop D-Area Groundwater OU Revision 0 ROD	60d	31-Mar-2027*	15-Jul-2027
34	RODDARA20	D-Area Groundwater OU Revision 0 ROD Submittal	0d		15-Jul-2027
35	RODDARA30	EPA/SCDHEC Review of ROD (Rev.0)	60d	16-Jul-2027	13-Sep-2027
36	RODDARA40	SRS Incorporate EPA/SCDHEC Comments	60d	14-Sep-2027	12-Nov-2027
37	RODDARA50	Submit ROD (Rev.1) to EPA/SCDHEC	0d		12-Nov-2027
38	RODDARA60	EPA/SCDHEC Final Review/Approval	30d	15-Nov-2027*	14-Dec-2027
39	RODDARA70	Approval of ROD	0d		14-Dec-2027
40	RODDARA80	DOE Obtain Signature on ROD	30d	16-Dec-2027	14-Jan-2028
41	RODDARA90	SCDHEC obtain Signature on ROD	30d	18-Jan-2028*	16-Feb-2028
42	RODDARA100	EPA obtain Signature on ROD	30d	14-Feb-2028	14-Mar-2028
43	RODDARA110	Prepare Public Notice	14d	15-Mar-2028	28-Mar-2028
44	RODDARA120	Issue ROD	0d		28-Mar-2028
45	**7 - RA Start**		0d	21-Jun-2029	21-Jun-2029
46	RASTART20	D-Area Groundwater OU Remedial Action Start	0d		21-Jun-2029



Remaining Level of Effort
Actual Level of Effort
Actual Work
Actual Work Crit
Milestone
Remaining Work
% Complete
Baseline Milestone
Summary

D - Area Groundwater OU Implementation Schedule 8_17_2020

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Figure 19. Implementation Schedule for the DAG OU *(Continued/End)*

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Table 1. DAG OU Monitoring Well and Surface Water Network Details and Additional Samples and Sample Stations

Well ID	Station Type	Aquifer	Easting (UTM Zone 17 - NAD 27)	Northing (UTM Zone 17 - NAD 27)	Screen Zone *(ft)*			Reference Elevation	VOCs	Tritium	TAL Metals	Sulfate	Uranium	Ethene	Fe^{+2} and Fe^{+3}	Field REDOX/DO	PFAS			Water Level Only
					Top Depth	Bottom Depth	Ground Elevation										GW	SW&Sed	Soil	
DAP 2	GW	UTRA	431093.916	3674374.377	8	25	143.9	147.25	x											
DBP 1	GW	UTRA	430364.81	3673925.84	10	40	133.2	135.49												x
DBR-01	Boring	UTRA/GA	431477.884	3674185.629	0	130	146	--											x	
DBR-02	Boring	UTRA/GA	431500.692	3674154.887	0	130	146	--											x	
DCB 1A	GW	UTRA	431136.63	3673484.04	5	35	125.1	127.3												x
DCB 2A	GW	UTRA	431498.81	3673524.41	5	35	132.4	134.5												x
DCB 3A	GW	UTRA	431636.48	3673337.73	5	35	131.2	133.2	x		x	x				x	x			
DCB 4A	GW	UTRA	431535.73	3673265.86	5	35	127.5	129.6	x		x	x				x				
DCB 5A	GW	UTRA	431368.31	3673312.57	5	35	120.9	123.1												x
DCB 6	GW	UTRA	431141.94	3673540.44	2	22	131.5	133.8					x							
DCB 7	GW	UTRA	431185.84	3673509.64	2	22	130.9	133.2					x							
DCB 8	GW	UTRA	431521.32	3673555.05	4.5	24.5	134.8	137.2		x	x	x	x				x			
DCB 8C	GW	UTRA	431524.8584	3673558.714	65.6	75.6	134.74	137.97	x		x	x	x				x			
DCB 9	GW	UTRA	431095.52	3673515.2	2.9	22.9	120.2	122.6												x
DCB 10	GW	UTRA	431176.07	3673427.79	2	22	121.8	124.4			x	x	x							
DCB 20A	GW	UTRA	431215.76	3673504.89	10	20	130.9	132.56			x	x								
DCB 20B	GW	UTRA	431214.02	3673505.25	28	30.5	130.8	132.9			x	x								
DCB 20C	GW	UTRA	431212	3673505.7	39	41.5	130.9	132.52			x	x								
DCB 20D	GW	GA	431207.17	3673507.05	82	84.5	130.7	132.69			x	x								
DCB 21A	GW	UTRA	431156.63	3673455.74	6.5	16.5	126.6	128.22			x	x	x		x	x				
DCB 21B	GW	UTRA	431154.91	3673456.45	22	24.5	126.7	128.23	x		x	x	x		x	x				
DCB 21C	GW	UTRA	431153.39	3673457.34	36	38.5	126.8	128.44	x		x	x	x		x	x				
DCB 22A	GW	UTRA	431143.02	3673443.12	5.5	15.5	125.3	127.15			x	x	x		x	x				
DCB 22B	GW	UTRA	431141.17	3673443.85	22	24.5	125.4	126.87			x	x	x		x	x				
DCB 22C	GW	UTRA	431139.6	3673444.97	35	37.5	125.6	127.24			x	x	x		x	x				
DCB 23A	GW	UTRA	431103.89	3673400.62	3.5	13.5	119.2	121.13			x	x								x
DCB 23B	GW	UTRA	431102.51	3673401.84	22.5	25	119.1	121.23			x	x	x							
DCB 23C	GW	UTRA	431101.08	3673403.13	30	32.5	119.1	120.99		x	x	x	x							
DCB 23D	GW	GA	431097.08	3673406.81	67.5	70	119.1	120.88			x	x								x
DCB 26AR	GW	UTRA	430790.4863	3673705.497	11	25.3	122.7	125.67	x	x	x	x					x			
DCB026D	GW	GA	430786.6125	3673710.586	81.12	91.08	123.33	126.57	x	x	x	x					x			
DCB 27	GW	UTRA	430379.0061	3673474.093	10.1	20.1	111.9	114.69	x	x	x	x								
DCB 27C	GW	UTRA	430373.223	3673468.614	40.15	50.18	110.68	113.76	x	x	x	x								
DCB027D	GW	GA	430360.5528	3673467.666	75.2	85.2	110.1	113.24	x	x	x	x								
DCB 28	GW	UTRA	430162.7032	3673314.007	7.9	17.91	100	102.96	x	x	x	x								
DCB030C	GW	UTRA	430702.0785	3672674.559	37.87	47.84	108.19	110.97	x		x	x								
DCB030D	GW	UTRA	430704.9418	3672673.273	87.07	97.03	107.97	110.76	x		x	x								
DCB 32A	GW	UTRA	430490.561	3674027.442	19.6	29.6	141.3	144.23												x
DCB 33B	GW	UTRA	431452.7969	3673862.248	26.5	36.5	140.5	143.5	x								x			
DCB 33C	GW	UTRA	431451.6634	3673859.565	62	71.37	140.7	143.4	x								x			

x blue shaded cells are requirements of the approved DAG OU Monitoring Work Plan

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Table 1. DAG OU Monitoring Well and Surface Water Network Details and Additional Samples and Sample Stations *(Continued)*

Well ID	Station Type	Aquifer	Easting (UTM Zone 17 - NAD 27)	Northing (UTM Zone 17 - NAD 27)	Screen Zone *(ft)*			Reference Elevation	VOCs	Tritium	TAL Metals	Sulfate	Uranium	Ethene	Fe^{+2} and Fe^{+3}	Field REDOX/DO	PFAS			Water Level Only
					Top Depth	Bottom Depth	Ground Elevation										GW	SW&Sed	Soil	
DCB 33D	GW	UTRA	431450.8382	3673857.426	88	98	140.5	143.26	x							x	x			
DCB 34A	GW	UTRA	431473.0502	3673255.462	16	26	128	130.85	x		x	x	x			x				
DCB 34C	GW	UTRA	431469.8242	3673256.445	46.8	56.8	127.6	130.53	x		x	x	x			x				
DCB 35A	GW	UTRA	431332.9836	3673237.043	14.8	24.8	118.2	121	x		x	x	x							
DCB 35C	GW	UTRA	431331.0307	3673234.393	33.8	43.8	118	120.95	x		x	x	x							
DCB035D	GW	UTRA	431334.3779	3673240.114	75.12	85.08	117.04	120.02	x		x	x								
DCB 36A	GW	UTRA	431236.5895	3673348.169	9.8	19.8	123.9	126.82	x		x	x				x				
DCB 36C	GW	UTRA	431234.7814	3673349.944	26.5	36.5	123.8	126.81	x		x	x				x				
DCB 37A	GW	UTRA	431055.1963	3673579.305	15.7	25.7	126.5	129.42	x	x	x	x					x			
DCB 37C	GW	UTRA	431052.3319	3673582.184	34.1	44.1	126.5	129.44	x	x	x	x					x			
DCB 37D	GW	GA	431052.622	3673592.547	80	90	127.19	130.23	x	x	x	x					x			
DCB 40A	GW	UTRA	430726.31	3673786.609	13.8	23.8	129.3	132.34	x	x										
DCB 41A	GW	UTRA	430879.0987	3673804.689	22.32	32.32	130.6	133.87	x	x	x	x								
DCB 41C	GW	UTRA	430876.5777	3673802.67	35.89	45.21	130.8	133.38	x	x	x	x								
DCB 43A	GW	UTRA	430999.1568	3673691.292	18	27.32	131.6	135.03	x	x	x	x								
DCB 43C	GW	UTRA	431001.5074	3673693.241	32	42	131.5	135.06	x	x	x	x								
DCB 44A	GW	UTRA	431108.13	3673846.577	11.3	26.3	134.6	137.79	x	x						x	x			
DCB 44C	GW	UTRA	431105.4102	3673844.68	37	45.98	134.7	137.62	x	x						x	x			
DCB 45A	GW	UTRA	431028.4796	3673926.548	9.7	24.7	134.9	137.94	x	x							x			
DCB 45C	GW	UTRA	431030.1443	3673924.044	36	46	134.8	137.9	x	x							x			
DCB045D	GW	UTRA	431034.6814	3673917.314	104.57	114.53	135.46	138.8	x	x							x			
DCB 48A	GW	UTRA	430359.345	3673208.551	26	31.04	107.28	110.43	x	x	x	x					x			
DCB 48D	GW	GA	430355.09	3673213.92	56	66	106.9	110.13	x	x	x	x					x			
DCB 49	GW	UTRA	431282.8056	3673364.856	3.35	15.85	122	124.52												x
DCB 50	GW	UTRA	431281.0369	3673362.294	3.54	16.1	122	124.33												x
DCB 51A	GW	UTRA	431799.117	3674403.72	19.37	29.41	157.69	160.84	x	x							x			
DCB 51D	GW	GA	431800.456	3674407.69	93.3	103.35	157.57	160.41	x	x							x			
DCB 52C	GW	UTRA	429674.05	3673200.679	25	35	97.28	100.4	x	x	x	x		x	x	x				
DCB 53	GW	UTRA	431042.31	3672711.992	26	36.1	113.58	116.6	x	x	x	x				x				
DCB 54	GW	UTRA	430490.702	3672912.267	34.5	44.55	111.13	114.24	x	x	x	x								
DCB 55	GW	UTRA	429888.1	3673308.916	24	34.04	96.68	99.79	x	x	x	x		x	x	x				
DCB 56	GW	UTRA	430830.21	3673961.543	23	33.04	130.78	133.56	x		x	x					x			
DCB 59A	GW	UTRA	430550.922	3674002.634	20	30	133.95	136.85												x
DCB 60	GW	UTRA	431681.676	3674215.993	28	38	148.61	151.46	x		x	x					x			
DCB 61	GW	UTRA	430385.609	3674316.302	17.8	27.84	136.14	139.1			x	x								
DCB 62	GW	UTRA	431257.367	3674186.439	30	40	144.1	147.56	x	x							x			

x blue shaded cells are requirements of the approved DAG OU Monitoring Work Plan

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Table 1. DAG OU Monitoring Well and Surface Water Network Details and Additional Samples and Sample Stations *(Continued)*

Well ID	Station Type	Aquifer	Easting (UTM Zone 17 - NAD 27)	Northing (UTM Zone 17 - NAD 27)	Screen Zone *(ft)*			Reference Elevation	VOCs	Tritium	TAL Metals	Sulfate	Uranium	Ethene	Fe^{+2} and Fe^{+3}	Field REDOX/DO	PFAS			Water Level Only
					Top Depth	Bottom Depth	Ground Elevation										GW	SW&Sed	Soil	
DCB 63	GW	UTRA	431236.183	3674186.6	8	23.1	142.9	146.02	x	x							x			
DCB063D+	Boring	UTRA/GA	431235.054	3674184.017	0	130	139.7	--											x#	
DCB063D*	GW	GA	431235.054	3674184.017	110	120	139.7	TBD	x								x			
DCB 64	GW	UTRA	431178.176	3674223.98	10.85	20.88	139.5	142.57	x								x			
DCB 65A	GW	UTRA	430211.348	3673688.886	8.76	18.79	112.74	115.85		x	x	x								
DCB 65C	GW	UTRA	430208.219	3673689.048	37.35	42.37	112.74	115.8		x	x	x								
DCB 70A	GW	UTRA	431125.881	3673428.485	1.8	11.8	116.49	119.22			x	x			x	x				
DCB 70B	GW	UTRA	431124.278	3673429.266	20.6	25.63	116.2	118.93			x	x			x	x				
DCB 72C	GW	UTRA	430085.457	3673499.573	20.7	25.2	99.5	102.11	x	x	x	x								
DCB077	GW	UTRA	430985.6802	3673528.707	9.7	29.7	127.7	130.64	x	x	x	x								
DCB078	GW	UTRA	430852.2748	3673189.192	19.7	39.7	126.7	126.56	x	x	x	x					x			
DCB079	GW	UTRA	430707.4955	3673083.911	23.7	43.7	127.8	127.65	x	x	x	x								
DCB080	GW	UTRA	430585.5075	3673019.197	13.1	33.1	116.1	119.03	x	x	x	x								
DCB081	GW	UTRA	430893.8894	3672935.211	14.7	34.7	113.11	115.67	x	x	x	x								
DCB082	GW	UTRA	430968.8364	3672831.307	9.7	29.7	110.44	113.07	x		x	x								
DCB083A	GW	UTRA	431347.4318	3672954.204	23.49	33.46	116.85	119.37			x	x								
DCB083D	GW	GA	431346.1597	3672949.587	80.01	89.97	116.56	119.25			x	x								
DCB084C	GW	UTRA	431516.6324	3672862.072	36.02	45.98	116.39	119.44			x	x								
DCB084D	GW	GA	431514.3245	3672860.363	81.99	91.95	116.45	119.57			x	x								
DCB085A	GW	UTRA	431045.0605	3672576.656	17.41	27.37	109.91	113.34			x	x								
DCB085C	GW	UTRA	431047.5264	3672578.246	49.18	59.14	110.35	113.33			x	x								
DCB085D	GW	GA	431049.7679	3672579.347	72.76	82.72	110.23	113.64			x	x								
DCB086C	GW	UTRA	431325.6833	3674420.316	40.15	50.13	145.75	148.93	x								x			
DCB087A	GW	UTRA	431223.0994	3673635.663	18	28	131.63	134.49	x		x	x								
DCB087D	GW	GA	431227.3259	3673632.223	105	115	131.79	134.36	x		x	x								
DCB088A*	GW	UTRA	431454.7189	3674110.321	20	30	144	TBD									x			
DCB088D*	Boring	UTRA/GA	431453.159	3674112.197	0	125	144	--	x (headspace soil samples) #										x#	
DCB088D*	GW	GA	431453.159	3674112.197	90	100	144	TBD	x								x			
DCB089D*	Boring	UTRA/GA	431347.202	3674018.772	0	125	139.8	--	x (headspace soil samples) #										x#	
DCB089D*	GW	GA	431347.202	3674018.772	100	110	139.8	TBD	x											
DRW 1	GW	UTRA	431499.493	3674038.761	29.64	59.64	144.7	147.79	x	x							x			
DRW001D	GW	GA	431504.857	3674034.448	88.7	98.67	144.71	147.89	x								x			
DUT001	GW	UTRA	431101.62757	3674143.3583	25	30	137.9	140.79	x								x			
DUT002	GW	UTRA	431146.86348	3674119.3344	20	25	138.6	141.39									x			
DUT003	GW	UTRA	431180.00356	3674108.1885	20	25	139	142.8									x			
DWP 1	GW	UTRA	429914.373	3673356.994	4.9	9.9	98.17	103.23												x
DWP001A	GW	UTRA	429916.0631	3673359.495	10	20	98.57	103.32	x	x	x	x				x				

*New Monitoring Well to be installed; +New Boring Investigation; #Soil samples will include multiple depth intervals during drilling activities (i.e., approximately every 3 feet and/or at clay interfaces) (All new stations include approximate and estimated station construction details);
x blue shaded cells are requirements of the approved DAG OU Monitoring Work Plan

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Table 1. DAG OU Monitoring Well and Surface Water Network Details and Additional Samples and Sample Stations *(Continued/End)*

Well ID	Station Type	Aquifer	Easting (UTM Zone 17 - NAD 27)	Northing (UTM Zone 17 - NAD 27)	Screen Zone *(ft)*			Reference Elevation	VOCs	Tritium	TAL Metals	Sulfate	Uranium	Ethene	Fe^{+2} and Fe^{+3}	Field REDOX/DO	PFAS			Water Level Only
					Top Depth	Bottom Depth	Ground Elevation										GW	SW&Sed	Soil	
DWP 2	GW	UTRA	429978.51	3673072.127	5	10	95.99	99.84	x	x	x	x		x	x	x				
DWP 3	GW	UTRA	429818.264	3673153.915	2.9	8	95.98	100.39												x
DWP003A	GW	UTRA	429819.8735	3673152.93	14.8	20	96.3	100.42	x	x	x	x				x				
DWP003C	GW	UTRA	430303.673	3672814.524	5.5	8	97.17	101.81	x	x	x	x				x				
DWP 6	GW	UTRA	430107.69	3673206.63	4.31	9.29	97.29	101.42												
DWP006A	GW	UTRA	430300.9129	3672814.605	9	14	96.14	100.8	x	x	x	x				x				
DWP 7	GW	UTRA	430071.825	3672924.399	4	8.99	96.14	101.42	x	x	x	x		x	x	x				
DWP 8	GW	UTRA	429886.112	3672992.715	3.98	8.97	95.83	101.31	x	x	x	x				x				
DWP 9	GW	UTRA	429885.9384	3672991.539	14.8	15.8	95.6	99.84	x	x	x	x				x	x			
DWP009A	GW	UTRA	429816.433	3673155.546	28	38	96.74	99.59	x	x	x	x				x	x			
DSWM-1	SW	--	430638.029	3673869.009	--	--	--	--	x	x	x							x		
DSWM-2	SW	--	430536.968	3673620.671	--	--	--	--	x	x	x							x		
DSWM-3	SW	--	430371.048	3673534.854	--	--	--	--	x	x	x									
DSWM-4	SW	--	431036.866	3673523.637	--	--	--	--	x	x	x	x						x		
DSWM-4A	SW	--	431153.3528	3673370.506	--	--	--	--			x	x								
DSWM-4B	SW	--	431298.5752	3673223.371	--	--	--	--			x	x								
DSWM-4C	SW	--	431365.718	3672916.411	--	--	--	--			x	x								
DSWM-5	SW	--	431643.943	3673157.821	--	--	--	--	x		x	x								
DSWM-6	SW	--	431458.119	3672856.243	--	--	--	--	x		x	x								
DSWM-7	SW	--	431218.579	3672718.928	--	--	--	--	x		x	x								
DSWM-8	SW	--	431098.6455	3672657.013	--	--	--	--			x	x	x							
DSWM-8A	SW	--	431078.4974	3672643.039	--	--	--	--			x	x	x							
DSWM-9	SW	--	431001.3268	3672605.296	--	--	--	--			x	x	x							
DSWM-10	SW	--	430556.0348	3672375.869	--	--	--	--			x	x								
DSWM-11[‡]	SW	--	430995.703	3674154.583	--	--	--	--										x (SW only due to accessibility		
DSWM-12[‡]	SW	--	431200.499	3674531.832	--	--	--	--										x		
DOBSW1	SW	--	431174	3674926	--	--	--	--										x		

[‡]New Surface Water/Sediment Location;
x blue shaded cells are requirements of the approved DAG OU Monitoring Work Plan

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Table 2. Potential ARARs and TBC Criteria for the DAG OU

ARAR/TBC	Type	Applicability
Federal		
Atomic Energy Act	Action/chemical-specific	Radioactive Waste
Resource Conservation and Recovery Act	Action/chemical-specific	Treatment, storage, and disposal of hazardous waste
Clean Air Act	Action/chemical-specific	Potential releases to air from units
Safe Drinking Water Act	Chemical-specific	MCLs and MCL goals
Clean Water Act	Action/chemical-specific	Discharge limitations
Toxic Substances Control Act	Action/chemical-specific	Potentially applicable if specific constituents are determined to be present
Federal Insecticide, Fungicide, and Rodenticide Control Act	Chemical-specific	Potentially applicable if specific pesticides are determined to be present
USDOE Orders	Action-specific	Treatment, storage, and disposal of hazardous and radioactive wastes
State		
SC Pollution Control Act	Action -specific	Potential releases to surface water, groundwater, air, or soil
SC Wastewater Regulations	Chemical-specific	Discharge limitations
SC Drinking Water Regulations	Chemical-specific	MCLs and MCL goals
SC Hazardous Waste Management Regulations	Action -specific	Treatment, storage, and disposal of hazardous and radioactive wastes
SC Air Pollution Control Regulations	Action-specific	Potential releases to air
SC Water Classification Standards	Chemical/location-specific	Surface water and groundwater classification
SC Well Standards	Action-specific	Well construction requirements

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Table 3. Data Quality Objectives Worksheet for D-Area Groundwater Operable Unit - Primary Source Material

Primary Sources	Probable Condition	Exposure Pathway and/or Release Mechanism	Data Needs and DQOs Including Engineering/Physical Processes	Field Activities including Removal and Characterization	Parameters	Potential Remedial Action Alternative
• 484-17D Coal Storage Area • 488-D Ash Basin • D-Area Coal Pile Runoff Basin (489-D) • D-Area Rubble Pit (431-2D) • D-Area Heavy Water Facility (411-D, 412-1D, and 413-D) • D-Area Heavy Water Rework Facility • D-Area Heavy Water Rework Facility (primarily 420-D Concentrator Building) • 420-2D Rework Handling Facility • 421-2D Moderator Handling Storage building • Gasoline Station (715-D) • Fire Training Area (411-1D/411-3D)	Existing data show VOCs, low pH and associated metals, tritium, PFAS in the groundwater. Multiple sources are involved in groundwater contamination. Commingling of groundwater plumes. No primary source material remains in the source area.	Exposure pathways within these source areas have been or will be addressed independently	None.	None.	**None.**	None.

Table 4. Data Quality Objectives Worksheet for D-Area Groundwater Operable Unit - Secondary Source Material

Secondary Sources	Probable Condition	Exposure Pathway and/or Release Mechanism	Data Needs and DQOs including Engineering/Physical Processes	Field Activities Including Removal and Characterization	Parameters	Potential Remedial Action Alternative
• Soils within and adjacent to the DAOU and DEXOU • Gasoline Station (715-D) • Fire Training Area (411-1D/411-3D)	Based on existing data, VOCs, pH/metals, tritium, and PFAs have migrated into the subsurface from multiple source areas.	Exposure pathways within these source areas were addressed independently under separate remedial investigations.	Refer to work plans for individual facilities for data needs	Soil cores	Screening level TCL, VOC suite, PFAS suite.	NA

NA = not applicable

Table 5. Data Quality Objectives Worksheet for D-Area Groundwater Operable Unit – Groundwater Pathway (Media)

Primary Sources	Probable Condition	Exposure Pathway and/or Release Mechanism	Data Needs and DQOs including Engineering/Physical Processes	Field Activities including Removal and Characterization	Parameters	Potential Remedial Action Alternative
• Groundwater	Contamination of groundwater from leaching and spills from primary sources. Contaminated groundwater exists. Plume commingled. Slow groundwater flow rates. Varying subsurface groundwater flow resulting in multiple plumes. Contaminated groundwater discharging into Beaver Creek and D-Area Discharge Canal.	Release mechanism is infiltration/leaching from soil	Primary sources inside D Area facilities that have contributed to tritium, TCE, pH/metals, and PFAS plumes have been identified and have been addressed under separate actions. Provide data on extent of tritium, TCE, pH/metals, and PFAS contamination. Groundwater analyses to determine location, concentration, and plume geometry.	Collect groundwater samples and analyze for VOCs, metals, tritium, and PFAS. Install new monitoring wells, as required, based on data collected to date.	Definitive level TCL, VOC suite, TCL meals, tritium, PFAS data for water samples collected from existing and new monitoring wells.	Alternatives include: monitored natural attenuation with LUCs, phytoremediation (tritium), targeted bioremediation (VOCs), and pH adjustment (pH/metals), and groundwater and surface water monitoring

NA = not applicable

Table 6. Data Quality Objectives Worksheet for D-Area Groundwater Operable Unit – Surface Water Pathway (Media)

Primary Sources	Probable Condition	Exposure Pathway and/or Release Mechanism	Data Needs and DQOs including Engineering/Physical Processes	Field Activities including Removal and Characterization	Parameters	Potential Remedial Action Alternative	Bias for Action
• Surface water	Surface water may be contaminated from groundwater discharging into Beaver Creek and D-Area Discharge Canal	Release mechanism is outcropping of contaminant plume into surface water	Data from surface water to determine impact to potential receptors from DAOU/DEXOU	Continue surface water sampling for VOCs, pH/metals, tritium, PFAS	Definitive level TCL, VOC suite, PFAS suite, tritium.	Alternatives include MNA with LUCs	None based on existing data

NA = not applicable

Table 7. Laboratory Analytical Specifications Table for TAL/TCL Analytes for Surface or Groundwater Media

Analyte	Analyte ID	Preparation [B] Method	Analytical [B] Method	CRDL [A] *(µg/L)*
Target Analyte List				
Metals				
Aluminum	7429-90-5	3005A,3015A	EPA6010C	2.0
Antimony	7440-36-0	3005A,3015A	EPA6010C	2.0
Arsenic	7440-38-2	3005A,3015A	EPA6010C	2.0
Barium	7440-39-3	3005A,3015A	EPA6010C	1.0
Beryllium	7440-41-7	3005A,3015A	EPA6010C	2.0
Cadmium	7440-43-9	3005A,3015A	EPA6010C	2.0
Calcium	7440-70-2	3005A,3015A	EPA6010C	2.0
Chromium	7440-47-3	3005A,3015A	EPA6010C	2.0
Cobalt	7440-48-4	3005A,3015A	EPA6010C	2.0
Copper	7440-50-8	3005A,3015A	EPA6010C	2.0
Iron	7439-89-6	3005A,3015A	EPA6010C	13.0
Lead	7439-92-1	3005A,3015A	EPA6010C	3.4
Magnesium	7439-95-4	3005A,3015A	EPA6010C	2.0
Manganese	7439-96-5	3005A,3015A	EPA6010C	2.0
Mercury	7439-97-6	3005A,3015A	EPA7470A	2.0
Nickel	7440-02-0	3005A,3015A	EPA6010C	2.0
Potassium	7440-09-7	3005A,3015A	EPA6010C	2.0
Selenium	7782-49-2	3005A,3015A	EPA6010C	10.0
Silver	7440-22-4	3005A,3015A	EPA6010C	2.0
Sodium	7440-23-5	3005A,3015A	EPA6010C	2.0
Thallium	7440-28-0	3005A,3015A	EPA6010C	2.0
Vanadium	7440-62-2	3005A,3015A	EPA6010C	10.0
Zinc	7440-66-6	3005A,3015A	EPA6010C	2.0
Volatiles				
1,1,1-Trichloroethane	71-55-6	5021A,5030C,5031,5032	EPA8260B	2.0
1,1,2,2-Tetrachloroethane	79-34-5	5021A,5030C,5031,5032	EPA8260B	2.0
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	5021A,5030C,5031,5032	EPA8260B	10.0
1,1,2-Trichloroethane	79-00-5	5021A,5030C,5031,5032	EPA8260B	1.0
1,1-Dichloroethane	75-34-3	5021A,5030C,5031,5032	EPA8260B	1.0
1,1-Dichloroethylene	75-35-4	5021A,5030C,5031,5032	EPA8260B	19.0
1,2,4-Trichlorobenzene	120-82-1	5021A,5030C,5031,5032	EPA8260B	0.14
1,2-Dibromo-3-chloropropane	96-12-8	5021A,5030C,5031,5032	EPA8260B	1.0
1,2-Dibromoethane	106-93-4	5021A,5030C,5031,5032	EPA8260B	2.0
1,2-Dichlorobenzene	95-50-1	5021A,5030C,5031,5032	EPA8260B	1.0
1,2-Dichloroethane (EDC)	107-06-2	5021A,5030C,5031,5032	EPA8260B	0.4
1,2-Dichloropropane	78-87-5	5021A,5030C,5031,5032	EPA8260B	10.0
1,3-Dichlorobenzene	541-73-1	5021A,5030C,5031,5032	EPA8260B	2.0
1,4-Dichlorobenzene	106-46-7	5021A,5030C,5031,5032	EPA8260B	8.0
2-Hexanone	591-78-6	5021A,5030C,5031,5032	EPA8260B	2.0
Acetone	67-64-1	5021A,5030C,5031,5032	EPA8260B	2.0

Table 7. Laboratory Analytical Specifications Table for TAL/TCL Analytes for Surface or Groundwater Media *(Continued)*

Analyte	Analyte ID	Preparation [B] Method	Analytical [B] Method	CRDL [A] *(µg/L)*
Target Analyte List				
Volatiles (cont'd)				
Benzene	71-43-2	5021A,5030C,5031,5032	EPA8260B	2.0
Bromodichloromethane	75-27-4	5021A,5030C,5031,5032	EPA8260B	1.0
Bromoform (Tribromomethane)	75-25-2	5021A,5030C,5031,5032	EPA8260B	1.0
Bromomethane (Methyl bromide)	74-83-9	5021A,5030C,5031,5032	EPA8260B	0.0096
Carbon disulfide	75-15-0	5021A,5030C,5031,5032	EPA8260B	C
Carbon tetrachloride	56-23-5	5021A,5030C,5031,5032	EPA8260B	2.0
Chlorobenzene	108-90-7	5021A,5030C,5031,5032	EPA8260B	10.0
Chloroethane	75-00-3	5021A,5030C,5031,5032	EPA8260B	2.0
Chloroethene (Vinyl chloride)	75-01-4	5021A,5030C,5031,5032	EPA8260B	1.0
Chloroform	67-66-3	5021A,5030C,5031,5032	EPA8260B	6.5
Chloromethane (Methyl chloride)	74-87-3	5021A,5030C,5031,5032	EPA8260B	2.0
cis-1,2-Dichloroethylene	156-59-2	5021A,5030C,5031,5032	EPA8260B	0.2
cis-1,3-Dichloropropene	10061-01-5	5021A,5030C,5031,5032	EPA8260B	0.6
Cumene (Isopropylbenzene)	98-82-8	5021A,5030C,5031,5032	EPA8260B	1.0
Cyclohexane	110-82-7	5021A,5030C,5031,5032	EPA8260B	15.0
Dibromochloromethane	124-48-1	5021A,5030C,5031,5032	EPA8260B	2.0
Dichlorodifluoromethane	75-71-8	5021A,5030C,5031,5032	EPA8260B	0.00075
Dichloromethane (Methylene chloride)	75-09-2	5021A,5030C,5031,5032	EPA8260B	1.0
Ethylbenzene	100-41-4	5021A,5030C,5031,5032	EPA8260B	6.0
Methyl acetate	79-20-9	5021A,5030C,5031,5032	EPA8260B	1.0
Methyl ethyl ketone	78-93-3	5021A,5030C,5031,5032	EPA8260B	20.0
Methyl isobutyl ketone	108-10-1	5021A,5030C,5031,5032	EPA8260B	10.0
Methyl tertiary butyl ether (MTBE)	1634-04-4	5021A,5030C,5031,5032	EPA8260B	2.0
Methylcyclohexane	108-87-2	5021A,5030C,5031,5032	EPA8260B	150.0
Styrene	100-42-5	5021A,5030C,5031,5032	EPA8260B	50.0
Tetrachloroethylene (PCE)	127-18-4	5021A,5030C,5031,5032	EPA8260B	2.0
Toluene	108-88-3	5021A,5030C,5031,5032	EPA8260B	10.0
trans-1,2-Dichloroethylene	156-60-5	5021A,5030C,5031,5032	EPA8260B	0.2
trans-1,3-Dichloropropene	10061-02-6	5021A,5030C,5031,5032	EPA8260B	8.0
Trichloroethylene (TCE)	79-01-6	5021A,5030C,5031,5032	EPA8260B	1
Trichlorofluoromethane	75-69-4	5021A,5030C,5031,5032	EPA8260B	0.2
o-Xylenes	95-47-6	5021A,5030C,5031,5032	EPA8260B	1.0
m,p-Xylene	MPXYL	5021A,5030C,5031,5032	EPA8260B	0.4
Bromochloromethane	74-97-5	5021A,5030C,5031,5032	EPA8260B	10.0
1,4-Dioxane	123-91-1	5021A,5030C,5031,5032	EPA8260B	6.0
1,2-Dichlorobenzene	95-50-1	5021A,5030C,5031,5032	EPA8260B	1.0
1,2,3-Trichlorobenzene	87-61-6	5021A,5030C,5031,5032	EPA8260B	0.88
Acetone	67-64-1	5021A,5030C,5031,5032	EPA8260B	2.0
Radionuclides				
Tritium	10028-17-8	EPA900.0MOD	EPA900.0MOD	15 pCi/mL

Table 7. Laboratory Analytical Specifications Table for TAL/TCL Analytes for Surface, Groundwater, Sediment, or Soil Media *(Continued)*

Analyte	Analyte ID	Preparation Method [B]	Analytical Method[B]	Matrix	CRDL *(µg/L)*[A]
PFAS					
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
1h, 1h, 2h, 2h-perfluorodecane sulfonic acid (8:2 FTS)	39108-34-4	TBD	EPA533	Groundwater/Surface Water	TBD
1h, 1h, 2h, 2h-perfluorooctane sulfonic acid (6:2 FTS)	27619-97-2	TBD	EPA533	Groundwater/Surface Water	TBD
1h,1h,2h,2h-perfluorohexane sulfonic acid (4:2 FTS)	757124-72-4	TBD	EPA533	Groundwater/Surface Water	TBD
4,8-dioxa-3h-perfluorononanoic acid (DONA)	919005-14-4	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (PF3ONS)	756426-58-1	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
hexafluoropropylene oxide dimer acid (HFPO-DA [Gen-X])	13252-13-6	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
N-ethyl perfluorooctane-sulfonamidoacetic acid (NEtFOSAA)	2991-50-6	TBD	537.1MOD/ EPA537MOD	Groundwater/Surface Water/Sediment	TBD
N-methyl perfluorooctane-sulfonamidoacetic acid (NMeFOSAA)	2355-31-9	TBD	537.1MOD/ EPA537MOD	Groundwater/Surface Water/Sediment	TBD
nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	151772-58-6	TBD	EPA533	Groundwater/Surface Water	TBD
perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	113507-82-7	TBD	EPA533	Groundwater/Surface Water	TBD
perfluoro-1-heptanesulfonic acid (PFHpS)	375-92-8	TBD	EPA533	Groundwater/Surface Water	TBD
perfluoro-1-pentanesulfonic acid (PFPeS)	2706-91-4	TBD	EPA533	Groundwater/Surface Water	TBD
perfluoro-3-methoxypropanoic acid (PFMPA)	377-73-1	TBD	EPA533	Groundwater/Surface Water	TBD
perfluoro-4-methoxybutanoic acid (PFMBA)	863090-89-5	TBD	EPA533	Groundwater/Surface Water	TBD
Perfluorobutanesulfonic acid (PFBS)	375-73-5	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
perfluorodecanoic acid (PFDA)	335-76-2	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
perfluorododecanoic acid (PFDoA)	307-55-1	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
perfluoroheptanoic acid (PFHpA)	375-85-9	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
perfluorohexanesulfonic acid (PFHxS)	355-46-4	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
perfluorohexanoic acid (PFHxA)	307-24-4	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD

Table 7. Laboratory Analytical Specifications Table for TAL/TCL Analytes for Surface, Groundwater, Sediment, or Soil Media *(Continued/End)*

Analyte	Analyte ID	Preparation Method [B]	Analytical Method[B]	Matrix	CRDL *(µg/L)*[A]
PFAS (cont'd)					
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (PF3OUdS)	763051-92-9	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
perfluoro-n-butanoic acid (PFBA)	375-22-4	TBD	EPA533	Groundwater/Surface Water	TBD
perfluoro-n-pentanoic acid (PFPeA)	2706-90-3	TBD	EPA533	Groundwater/Surface Water	TBD
perfluorononanoic acid (PFNA)	375-95-1	TBD	EPA533/537.1	Groundwater/Surface Water/Sediment	TBD
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
Perfluorooctanoic acid (PFOA)	335-67-1	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
perfluorotetradecanoic acid (PFTDA)	376-06-7	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
perfluorotridecanoic acid (PFTrDA)	72629-94-8	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD
perfluoroundecanoic acid (PFUnDA)	2058-94-8	TBD	EPA533/537.1MOD /EPA537MOD	Groundwater/Surface Water/Sediment	TBD

A) CRDL is the Contract Required Detection Limit and is not always attainable.
B) Extraction and preparation methods differ depending upon media, concentration, instrument, laboratory, and analytical method. Preparation methods will also influence detection limits.
C) Laboratory instructed to obtain the lowest possible method detection limit.

Table 8. Minimum Field Quality Control/Quality Assurance Sampling Requirements

Data Quality Level	Field Quality Control/Quality Assurance Samples	Frequency of Field Quality Control/ Quality Assurance Sample
UU	None	
VU	None	
VV	Co-located Field Duplicate	Minimum 5%[1]
	Trip Blank	Minimum 1 per cooler
	Equipment Blank	1 per 40 samples[2]
	Field Blank	Optional; 1 per 40 samples[3]
	Split Sample	Minimum 5%
SD	Co-located Field Duplicate	Minimum 5%[1]
	Trip Blank	1 per cooler
	Equipment Blank	1 per 40 samples[2]
	Field Blank	Optional; 1 per 40 samples[3]
	Split Sample	Minimum 5%
D	Co-located Field Duplicate	Minimum 5%[1]
	Trip Blank	1 per cooler
	Equipment Blank	1 per 40 samples[2]
	Field Blank	Optional; 1 per 40 samples[3]
	Split Sample	Minimum 5%

Data Quality Levels
UU Data Unverified and Unvalidated Data (no errors from ERDMs database loading screens)
VU Data Verified and Unvalidated Data (includes missing data checks)
VV Data Verified and Validated Data (validated to automated criteria; equivalent to USEPA Screening Level Data)
SD Data USEPA Screening Level Data with 10% Definitive Confirmation
D Data USEPA Definitive Level Data

Footnotes:
1 Minimum frequency established per ER-SOP-043
2 Typical frequency
3 Recommended based on project needs; typical frequency

Table 9. Preservatives, Holding Times, and Sample Containers

Parameter	Preservatives		Holding Time		Containers	
	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid
Volatile Organic Compounds (VOCs) Including: 8260- VOCs, 8021 – Aromatic VOCs, 8021 Halogenated VOCs, 8015 – Nonhalogenated VOCs, 8032 – Acrylamide	No Residual Chlorine Adjust pH to <2 with H_2SO_4, HCL, or solid sodium bisulfate ($NaHSO_4$). Cool to 4° C	Low-level soil Add ~5 g soil to 40 mL VOA vial preserved with 1 g of $NaHSO_4$/5 mL water	14 days	Low/High Level 14 days`	3x40 mL glass VOC vial, PTFE septa cap	3x40 (or 60) mL glass VOA vial (with stir bar for low-level soil), PTFE septa cap
8033 – Acetonitrile, 8315 – Carbonyl Compounds Prepped by: 5030 – Purge and trap (aqueous) 5035 – Closed system purge and trap (solid)	Residual Chlorine Present Collect sample in a 125 mL container, preserved with 4 drops of 10% sodium thiosulfate (Na2S2O3) solution. Gently swirl to mix and transfer to 40 mL VOC vials. Adjust pH to <2 with H2SO4, HCL, or solid NaHSO4. Cool to 4° C, no headspace	High-Level Soil Add ~5 g soil to 40 (or 60) ML VOC vial preserved with 10 mL methanol	14 days	Low/High Level 14 days`	3x40 mL glass VOC vial, PTFE septa cap	3x40 (or 60) mL glass VOA vial (with stir bar for low-level soil), PTFE septa cap

Table 9. Preservatives, Holding Times, and Sample Containers *(Continued)*

Parameter	Preservatives		Holding Time		Containers	
	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid
Prepared by: 5021 – Automated Headspace	NA	Soil Only Add ~2 g soil to 22 mL soil vial. Cool to 4° C. Soil/Matrix Modifier Add ~2 g soil to 22 mL soil vial preserved with 10 mL matrix modifier. Cool to 4° C. Soil/Water Add ~2 g soil to 22 mL soil vial preserved with 10 mL water. Cool to 4° C.	NA	14 days	NA	2 x 22 mL glass soil headspace vial, PTFE-lined septa with crimp or screw–top cap
Prepared by: 5032 – Vacuum Distillation	Same as VOC – purge and trap	Cool to 4° C. No headspace	14 days	14 days	2 x 40 mL glass vial, PTFE septa cap	2 x 125 mL clear wide-mouth glass jars with PTFE –lined lids (CWM)
Nonpurgeable Water-Soluble VOCs Prepared by: 5031 - Azeotropic Distillation	Same as VOC – purge and trap	Cool to 4° C. No headspace	14 days	14 days	2 x 40 mL glass vial, PTFE septa cap	2 x 2125 mL CWM
VOCs Prepared by: 3585 – Solvent Dilution	NA	Oily Waste Cool to 4° C.	NA	14 days	NA	125 mL CWM
VOCs Including: 8031 – Acrylonitrile, 8316 – Acrolein, Acrylamide, Acrylonitrile	Adjust pH to 4-5 with H_2SO_4, HCL, or solid $NaHSO_4$. Cool to4° C.	NA	14 days	NA	2 x 40 mL glass vial, PTFE septa cap	250 mL CWM
Metals	HNO_3 to pH <2	Cool to 4° C.	6 months – Hg has maximum hold time of 28 days	6 months – Hg has maximum hold time of 28 days	1 L HDPE	250 mL CWM (metals and cyanide may be collected in the same container for soils)

Table 9. Preservatives, Holding Times, and Sample Containers *(Continued)*

Parameter	Preservatives		Holding Time		Containers	
	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid
Miscellaneous Including MNA Parameters						
Acidity	Cool to 4° C.	NA	48 hours	NA	250 mL HDPE	NA
Alkalinity	Cool to 4° C.	NA	48 hours	NA	250 mL HDPE	NA
Tritium	None Cool 0 to 6 C	None Cool 0 to 6 C	180 days	180 days	250 Amber Glass	250 HDPE or 4 oz Amber Glass
Sulfate	Cool to 4° C.	Cool to 4° C.	28 days	28 days	125 mL HDPE	125 mL CWM
Sulfide	Cool to 4° C and add 4 drops zinc acetate and NaOH to pH > 9.	Add 2 N zinc acetate until moistened and cool to 4° C.	7 days	7 days	1 L HDPE	250 mL CWM
Sulfite	Cool to 4° C.	NA	ASAP	NA	125 mL HDPE	NA
Radionuclides						
Tritium	NA	NA	6 months	6 months	125 mL or 250 mL glass bottle	NA
PFAS[1]						
N-ethyl perfluorooctane-sulfonamidoacetic acid	Trizma/Cold	Trizma/Cold	14 days	14 days	250 mL HDPE	250 mL HDPE
	Ammonium Acetate/Cold		28 days		250 mL Plastic	
N-methyl perfluorooctane-sulfonamidoacetic acid	Trizma/Cold	Trizma/Cold	14 days	14 days	250 mL HDPE	250 mL HDPE
	Ammonium Acetate/Cold		28 days		250 mL Plastic	
Perfluorobutane-sulfonic acid	Trizma/Cold	Trizma/Cold	14 days	14 days	250 mL HDPE	250 mL HDPE
	Ammonium Acetate/Cold		28 days		250 mL Plastic	
Perfluorodecanoic acid	Trizma/Cold	Trizma/Cold	14 days	14 days	250 mL HDPE	250 mL HDPE
	Ammonium Acetate/Cold		28 days		250 mL Plastic	
Perfluorododecanoic acid	Trizma/Cold	Trizma/Cold	14 days	14 days	250 mL HDPE	250 mL HDPE
	Ammonium Acetate/Cold		28 days		250 mL Plastic	
Perfluoroheptanoic acid	Trizma/Cold	Trizma/Cold	14 days	14 days	250 mL HDPE	250 mL HDPE
	Ammonium Acetate/Cold		28 days		250 mL Plastic	
Perfluorohexane-sulfonic acid	Trizma/Cold	Trizma/Cold	14 days	14 days	250 mL HDPE	250 mL HDPE
	Ammonium Acetate/Cold		28 days		250 mL Plastic	
Perfluorohexanoic acid	Trizma/Cold	Trizma/Cold	14 days	14 days	250 mL HDPE	250 mL HDPE
	Ammonium Acetate/Cold		28 days		250 mL Plastic	
Perfluorononanoic acid	Trizma/Cold	Trizma/Cold	14 days	14 days	250 mL HDPE	250 mL HDPE
	Ammonium Acetate/Cold		28 days		250 mL Plastic	
Perfluorooctane-sulfonic acid	Trizma/Cold	Trizma/Cold	14 days	14 days	250 mL HDPE	250 mL HDPE
	Ammonium Acetate/Cold		28 days		250 mL Plastic	

Table 9. Preservatives, Holding Times, and Sample Containers *(Continued/End)*

Parameter	Preservatives		Holding Time		Containers	
	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid
PFAS *(cont'd)*						
Perfluorooctanoic acid	Trizma/Cold Ammonium Acetate/Cold	Trizma/Cold	14 days 28 days	14 days	250 mL HDPE 250 mL Plastic	250 mL HDPE
Perfluorotetradecanoic acid	Trizma/Cold Ammonium Acetate/Cold	Trizma/Cold	14 days 28 days	14 days	250 mL HDPE 250 mL Plastic	250 mL HDPE

Abbreviations used in Table:

H_2SO_4	– Sulfuric acid	CWM	– Clear Wide-Mouth Glass Jar
HCL	– Hydrochloric acid	AG	– Amber Glass Jar
$NaHSO_4$	– Sodium bisulfate	HNO_3	– Nitric acid
PTFE	– Teflon lined seals	HDPE	– High-Density Polyethylene plastic bottle
$Na_2S_2O_3$	– Sodium Thiosulfate	BR	– Boston Round bottle

Footnote:
1 There are two analytical methods for PFAS aqueous samples. First entry in PFAS aqueous column represents criteria for EPA 537.1 MOD. Second entry represents criteria for EPA 533.

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