Critical Process Analysis After Action Report
Stewart Air National Guard Base Response Action for Per- and Polyfluoroalkyl Substances
Recommended Technical Activities and Specifications Phase 2 Report for Stormwater Sewer Rehabilitation and Interim Groundwater Containment and Treatment System at Southern Base Boundary

Final

22 January 2025

Introduction

This Phase 2 report discusses the recommended technical activities and specifications for informing a response action to mitigate per- and polyfluoroalkyl substances (PFAS) impacts at Stewart Air National Guard Base (ANGB). The recommendations are specific to an interim response action and other remediation activities to address PFAS contamination migration via the stormwater infrastructure at Stewart ANGB.

The information provided in this Phase 2 report is intended to support cost estimation approaches, which may include Remedial Action Cost Engineering and Requirements (RACER) estimates. Additional details are provided to facilitate understanding of specified activities for programming, cost estimation, and project scoping decision purposes. Not all information provided in this Phase 2 report is needed nor may be appropriate for including in cost estimating documents and project scopes of work. For additional information regarding the basis for proposed approaches, refer to the Critical Process Analysis (CPA) Phase 1 report.[1]

The analysis performed to generate the recommended technical activities and specifications provided in this Phase 2 report is based on a preliminary, limited dataset available to the CPA Team at the time of the CPA (13–15 January 2024). Specifications are not intended to be final designs. Specifications are not design-level estimates and were generated for purposes of supporting Government cost estimation and contract scoping. This Stormwater Infrastructure Response Action is necessary for collecting data to inform appropriate approaches and design specifications. Final proposed approaches and designs may differ from those recommended in this Phase 2 report, as determined by future data collection.

The recommendations for technical activities and specifications are specific to providing data useful for informing a groundwater response action. The recommended activities leading to a selection of a final response action consist of the rehabilitation of the stormwater sewer system, installation of a Pilot-Scale Groundwater Response Containment and Treatment System at the Southern Boundary and a Pilot System Optimization Study (POS) involving characterization of soil, groundwater, and site-specific testing.

[1] Noblis. 2024. *Critical Process Analysis for Per-and Polyfluoroalkyl Substances, Stewart ANGB, Phase 1 Report, Meeting Date: 13-15 January 2024*.

In addition, this Phase 2 report includes options for the additional actions/studies to limit possible future revisions to the scope if data or recommendations from Stormwater Sewer Rehabilitation and Groundwater Response Action activities and/or site conditions suggest modifications to the proposed actions identified in this report.

GENERAL NOTES

NOTE 1: All intrusive work, including soil borings (SBs), extraction wells (EWs), and monitoring wells (MWs) described in this report will be surveyed by a state licensed surveyor.

NOTE 2: All intrusive/subsurface work described in this report will require underground utility clearance at locations by the selected contractor and a third-party utility locating subcontractor. Coordination with Base Civil Engineering should be conducted to gain access prior to utility clearance. Adjustments to field activities should be completed as needed based on utility clearance and field conditions.

NOTE 3: Safety Level D is anticipated and assumed for all field activities including installation of SBs and MWs, other sampling and monitoring, and response action system construction, installation, operations and maintenance (O&M), and monitoring.

NOTE 4: Follow Interstate Technology and Regulatory Council (ITRC)[2]and United States Environmental Protection Agency (USEPA)[3] guidelines for decontaminating sampling equipment to prevent cross-contamination. Decontaminate any reusable sampling equipment between sampling points with non-phosphate detergent and PFAS-free water. Collect equipment blanks (EBs) between each decontamination event to confirm reusable sampling equipment is PFAS-free. This approach applies to all sediment, surface and subsurface soil, and groundwater sampling at Stewart ANGB Stormwater Infrastructure.

NOTE 5: Decontaminating sampling equipment is required between each MW sample collection to prevent cross-contamination.

NOTE 6: Quality control (QC) samples consist of 10% field duplicates (FDs), 5% field blanks (FBs), 5% matrix spike (MS), 5% matrix spike duplicate (MSD) each, and one EB per field day of sampling.

NOTE 7: Analysis of all samples collected from various media for PFAS and other analytical parameters will be performed offsite using Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP)-accredited laboratories. PFAS will be analyzed by USEPA Method 1633, liquid chromatography with tandem mass spectrometry (LC-MS-MS) compliant with Table B-24 of DoD Quality Systems Manual (QSM) Version 5.4 or latest version.[4] Data quality for PFAS deliverables produced by the

[2] ITRC. 2022. *PFAS Technical and Regulatory Guidance Document and Fact Sheets PFAS-1*. Washington, D.C. Web. https://pfas-1.itrcweb.org/11-sampling-and-analytical-methods/.
[3]USEPA. 2019. *Field Equipment Cleaning and Decontamination at the FEC*. United States Environmental Protection Agency Laboratory Services and Applied Science Division. Web. https://www.epa.gov/quality/field-equipment-cleaning-and-decontamination-fec.
[4]USEPA. 2021. *Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.4*.

offsite laboratory are Stage 2b for 90% of the deliverables and Stage 4 for 10% of the deliverables. Data quality for other analytes will be Stage 2b for 100% of the data deliverables.

NOTE 8: In accordance with the latest guidance from the Assistant Secretary of Defense[5,6], incineration of PFAS-containing materials is included as a destruction/disposal option. However, additional planning and coordination time is necessary before incineration operations resume; thus, incineration remains prohibited until further notice. Decisions regarding options for the destruction or disposal of PFAS-containing materials should be consistent with the most up-to-date DoD guidance.

NOTE 9: Non-impacted (non-hazardous) waste should be shipped to a Resource Conservation and Recovery Act (RCRA) Subtitle D solid waste landfill equipped with a composite liner and leachate collection and management systems. For estimating purposes, assume transport to a RCRA Subtitle D landfill is 200 miles from Stewart ANGB. Disposal of the PFAS impacted media should be performed at permitted RCRA Subtitle C hazardous waste landfills. These landfills have the most stringent environmental controls in place and higher potential capacity to manage the migration of PFAS into the environment. For estimating purposes, assume transport to RCRA Subtitle C landfill is 1,000 miles from Stewart ANGB.

NOTE 10: Based on discussions with the surface-active foam fractionation (SAFF®) system vendor, a second equalization tank and transfer pump were added to supply water to the polishing sorbent media vessels.

NOTE 11: In addition to PFAS analysis by USEPA Method 1633, water samples analyzed to evaluate if treated water meets criteria for sanitary sewer of Town of New Windsor will be analyzed for the following parameters in accordance with New York State Department of Environmental Conservation (NYSDEC):

- static water level,
- specific conductance,
- pH,
- chloride,
- alkalinity
- total hardness as $CaCO_3$,
- five-day biochemical oxygen demand (BOD5),
- total suspended solids (TSS),
- fats, oil, and grease,
- field observations (e.g., colors, odors, surface sheens),
- ammonia,
- total kjeldahl nitrogen (TKN),
- nitrate and nitrite as nitrogen,

[5] Office of Assistant Secretary of Defense for Energy, Installations, and Environment (ASD [EIE]). 2023. Interim Guidance on Destruction or Disposal of Materials Containing Per- and Polyfluoroalkyl Substances in the United States. 11 July 2023.

[6] ASD (EIE). 2023. Guidance on Incineration of Materials Containing Per- and Polyfluoroalkyl Substances. 14 July 2023.

- sulfate,
- total dissolved solids (TDS),
- methylene blue active substances (MBAS; - an indicator of foaming agents),
- fecal coliform, and
- total phosphorus.

Contents

Acronyms and Abbreviations

µm	micrometer
AER	anion exchange resin
ANGB	Air National Guard Base
ASD (EIE)	Assistant Secretary of Defense Energy, Installations, and Environment
ASTM	American Society for Testing and Materials
bgs	below ground surface
BOD5	five-day biochemical oxygen demand
CCTV	closed-circuit television
CIC	combustion ion chromatography
CIPP	Cured-In-Place-Pipe
CPA	Critical Process Analysis
CY	cubic yard(s)
DGS	Data Gap Study
DO	dissolved oxygen
DoD	Department of Defense
DRO	diesel range organics
EB	equipment blank
EBCT	empty bed contact time
ELAP	Environmental Laboratory Accreditation Program
ERPIMS	Environmental Resources Program Information Management System
ESS	environmental sequence stratigraphy
EW	extraction well
FB	field blank
FD	field duplicate
ft	foot/feet
F_{oc}	fraction of organic carbon
GAC	granular activated carbon
gal	gallon(s)
gpm	gallons per minute
GRO	gasoline range organics
HDPE	high-density polyethylene
HP	horsepower
HRT	hydraulic residence times
ID	inside diameter
IDW	investigation derived waste
in	inch(es)
ISWTS	Interim Surface Water Treatment System
ITRC	Interstate Technology and Regulatory Council
kW	kilowatt
lbs	pounds
LC-MS-MS	liquid chromatography with tandem mass spectrometry
MBAS	methylene blue active substances
mL	milliliter(s)
MS	matrix spike
MSD	matrix spike duplicate
MW	monitoring well
NTU	Nephelometric Turbidity Units
NYSDEC	New York State Department of Environmental Conservation
O&M	operations and maintenance
ORP	oxidation-reduction potential
OTM	Other Test Method
PCB	polychlorinated biphenyl
PID	photoionization detector
PLC	programmable logic controller
PFAS	per- and polyfluoroalkyl substances
POS	Pilot System Optimization Study
psi	pounds per square inch
PVC	polyvinyl chloride
QC	quality control
QSM	Quality Systems Manual
RACER	Remedial Action Cost Engineering and Requirements
RCRA	Resource Conservation and Recovery Act
RSSCT	rapid small-scale column tests
SAFF®	Surface-Active Foam Fractionation
SB	soil boring
SCADA	supervisory control and data acquisition
SOP	Standard Operating Procedure

SPDES	State Pollutant Discharge Elimination System
SS	stainless steel
SVOC	semi-volatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TKN	Total Kjeldahl Nitrogen
TOC	total organic carbon
TOF	total organic fluorine
TOP	total oxidizable precursors
TPH	total petroleum hydrocarbon
TS	treatability study
TSS	total suspended solids
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
V	volt(s)
VOC	volatile organic compound

1.0 Data Gap Study

Prepare a Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) for the Data Gap Study (DGS) activities outlined in this Section. Assume a draft, draft final, and final version of the UFP-QAPP using standard professional labor management.

1.1. Storm Sewer Water Sampling

- Perform storm sewer water sampling at 27 locations to assess the spatial extent of PFAS impacts in areas with elevated groundwater concentrations and in areas with limited data from prior investigations. Recommended sample locations are included in CPA Phase 1 report Figure 11.
  - Collect stormwater samples from 27 accessible stormwater drainage manholes on-Installation (CPA-SW/SD1 through CPA-SW/SD27).
- Stormwater and sediment sampling locations are co-located.
- Measure the following standard field parameters using an in-line multiparameter sonde such as a YSI ProDSS multimeter (or equivalent) per guidance in United States Geological Survey (USGS) Series 09-A6.8:
  - pH,
  - temperature,
  - conductivity,
  - dissolved oxygen (DO),
  - oxidation-reduction potential (ORP), and
  - turbidity.
- Analyze stormwater samples using a DoD ELAP certified off-site laboratory for PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version).
- At 10 locations, collect extra sample volume for laboratory filtration and analysis of PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DOD QSM Version 5.4 (or latest version) in laboratory-filtered samples to determine PFAS mass associated with suspended solids in the stormwater.

1.2. Storm Sewer Sediment Sampling

- Perform surficial sediment sampling at 27 locations collocated with stormwater samples. Recommended sample locations are included in CPA Phase 1 report Figure 11.
  - If sediments are present, collect surficial sediment samples (0–0.5 feet [ft] below ground surface [bgs]) from 27 accessible stormwater drainage manholes on-Installation (CPA-SW/SD1 through CPA-SW/SD27).
- Conduct sediment sampling following stormwater sampling to minimize silt suspension in stormwater samples collected from the same location.
- Collected sediment from each location will be homogenized prior to filling the laboratory provided sample container.

- Analyze 27 sediment samples using a DoD ELAP certified off-site laboratory for the following parameters:
  - PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version),
  - total organic carbon (TOC) by USEPA Method 9060, and
  - grain size distribution by American Society for Testing and Materials (ASTM) Method D422.
- Compare against the Assistant Secretary of Defense Energy, Installations, and Environment (ASD [EIE]) soil/sediment screening levels (for direct contact and impact to groundwater).
- Prepare technical memorandum in draft, draft final, and final versions to document results.
- Use data for planning storm sewer cleaning project and to segregate sediments and solid debris in separate roll off containers as described in Section 2.3.1. Wastes will be stored temporarily in area designated by the Installation and subsequently dispose of in hazardous or non-hazardous waste landfills depending on sampling results.

1.3. Surficial Soil Sampling

- Identify and characterize PFAS impacts in shallow soils associated with the Outfall 003 drainage area from 27 proposed surficial soil sample locations (see CPA Phase 1 Report Figure 12).
- Collect surficial soil samples in grassy areas using a hand auger.
- Advance a hand auger for collection of surficial soil samples at depth from the ground surface to 2 ft bgs.
- Collect two (2) separate surficial soil samples upon retrieval at each location. Assume the following depths for 27 surficial soil sampling locations:
  - Assume one (1) from the 0–0.5 ft bgs interval.
  - Assume one (1) from the 1–2 ft bgs interval.
  - Adjust locations based on site-specific constraints.
- Homogenize surficial soil samples collected prior to transferring contents into laboratory provided containers.
- Assume an average depth to groundwater of approximately 5 ft bgs.
- Assume clay mixed with sandy silt and gravel soil type.
- Screen soil cores collected during hand augering with a photoionization detector (PID), for evidence of visual/olfactory contaminant impacts.
- Collect a total of 71 samples including 54 grab samples (2 each from 27 locations), and 17 QC samples (10% FD [6 samples], 5% EB [3 samples], 1 RB per day for two days of sampling [2 total RB samples], 5% MS [3 samples], and 5% MSD [3 samples]) for sampling.
- Analyze 71 surficial soil samples using DoD ELAP-accredited off-site laboratories for the following parameters:
  - PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version),
  - fraction of organic carbon (F_{oc}) by ASTM Method D2974 and,
  - grain size distribution by ASTM Method D422.

- Compare analytical results to the ASD (EIE) soil screening levels (direct contact and impact to groundwater) to identify areas that may need a shallow interim action from reducing PFAS mass discharge to Outfall 003.
- Prepare DGS technical memorandum in draft, draft final, and final version to document findings and recommendations for surficial soil actions, if necessary.

2.0 Stormwater Sewer Rehabilitation

Prepare a UFP-QAPP for the activities outlined in this section for sequencing stormwater sewer cleaning, waste material (water and solids) sampling, storing, and management. The objective is to remove and segregate water and solid materials in separate dewatering roll off containers for subsequent sampling and analysis followed by waste disposal. Assume draft, draft final, and final versions of the UFP-QAPP using standard professional labor management.

2.1. Stormwater Sewer Cleaning

- Evaluate analytical data from DGS related to storm sewer water and sediment data.
- Identify and select, licensed hazardous and non-hazardous facilities for disposal.

2.1.1. Stormwater Sewer Water and Solids Removal

- Review installation geographic information system and construction details to identify the stormwater lines connected to outfalls and associated storm sewer piping.
- Inspect closed-circuit television (CCTV) logs of suspected stormwater drainage to evaluate media within the stormwater drainage system as a continuing source(s) of sporadic and highly variable contaminant along the network during storm events.
- Locate potential line breaks, leaky joints, floating debris, and oversized concrete chunks and other debris which may require confined space entry for removal.
- Identify upstream and downstream manholes (approximate 600-ft spacing) of segments to be cleaned. Place rubber plugs in downstream manholes, as needed, to contain and collect flushed waste material.
- Conduct storm sewer cleaning in storm sewer lines Outfall A, Outfall 002, and Outfall 003.
    - Assume total pipe length of approximately 7,300 ft, 30,500 ft, and 15,800 ft in Outfall A, Outfall 002, and Outfall 003, respectively. Assume estimated total pipe volume of 74,000 ft^3, 163,000 ft^3, and 76,000 ft^3 in Outfall A, Outfall 002, and Outfall 003, respectively.
    - Storm sewer lines and segments that require cleaning are shown on Figure 1 and tabulated in Attachment A. Assume approximately 25%, 10%, 15% of the total pipe volume in Outfall A, Outfall 002, and Outfall 003, respectively, needs to be cleaned.

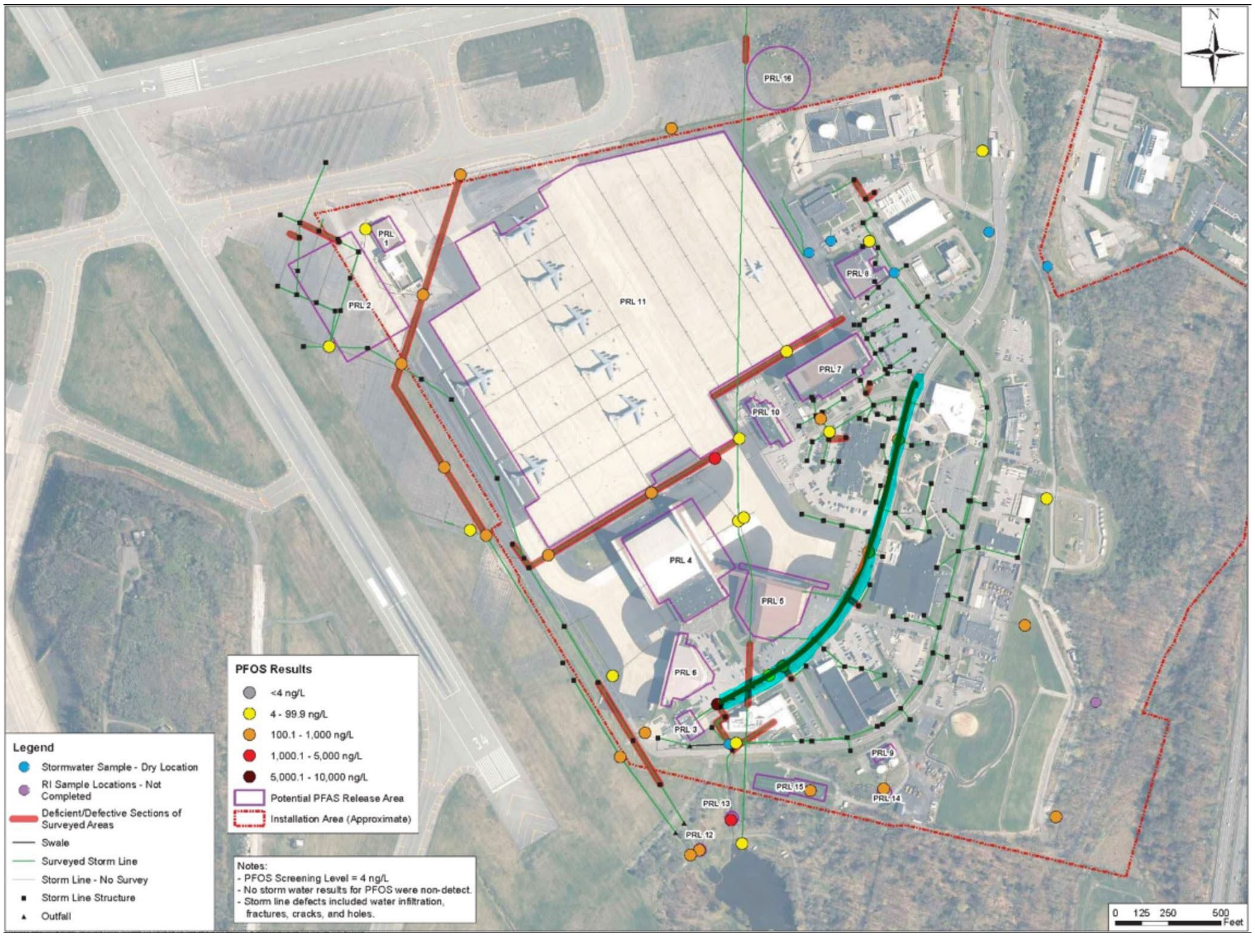

Figure 1. Stormwater Sewer lines recommended for cleaning (adapted from the Stewart ANGB Restoration Advisory Board Presentation [31 January 2024 Meeting #17]). Orange lines show deficient/defective sections of surveyed areas. Blue line reflects segment to be cleaned based on discussions with the Base.

- Remove water and solids from segments that require cleaning.
  - Mobilize a Vacuum truck with hydrojetting, pump-off, and dump capability (Vac-Con combination machine or equivalent). Vac truck should have 28-inches (in) mercury vacuum power at ~6,000 cubic ft per minute, 1,500-gallon (gal) freshwater storage tank, and 60–80 gal per minute (gpm) at 3,000 pounds (lbs) per square inch (psi) hydrojetting capability. Vac truck should be equipped with 2- or 3-in trash pump to pump-off storm sewer water at up to 300 gpm to on-site frac tanks. Truck should also have lift capability to off-load solids and debris to dewatering 25 cubic yards (CY) roll off containers.
  - Assume that half of the waste material volume removed is water and half is solids.
    - The total volume of water to be removed is 7,000, 5,600, and 4,500 gal in Outfall A, Outfall 002, and Outfall 003, respectively. The volume of water in the impacted storm sewers to be removed is 17,100 gal.
    - The total volume of solids to be removed is 35, 28, and 22 CY in Outfall A, Outfall 002, and Outfall 003, respectively. The total volume of solids to be removed is 85 CY. Assume 5% of solids (approximately 4.3 CY) are oversized broken

concrete pieces and other debris that cannot be removed by vac truck and will require confined space entry for manual removal.

        - Assume two (2) flushes of the pipes to be rehabbed prior to Cured-In-Place-Pipe (CIPP) liner installation. Assume first flush will be medium or light and will be performed as follows:
            - Assume 60 gpm at 3,000 psi and 20 minutes time will be needed to jet and flush solids through 600 ft segment of pipe during first flush.
            - Perform CCTV inspection to assess extent of cleaning and pipe condition.
        - Perform second jetting/flush and assume light rinsing will be needed.
            - Assume five (5) minutes of rinsing will be needed for second flush.
        - There are approximately 11 segments of 600-ft pipe to be rehabilitated. Estimated volume of wastewater to be generated during cleaning is 16,500 gal. The total estimated volume of wastewater is 33,600 gal.

- Containerize solids removed from storm sewer lines.
    - Assume approximately 85 CY into four (4) 25-CY lined, dewatering roll off containers.
- Containerize water recovered during cleaning (comprised of water from sewer and cleaning water).
    - Assume approximately 33,600 gal into two (2) rented 21,000-gal frac tanks.
- Supply a skid-mounted granular activated carbon (GAC) treatment unit with two in-series vessels containing 500 lbs, or 110 gal, GAC each.
- Treat wastewater to remove PFAS for compliance with Town of New Windsor/NYSDEC requirements. Treatment goal is 10 nanograms per liter (ng/L) for PFAS as demonstrated by treated water sample analysis by USEPA Method 537.1. To achieve this goal, supply a centrifugal pump to transfer water from frac tanks through the skid-mounted GAC vessels at a flow rate of up to 20 gpm and 15 ft of head. Total empty bed contact time (EBCT) is ~11 min. An alternate treatment system may be implemented to achieve the treatment goal, if needed.
- Transport solids and water resulting from cleaning to approved staging area and dispose of in accordance with waste disposal requirements as outlined in Section 2.3.

2.2. Stormwater System Rehabilitation

- Prepare storm sewer rehabilitation work plan in draft, draft-final, and final form for the selected CIPP liner specifications.

2.2.1. CIPP Liner Selection and Design

- Use epoxy or equivalent resin-impregnated felt tube coated with polyurethane or polypropylene will be installed to provide additional strength and chemical resistance. Curing will be performed using steam or hot water.
- Liner materials and thickness specifications and installation procedure will be determined following removal of water and debris from the sewer lines and CCTV inspection.

2.3. Stormwater Sewer Rehabilitation Waste Management

2.3.1. Temporary Storage and Disposal of Stormwater Sewer Solids

- Coordinate with Installation personnel to determine the staging area location for temporary storage of stormwater sewer cleaning solid and water waste until hazardous waste characteristics are determined. An area behind Building 108 will be provided for this operation. Site work may require site preparation and compaction of base layer using coarse aggregate. Electrical service will come from the switchgear in front of Building 109 and water service from the hydrant behind Building 108.
- Solids should be stored in roll off containers based on DGS analytical results: segregate solids in boxes with no PFAS detections per USEPA Method 1633; place solids with PFAS detections and/or hazardous waste characteristics in separate roll off containers. Transport to designated area by the Installation and off-load solids in two (2) separate stockpiles (PFAS/hazardous vs. non-PFAS/hazardous).
- Collect a total of 20 grab samples of five (5) samples from each roll-off container of solids (five grab samples per container x four total containers) for hazardous waste characterization.
- Analyze grab samples for the following parameters using a DoD ELAP-certified offsite laboratory:
    - Perform the Toxicity Characteristic Leaching Procedure (TCLP) by USEPA Method 1311 then analyze the extracted liquid for the following:
        - volatile organic compounds (VOCs) by USEPA Method 8260, and
        - semi-VOCs (SVOCs) by USEPA Method 8270.
- Collect a total of four (4) composite samples from roll off containers (one [1] composite sample per container x four total containers) for hazardous waste characterization.
- Analyze four (4) composite samples for the following parameters using a DoD ELAP-certified offsite laboratory:
    - Perform the TCLP by USEPA Method 1311 then analyze the extracted liquid for the following:
        - pesticides by USEPA Method 8081,
        - herbicides by USEPA Method 8151,
        - polychlorinated biphenyls (PCBs) by USEPA Method 8082, and
        - RCRA 8 Metals (arsenic, barium, cadmium, chromium, lead, selenium, and silver) by USEPA Method 6010 and mercury by USEPA Method 7470.
    - Corrosivity by USEPA Method 9045 (corrosivity is determined by pH level, Method 9045 determines the pH of soil and waste).
    - Ignitability (Flash point) by USEPA Method 1010.
    - Reactivity (sulfide and cyanide) by USEPA Method 335.
- Assume solids will not be classified as hazardous waste.
- Containerize, manifest, transport, and dispose of drill cuttings and excavated soil at an offsite RCRA Subtitle D licensed facility (assume 200 miles away).

2.3.2. Handling of Stormwater Sewer Liquid Investigation Derived Waste

- Coordinate with Installation personnel to determine the staging area location for temporary storage of liquid investigation derived waste (IDW) prior to treatment. Assume the following waste summary calculations:
  - Approximately 33,600 gal of water generated from stormwater sewer cleaning.
- Supply one (1) skid-mounted treatment system with two (2) 500-lb GAC vessels in a lead-lag configuration to treat purge and wastewater from sewer cleaning on site.
  - Supply a centrifugal pump to transfer untreated water for treatment through the skid-mounted GAC vessels (treated effluent).
  - Assume approximately 3.5 workdays at 8 hours per work day are required for approximately 33,600 gal water generated from stormwater sewer cleaning activities (at 20 gpm).
  - Supply two (2) 21,000-gal rental frac tanks to store stormwater recovered during stormwater sewer cleaning (sewer and cleaning water).
- Supply four (4) 3,000-gal frac tanks to store treated stormwater to allow water treatment to continue while waiting for laboratory analytical results to confirm treated water complies with sanitary sewer requirements. Analytical parameters for discharge to sanitary sewer include PFAS by USEPA Method 1633 and those listed in Note 11.
- Collect one (1) sample from each 3,000-gal batch treated (total of 12 samples) for analysis as described in Section 3.5.5.
- Discharge treated effluent to sanitary sewer complying with Town of New Windsor/NYSDEC State Pollutant Discharge Elimination System (SPDES) requirements.

2.4. Stormwater Sewer Rehabilitation Project Management and Reporting

- Prepare report summarizing results of rehabilitation in draft, draft final, and final versions with standard professional labor management.
- Assume three (3) meetings (one [1] scoping meeting, one [1] review meeting, and one [1] regulatory meeting).
- Data Management:
  - Perform data evaluation/validation, including Stage 2b/Stage 4 laboratory data review (see Note 7).
  - Assume standard turnaround time.
  - Submit data electronically to the Environmental Resources Program Information Management System (ERPIMS) within 90 days once the data has been validated.

3.0 Groundwater Response Action at the Southern Boundary

3.1. Groundwater Extraction System

Construct a pilot groundwater extraction and treatment system for the Southern Boundary to contain the highest PFAS-impacted groundwater in the glacial till and reduce off-base migration.

- Prepare permits and engineering design in draft, draft-final, and final format (engineering drawings specifications and construction completion report).
- Prepare a UFP-QAPP for the POS activities outlined in this section and use it as the monitoring plan. Assume a draft, draft final, and final UFP-QAPP using standard professional labor management.

3.1.1. Groundwater Extraction Trench Excavation

- Prior to trench excavation, provide the following supplies, instruments, materials, and labor required to complete the proposed groundwater extraction system (trench and associated sumps/pumps):
    - temporary facilities such as, but not limited to, dumpster, portable washroom, fencing, warning signs, and barriers as required;
    - utilities locating;
    - stormwater management control, soil erosion, dust and noise control;
    - one-pass trencher (DeWind MT2000 or equivalent);
    - one (1) 5,000-gal equalization tank insulated and/or heat traced for cold weather conditions;
    - one (1) programmable logic controller (PLC) with level controls and a power disconnect;
    - geotextile fabric;
    - influent conveyance piping;
    - effluent conveyance piping;
    - four (4) 25-CY lined, dewatering roll off containers;
    - two (2) submersible pumps;
    - two (2) stainless steel (SS) slotted sumps;
    - 900 ft of 6-in diameter SDR 11 high-density polyethylene (HDPE) drainage pipe; and
    - support equipment, materials, and field activities including:
        - excavator (CAT 336 [80,000 lbs model], or equivalent),
        - front end loader,
        - 20-CY bedding box,
        - three (3) 21,000-gal frac tanks,
        - aerial man lift with 40-ft boom,
        - 150 kilowatt (kW) generator,
        - work platform (standard width of 40 ft, level side-to-side, and able to support the trencher and support equipment),
        - PFAS-free backfill (approximately 3,750 tons (approximately 500 tons of clay and 3,250 tons of gravel),
        - field surveying and staking, and
        - sitework, spoil removal, cleanup, and site restoration.
- Install two (2) 12-in diameter SS sumps with wire-wrapped screens (40 slot) with the one-pass trencher at the approximate mid-point of the proposed trench location. The one-pass trencher will install a 40 slot SDR 11 6-in diameter HDPE drainage pipe approximately 8-in above the bottom of the trench concurrently with trench excavation.

  - Screened sections of sumps to extend 15 ft bgs to 30 ft bgs depending on location and groundwater elevation.
  - Sump #1 and Sump #2 to be installed 20–30 ft apart.
  - Sump #1 will capture water collected in the western segment of the trench.
  - Sump #2 will capture water collected in the eastern segment of the trench.
- Furnish each sump with a 4-in diameter HDPE clean-out pipe to allow for periodic maintenance. Cleanout will be installed by trencher.
- Provide labor, equipment, and materials for construction associated with equalization tank installation.
- Furnish one of two equalization tanks consisting of the following:
  - Provide a 5,000-gal bolted carbon steel tank (10-in diameter by 10-ft high) to allow approximately 70 minutes of holding time for storage based on the maximum operating flowrate of 70 gpm (35 gpm from each of two [2] sump pumps). Tank to be heated/insulated for cold weather.
  - Construct a 15-ft x 15-ft x 6-in reinforced concrete slab for equalization tank.
  - Provide secondary containment (7,000 gal) for the equalization tank.
- Excavate a 2-ft wide by 30-ft deep and approximately 900-ft long trench to capture PFAS-impacted groundwater using a one-pass trencher.
  - First (single) pass to install western segment of the trench.
  - Second pass to install the eastern segment of the trench.
  - Place the bottom of the trench at the approximate interface between the glacial till and fractured bedrock.
- Remove approximately 2,000 bank CY of glacial till spoils (900-ft by 30-ft by 2-ft converted to CY) from the trench excavation and place directly into four (4) 25-CY lined dewatering roll off containers.
- Stage roll off containers temporarily on either side of the excavation (four [4] 25-CY lined dewatering roll off containers).
- Assume depth to groundwater varies from 4 ft bgs to 15 ft bgs. Assume an average of 8 ft bgs.
- Assume the amount of excavated soil is approximately 3,000 tons (900-ft by 2-ft by 30-ft trench and 1.5 tons per CY).
- Supply approximately 3,750 tons of clean backfill assuming 25% compaction (500 tons of clay and 3,250 tons of gravel).
- Using one-pass trencher, backfill trench with approximately 26 ft of gravel/coarse aggregate certified PFAS free to approximately 4 ft bgs (bottom of trench at approximately 30 ft bgs).
- Place geotextile fabric (approximately 900-ft long by 2-ft wide) on top of gravel/coarse aggregate backfill.
- Place a layer of clay approximately 4-ft thick above the geotextile. Compact in 12-in lifts with a trench roller.
- Add topsoil to ground surface to match the existing grade.
- Install an electric conduit in the trench to provide power from the proposed treatment system to the extraction sump pumps.

- Install an electrical, submersible pump at the bottom of each sump (Sump #1 and Sump #2)-See Phase 1 report for sump and treatment system locations.
    - Furnish two (2) submersible pumps with variable frequency drives. Each pump will be a Grundfos 30 SQE10-130 (or equivalent) capable of delivering up to 35 gpm for a total of up to 70 gpm, if needed, at 65 ft of head. Pumps are SS, variable speed, multistage, single phase, with 2 horsepower (HP) motor.
    - HDPE discharge pipe from each sump (Sump #1 and Sump #2) will be manifolded into one conveyance pipe to pilot-scale Surface-Active Foam Fractionation (SAFF®20) Polishing Treatment System for PFAS removal (see Section 3.1.1).
    - Groundwater will be pumped at a flow rate of 35–40 gpm as formation recharges trench.
    - Lift and transfer groundwater from approximately 25 ft bgs to the conveyance HDPE pipe (at approximately 4 ft bgs) and then to equalization tank.
- Install one (1) 3-in HDPE pipe just below the frost line to convey combined groundwater flow from the sumps (Sump #1 and Sump #2) to the pilot treatment system equalization tank.
- Construct a galvanized steel manifold with necessary valves for transfer of water from influent conveyance pipe to the equalization tank.
- Install one (1) 3-in HDPE pipe just below the frost line to convey combined groundwater flow from the sumps (Sump #1 and Sump #2) to the pilot treatment system equalization tank.
- Assume dewatering of trench within approximately one day (estimated volume of approximately 50,500 gal).
- Sample water in accordance with the Town of New Windsor and NYSDEC requirements per Note 11 before final discharge to the sanitary sewer.

3.1.2. Trench Excavation IDW Management

Temporary Storage and Disposal of Soil Pile

- Temporarily stage soil pile from the groundwater extraction trench excavation on either side of the excavation and directly load soil into lined roll off containers when not sampling.
- Collect 30 soil samples from the excavator bucket before spoils are loaded into roll off containers. This will be one sample every 30 linear ft of trench excavation.
- Analyze 30 samples (grab for VOCs and composited for the remaining parameters) as shown below:
    - Perform the TCLP by USEPA Method 1311 then analyze the extracted liquid for the following:
        - VOCs by USEPA Method 8260,
        - SVOCs by USEPA Method 8270,
        - pesticides by USEPA Method 8081,
        - herbicides by USEPA Method 8151,
        - PCBs by USEPA Method 8082, and
        - RCRA 8 Metals (arsenic, barium, cadmium, chromium, lead, selenium, and silver) by USEPA Method 6010 and mercury by USEPA Method 7470.

    - Corrosivity by USEPA Method 9045. Corrosivity is determined by pH level. Method 9045 determines the pH of soil and waste.
    - Ignitability (Flash point) by USEPA Method 1010.
    - Reactivity (sulfide and cyanide) by USEPA Method 335.
- Transfer soils to two (2) soil piles in temporary on-site storage area designated by the Base depending on analytical results; one pile for soils with non-detect levels of PFAS and non-hazardous characteristics and the other pile with soils containing PFAS and/or exhibit hazardous waste characteristics.
- Transport to selected off-base, licensed landfill facilities. Assume approximately one-third of soil excavated (1,000 tons) will be transported and disposed of at an off-installation RCRA Subtitle C landfill (assume approximately 1,000 miles from Installation) and 2,000 tons will be disposed of in a Subtitle D landfill (assume approximately 200 miles from Installation).

<u>Handling Of Water Generated During Trench Excavation</u>

- Transfer approximately 50,500 gal of trench water (900-ft by 25-ft by 2-ft saturated zone in trench with 15% mobile porosity) from dewatering roll off containers into three (3) 21,000-gal frac tanks.
- Assume water will be stored in tanks until it can be processed through the groundwater pilot-scale SAFF®20 and Polishing Treatment System (see Section 3.1.2).
    - Assume approximately 1 day of total treatment time will be required at a rate of 40 gpm to treat approximately 50,500 gal of water generated from the excavation of the groundwater extraction trench.
    - Obtain treated effluent samples and analyze monthly for parameters listed in Note 11.
- Supply three (3) additional 21,000-gal frac tanks for temporary storage of treated water.
- Temporarily store treated effluent in frac tanks until analytical results confirm that requirements established by the Town of New Windsor/NYSDEC have been met.
- Upon confirmation, discharge treated effluent to the sanitary sewer complying discharge requirements.

3.2. Influent Conveyance and Treated Effluent Discharge

3.2.1. Construction of Influent Conveyance

- Clear the proposed trenching footprint for underground utilities with Base Civil Engineering Department and a third-party utility locating contractor. Adjust the trenching areas as needed based on utility clearance results and field conditions.
- Prepare a permit to gain site access if required.
- Excavate an influent conveyance trench approximately 1-ft wide by 4-ft deep for piping connecting the equalization tank to the SAFF®20 unit.
- Assume one (1) of three (3) influent conveyance location options (see CPA Phase 1 report for the proposed options [Option 1 in Figure 14, Option 2 in Figure 15, and Option 3 in Figure 16]).
    - Options 1 and 2: Place effluent discharge above the weir of Outfall 10 near the Interim Surface Water Treatment System (ISWTS).

        - Option 1: Install approximately 360 ft of influent conveyance piping from extraction trench to the first of two (2) equalization tanks (see Section 3.3.1).
        - Option 2: Install approximately 960 ft of influent conveyance piping from extraction trench to first of two equalization tanks.
    - Option 3: Place treatment system equipment northeast of the industrial wastewater lagoons and discharge treated effluent to the sanitary sewer.
        - Install approximately 250 ft of influent conveyance piping from extraction trench manifold to the first of two equalization tanks.
- Assume influent conveyance piping to treatment system will be a 3-in diameter HDPE pipe.
- Assume soil type is clay with sandy silt and gravel mixture.
- Assume that dewatering is not required for the influent conveyance trenching.
- Install sidewall protection as a safety precaution.
- Place 6-in of pea gravel or sand at the trench bottom for HDPE pipe bedding and compact with trench roller.
- Install conveyance pipe (3-in HDPE pipe).
- Perform pressure testing for newly installed piping.
- Install electrical conduit line within trench to provide power to the treatment system. Assume a total of 960 linear ft of electrical conduit to connect the electrical service from equalization tank to the treatment facility.
- Backfill the trench to approximately 6-in below grade and restore surface to match existing grade.
- Construct clean-outs at approximate 200-ft spacing along influent conveyance pipe: five (5) cleanouts for Option 2 and one (1) cleanout each for Options 1 and 3.
- Assume one (1) of the three (3) influent conveyance options of soil excavated and removed from within a 1-ft wide by 4-ft deep trench:
    - Option 1: approximately 53 CY, 80 tons.
    - Option 2: approximately 142 CY, 213 tons.
    - Option 3: approximately 37 CY, 56 tons.
- Assume one (1) of the three (3) influent conveyance options for the amount of excavated soil to be backfilled within a 1-ft wide by 4-ft deep trench following pipe installation:
    - Option 1: Assume approximately 69 CY, 103 tons of clean backfill. Supply approximately 69 CY (103 tons) of coarse aggregate, place in trench and compact.
    - Option 2: Assume approximately 185 CY, 277 tons of clean backfill. Supply approximately 185 CY, 277 tons of coarse aggregate, place in trench and compact.
    - Option 3: Assume approximately 48 CY, 73 tons of clean backfill. Supply approximately 48 CY, 73 tons of coarse aggregate, place in trench and compact.
- Containerize, manifest, transport, and dispose of excavated soil from trenching activities as follows:
    - Assume approximately one-third of excavated soil removed from trench will be disposed of at an off-site RCRA Subtitle C licensed facility approximately 1,000 miles away.
    - Assume approximately two-thirds of excavated soil removed from trench will be disposed of at an off-site RCRA Subtitle D licensed facility approximately 200 miles away.

3.2.2. *Construction of Effluent Discharge Conveyance*

- Clear the proposed trenching footprint for underground utilities with Base Civil Engineering Department and a third-party utility locating contractor. Adjust the trenching areas as needed based on utility clearance results and field conditions.
  - Prepare a permit to gain site access if required.
- Excavate an effluent conveyance trench approximately 1-ft wide by 4-ft deep.
- Assume one (1) of three (3) effluent conveyance location options (see CPA Phase 1 report for the proposed options [Option 1 in Figure 14, Option 2 in Figure 15, and Option 3 in Figure 16]).
  - Options 1 and 2: Place effluent discharge above the weir of Outfall 10 near the ISWTS.
    - Option 1: Install approximately 780 ft of effluent conveyance piping from the second equalization tank to above the weir of Outfall 10 near the ISWTS (see Section 3.2.2)
    - Option 2: Install approximately 160 ft of effluent conveyance piping from the second equalization tank to above the weir of Outfall 10 near ISWTS.
  - Option 3: Place treatment system equipment northeast of the industrial wastewater lagoons and discharge treated effluent to the sanitary sewer.
    - Install approximately 90 ft of effluent conveyance piping from the second equalization tank to sanitary sewer.
    - Perform necessary site work for sanitary sewer modification to connect pilot system effluent to sanitary sewer.
- Assume effluent conveyance piping to the pilot-scale SAFF®20 and Polishing Treatment System will be a 3-in diameter HDPE pipe.
- Assume soil type is clay with sandy silt and gravel mixture.
- Assume that dewatering is not required for the effluent conveyance trenching.
- Install sidewall protection as a safety precaution.
- Fill the trench with 6-in of pea gravel or sand for HDPE pipe bedding and allow placement of aggregate between piping and compaction.
- Perform pressure testing for newly installed piping.
- Construct five (5) clean-outs at approximate 200-ft spacing along effluent pipe corridor.
- Install electrical lines to provide power to the pilot-scale SAFF®20 Polishing Treatment System operation. Assume a total 780 linear ft of electrical conduit is needed to connect the electrical service from pilot-scale SAFF®20 Polishing Treatment System to the sanitary sewer discharge.
- Assume one (1) of three (3) effluent discharge conveyance options of soil excavated and removed from within a 1-ft wide by 4-ft deep trench:
  - Option 1: approximately 116 CY, 173 tons.
  - Option 2: approximately 24 CY, 36 tons.
  - Option 3: approximately 13 CY, 20 tons.
- Assume one (1) of the three (3) effluent discharge conveyance options for the amount of excavated soil to be backfilled within a 1-ft wide by 4-ft deep trench following pipe installation:
  - Option 1: Assume approximately 151 CY, 226 tons of clean backfill. Supply approximately 151 CY, 226 tons of coarse aggregate, place in trench and compact.

  - Option 2: Assume approximately 31 CY, 47 tons of clean backfill. Supply approximately 31 CY (47 tons) of coarse aggregate, place in trench and compact.
  - Option 3: Assume approximately 17 CY, 25 tons of clean backfill. Supply approximately 17 CY (25 tons) of coarse aggregate, place in trench and compact.
- Containerize, sample for PFAS and hazardous waste characteristics (1 sample per 100 tons of soil IDW), manifest, transport, and dispose of excavated soil from trenching activities as follows:
  - Assume approximately one-third of excavated soil removed from trench will be disposed of at an off-site RCRA Subtitle C licensed facility approximately 1,000 miles away.
  - Assume approximately two-thirds of excavated soil removed from trench will be disposed of at an off-site RCRA Subtitle D licensed facility approximately 200 miles away.

3.2.3. Piping, Electrical, and Telecommunications Installation

- Coordinate with Stewart ANGB Civil and Electrical Department.
- Install a pad-mounted transformer and a 3-Phase, 460 volt (V) electrical service for a power drop near the location of the preferred option (Option 1, Option 2, or Option 3) for staging the pilot treatment system.
- Install supervisory control and data acquisition (SCADA) system, PLC, digital control screen, system alarms, and emergency stop control panel box. PLC will be configured to communicate with two (2) equalization tanks, four (4) transfer pumps (including two standby pumps), two (2) extraction sump pumps, bag filters, one (1) anion exchange resin (AER) vessel, and one (1) GAC vessel. System must interface with process components such as variable speed drive, actuated valves, and pressure transmitters. Connect service wires from/to influent and effluent transfer pumps. Connect check valves following sump pumps, butterfly valves, air release valves, pressure gauges (approximately 0–150 psi or similar), pressure transmitters (pre- and post-bag filtration, post-SAFF®20 unit, post-lead AER tank and post-lag GAC tank, 0–150 psi), digital liquid flow meters (pre- and post-SAFF®20 unit, pre-lead AER tank, post-lag tank effluent), and ball valves for sampling (pre-SAFF®20 unit, lead AER influent, lag GAC influent, lag GAC effluent).
- Assume electrical and water service are available in proximity (approximately 500 ft) to pilot treatment system.
- Installation of electrical and water utility lines to provide power and supply water to pilot treatment system will be in accordance with Air Force specifications.

3.2.4. Temporary Storage and Disposal of Soil

- Coordinate with the Installation personnel to determine the staging area location for temporary storage of IDW until hazardous waste characteristics are determined (see Section 3.7.1).

3.3. Pilot-Scale Surface-Active Foam Fractionation (SAFF®20) and Polishing Treatment System

3.3.1. Pilot-Scale SAFF®20 and Polishing Treatment System Construction

- See CPA Phase 1 report Figure 18 for the pilot-scale SAFF®20 and Polishing Pilot Treatment System conceptual treatment process scheme.

- Assume the location of the pilot-scale SAFF®20 and Polishing Treatment System will be to the north or south of the Recreation Pond (see CPA Phase 1 report for the proposed options [Option 1 in Figure 14, Option 2 in Figure 15, and Option 3 in Figure 16]).
- Prior to installing pilot treatment system related equipment, Conex boxes, and concrete pad or other subgrade support base material, the area should be cleared, grubbed, graded, compacted, and leveled for staging pilot treatment system equipment, equalization tanks, any other system infrastructure, including secondary containment areas.
- Install a pilot-scale SAFF®20 Polishing and Pilot Treatment System containing prefiltration (PRM Filtration multi-cartridge 2.5-in by 20-in cartridge or equivalent) for solids removal containing 100-micrometer (µm) bag filters and polishing AER and GAC vessels and packaged within an insulated Conex box.
    - Assume SAFF®20 unit contained within an 8-ft wide by 40-ft long by 9.5-ft high insulated Conex box.
- Install PRM Filtration multi-cartridge (2.5-in by 20-in cartridge) or equivalent for solids removal containing 10-µm bag filters.
- Assume one (1) AER vessel in series with one (1) GAC vessel arranged in series and operating in a lead-lag configuration.
    - One (1) AER vessel approximately 2-ft in diameter containing 5 ft of media (EBCT = 3 minutes).
    - One (1) GAC vessel approximately 4-ft in diameter containing 4 ft of media (EBCT=9.4 minutes).
    - Influent conveyance piping to the SAFF®20 unit will be reduced to a 3-in diameter HDPE pipe.
    - Effluent discharge from the SAFF®20 unit will be further filtered to reduce finer particulates prior to polishing.
- Furnish a second equalization tank consisting of the following:
    - Provide a 5,000-gal bolted carbon steel tank (10-ft diameter by 10 ft high) to allow 50 minutes of holding time for a storage based on the maximum operating flowrate.
    - Construct a 15-ft x 15-ft x 6-in reinforced concrete slab.
    - Provide secondary containment to provide volume of 7,000 gal for the equalization tank.
    - Install 50 ft of 3-in HDPE piping to connect the SAFF®20 unit effluent to the second equalization tank.
    - Install 50 ft of 3-in HDPE piping to connect second equalization tank to the one (1) AER vessel and one (1) GAC vessel (polishing treatment vessels).
- Provide two (2) transfer pumps and two (2) standby pumps (two [2] influent transfer pumps to the pilot-scale SAFF®20 unit and two [2] effluent transfer pumps to polishing vessels) with the following:
    - 50 gpm at 25-ft head with Grundfos CME 10-1 A-S-A-E-AQQE U-A-A-N multistage end-suction centrifugal pump or equivalent, single phase 200/240V, 1.5 HP, multistage, with integrated frequency converter for variable control of motor speed.

3.3.2. Design and Construction Project Management and Reporting

- Upon completion of pilot-scale SAFF®20 and Polishing Treatment System construction, prepare and submit a standard report including construction completion report with as-built drawings using moderate to high professional labor management. The report will be prepared in draft, draft final, and final versions.
- Assume three (3) meetings (one [1] scoping meeting, one [1] review meeting, and one [1] regulatory meeting).

3.4. Pilot-Scale SAFF®20 and Polishing Treatment System Operations, Maintenance, and Performance Monitoring

Entails O&M and performance monitoring associated with the pilot-scale SAFF®20 Polishing Treatment System and includes system start-up and shakedown testing.

- Prepare a UFP-QAPP for the system and site monitoring activities that will be used as the monitoring plan. Assume draft, draft final, and final UFP-QAPP using standard professional labor management.
- Prepare pilot-scale SAFF®20 and Polishing Treatment System O&M manual in draft, draft final, and final versions using standard professional labor management.
- Perform pilot-scale SAFF®20 and Polishing Treatment System O&M for the duration of one (1) year in accordance with the O&M manual and treatment equipment manufacturer to collect performance monitoring data using a high level of complexity for O&M labor during the first year of operation. The estimated operation period is for 12 months.
- Perform system start-up and shakedown.
- Perform weekly checks for leaks and pressure readings across each bag filter, the pilot-scale treatment system, including one (1) SAFF®20 unit, one (1) AER vessel, and one (1) GAC vessel for the first month.
- Collect weekly samples during the first month of operation to demonstrate that the SAFF®20 unit can bypass the equalization tank and meet the Town of New Windsor/NYSDEC requirements (Note 11 analytical parameters).
    - Collect 16 grab samples for the first month of operation. Collect four (4) samples (one [1] pilot-scale SAFF®20 unit influent sample, one [1] pilot-scale SAFF®20 unit effluent sample, one [1] AER effluent sample, and one [1] GAC effluent sample) weekly for 4 weeks (4 locations x 1 sample per location x 4 weeks).
    - Collect a total of 32 samples for first month of operation from four (4) sampling locations, including QC samples (10% FD [1 sample weekly], 5% EB [1 sample weekly], 5% MS [1 sample weekly], and 5% MSD [1 sample weekly]) for sampling.
- After one month of weekly sampling, perform monthly system sampling for 11 months (for a total of one year of sampling) from the pilot-scale SAFF®20 Polishing Treatment System influent, pilot-scale SAFF®20 unit effluent, AER unit effluent, and GAC unit effluent.
    - Assume 44 grab samples (4 locations x 1 sample per location per month x 11 months per year x 1 year).

  - Collect a total of 88 samples over 11 months from four (4) sampling locations, including 44 grab samples and 44 QC samples (10% FD [1 sample month x 11 months], 5% EB [1 sample monthly x 11 months], 5% MS [1 sample monthly x 11 months], and 5% MSD [1 sample monthly x 11 months]) for sampling.
- Analyze 120 water samples (including all weekly and all monthly samples) for the following parameters, using a DoD ELAP certified off-site laboratory:
  - PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version).
  - Field parameters per Note 11.
  - Groundwater quality parameters:
    - TOC by USEPA Method 9060,
    - TSS by USEPA Method2540,
    - TDS by USEPA Method 2540,
    - alkalinity by USEPA Method 130.1,
    - hardness by USEPA Method 130.2,
    - cations (e.g., iron, manganese, calcium, magnesium), total and dissolved, by ASTM Method D6919, and
    - anions:
      - chloride, nitrate, sulfate, etc. by USEPA Method 9056, and
      - bicarbonate by USEPA Method 2320.
- Assume 40-gpm extraction rate; AER and GAC media change-outs and residuals generated will be as follows:
  - Assume approximately 690 lbs of AER resin and 1,700 lbs of GAC will be required for PFAS treatment for one (1) year.
  - AER media and GAC media will require one change-out during the 12-month operation for costing purposes.
- Collect pilot system data for system performance and discharge monitoring purposes. Monitor for the following parameters based on the Town of New Windsor/NYSDEC requirements:
  - system flow rates and pressures,
  - influent and effluent PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version),
  - VOCs by USEPA Methos 8260,
  - SVOCs by USEPA Method 8270,
  - metal contaminants by USEPA Method 6010 and 6020, and
  - mercury by USEPA Method 7470.
- Document and report sample results on a monthly basis.
- Assume that AER and GAC media, (approximately 690 lbs and 1,700 lbs), will be disposed of off-base at a licensed RCRA subtitle C facility based on DoD, USEPA, and Air Force policy.
- Assume a SAFF®20 process concentration factor of 5000x and a 40-gpm flow rate for one (1) year to generate approximately 4,200 gal of foamate. Destructive technology selection and frequency of foamate removal/treatment will be based on data collected during pilot system operation and data collected during parallel laboratory treatability studies (TSs) which are

briefly described in Section 3.6. For planning and costing purposes assume foamate incineration at a licensed facility.

- Destruction will be in accordance with current DoD, USEPA, and Air Force policy.

3.4.1. Pilot-Scale SAFF® 20 and Polishing Treatment System O&M and Performance Monitoring Project Management and Reporting

- Prepare required annual report using standard professional labor management for a period of one (1) year during pilot system O&M and monitoring. Prepare draft, draft final, and final versions. Provide recommendations for pilot groundwater system modifications/retrofitting, as needed, based on data collected during system O&M and the data from POS (Section 3.5).
- Prepare monthly discharge monitoring reports as required by USEPA and State Regulatory Agency.
- Assume 3 meetings (one (1) scoping meeting, one (1) review meeting, and one (1) regulatory meeting).
- Data Management:
    - Perform data evaluation/validation, including Stage 2b/4 lab data review (see Note 7).
    - Assume standard turnaround time.
    - Submit data electronically to the ERPIMS within 90 days once the data has been validated.

3.5. Pilot System Optimization Study

Prepare a UFP-QAPP for the POS activities outlined in this Section and use it as the monitoring plan. Assume a draft, draft final, and final UFP-QAPP using standard professional labor management.

3.5.1. Soil Borings

- Install SBs at 13 proposed locations: CPA-MW01Shallow (S)/Intermediate (I) through CPA-MW04S/I, CPA-MW05I and CPA-MW06S/I through CPA-MW07S/I (see Figure 13).
    - Six (6) borehole clusters (CPAMW01S/I through CPA-MW04S/I [CPA-MW04S is optional], and CPA-MW06S/I through CPA-MW07S/I).
    - One (1) borehole (CPAMW05I) will be paired with existing shallow well MW-113.
- Assume a Rotosonic drilling method with a 4-in soil core barrel for soil sampling.
- Perform continuous geologic logging on each SB in accordance with Unified Soil Classification System (USCS) standards with grain size and other pertinent details for environmental sequence stratigraphy (ESS). Geologic logging will be performed by a licensed professional geologist.
- Assume the following depths for 13 SB locations:
    - Six (6) boreholes (CPA-MW01S through CPA-MW04S, CPA-MW06S, and CPA-MW07S) with an average total depth of 15 ft bgs.
    - Seven (7) boreholes (CPA-MW01I through CPA-MW07I) with an average total depth of 30 ft bgs.
- Assume an average depth to groundwater of approximately 5 ft bgs.
- Assume formation type is unconsolidated.
- Assume clay mixed with sandy silt and gravel soil type.

- Screen soil cores collected during drilling with a PID for evidence of visual/olfactory contaminant impacts.
- Collect a total of 28 soil core samples (7 locations x 4 cores per location) from the deeper borehole locations (CPA-MW01I through CPA-MW07I). Collect four (4) soil core samples per borehole (collect one [1] sample from the vadose zone and three [3] samples from the saturated zone).
- Assume four (4) undisturbed soil cores per SB cluster for geotechnical analysis for a total of 28 borehole samples (7 locations x 4 soil core samples collected per location).
- Analyze 28 soil core samples for geotechnical (and sorption) parameters as identified below. No QC samples are required for the geotechnical (and sorption) parameters:
    - soil classification by ASTM Method D2487,
    - particle size distribution by ASTM Method D4464,
    - soil bulk density by ASTM Method D7263,
    - moisture content by ASTM Method D2216,
    - porosity by ASTM Method D4404,
    - clay content by ASTM Methods D6919 and D422,
    - cation exchange capacity by USEPA Method 9080, and
    - F_{oc} by ASTM Method D2974.
- Collect a total of 21 soil grab samples for analytical parameter analysis. For each location assume one (1) soil grab sample near ground surface, one (1) soil grab sample above the field interpreted water table (assume approximately 4–15 ft bgs) and one (1) soil grab sample at the depth where impacts are observed or detected using a PID (7 locations x 3 samples collected per location).
- Analyze a total of 32 grab soil samples, including 21 grab samples and 11 QC samples (10% FD [3 samples], 5% EB [2 samples], one [1] RB sample per field day for 2 days of sampling [2 total RB samples], 5% MS [2 samples], and 5% MSD [2 samples]) for the following parameters:
    - PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version),
    - VOCs by USEPA Method 8260,
    - SVOCs by USEPA Method 8270,
    - metals by USEPA Method 6010 and 6020, and
    - mercury by USEPA Method 7470,
- Containerize drill cuttings/soil resulting from SB study. Assume approximately 6 CY into 23 (55-gal) drums. These SBs will be used for MW installation, therefore this solid IDW accounts for the solid IDW generated for MW installation.
- Transport IDW to an approved staging area and dispose of in accordance with waste disposal requirements as outlined in Section 3.7.1.

3.5.2. MW Network Installation

- Install 13 MWs (CPA-MW01S/I through CPA-MW04S/I, CPA-MW05I, CPA-MW06S/I, and CPA-MW07S/I; see Figure 13 for well locations). Assume 12 of the 13 MWs will be arranged in clusters to various total depths or to refusal.

- Six (6) MW clusters to include CPA-MW01S/I through CPA-MW04S/I (CPA-MW04A is optional) and CPA-MW06S/I through CPA-MW07S/I.
    - CPA-MW01S through CPA-MW04S and CPA-MW06S through CPA-MW07S. Assume total depth of 15 ft bgs with screen 5–15 ft bgs.
    - CPA-MW01I through CPA-MW04I and CPA-MW06I through CPA-MW07I. Assume total depth of 30 ft bgs with screen 20–30 ft bgs.
- One (1) MW (CPAMW05I) will be paired with existing shallow well MW-113.
    - CPA-MW5I assume total depth of 30 ft bgs with screen 20–30 ft bgs.

- Assume an aquifer thickness of 25 ft.
- Assume an average depth to groundwater of approximately 5 ft bgs.
- Assume formation type is unconsolidated.
- Assume clay mixed with sandy silt and gravel soil type.
- Drill to target depths listed above using Rotosonic drilling method with approximately 8-in. diameter to set a well.
- Perform geologic logging on the SB prior to MW installation in accordance with USCS standards for grain size and other pertinent details for ESS. Geologic logging will be performed by a licensed professional geologist (if applicable).
- Construct MW with a 2-in inside diameter (ID) Schedule 40 polyvinyl chloride (PVC) casing, continuous wire-wrapped 10-slotted (0.010-in slot) PVC screen.
- Seal borehole between monitoring zones to prevent the vertical flow of groundwater in the wellbore and maintain the in-situ distribution of fluid pressures and chemistry.
- Develop the MW using low-flow pumping until water is clear of turbidity or until water reaches a goal of 5 Nephelometric Turbidity Units (NTU)s by USEPA Method 180.1. If a turbidity goal of 5 NTUs or less cannot be achieved within three (3) readings, using a water quality monitoring meter develop wells until groundwater parameters stabilize. If the well goes dry during development, allow well to recharge once, purge one well volume or until well is dry, and record turbidity. For estimating, assume three (3) well volumes will be extracted.
- Conduct other standard well completion tasks for each MW: construct wells with well protections and provide well caps, locks, and tags; a concrete pad; and bollards for each well/well cluster.
- Drill cuttings/soil IDW enumerated in borehole section (Section 3.5.1)
- Containerize liquid waste generated during MW development (assume approximately 116 gal) within three (3) 55-gal drums.
- Transport IDW to approved staging area and dispose of in accordance with waste disposal requirements as outlined in Section 3.7.1.

3.5.3. Quarterly Groundwater Monitoring

- Gauge all wells prior to sampling using an oil/water interface probe.
- Purge wells prior to sampling. Assume groundwater will be purged using low-flow pumping until water is clear of turbidity or until water reaches a goal of 5 NTUs by USEPA Method 180.1. If a turbidity goal of 5 NTUs or less cannot be achieved within three (3) readings using a water quality monitoring meter, develop wells until groundwater parameters stabilize. If the well goes

dry during purging, allow well to recharge once, purge one well volume or until well is dry, and record field parameters. Measure the following standard field parameters using an in-line multiparameter sonde such as a YSI ProDSS multimeter (or equivalent) per guidance in USGS Series 09-A6.8:
  - pH,
  - temperature,
  - conductivity,
  - DO,
  - ORP, and
  - turbidity.
- Perform quarterly groundwater monitoring events for a 1-year period using a low-flow groundwater sampling method from a total of 14 MWs (13 newly installed and one [1] existing). Low-flow sampling will be completed at 15–30-ft intervals along screen lengths to ensure sample representativeness per NYSDEC requirements. Groundwater monitoring should occur for the following 14 MWs:
  - One (1) existing MW (MW-113) to be paired with one (1) new single MW (CPA-MW05I).
    - Total depth of MW-113 and sample depth of 10 ft. Low-flow sampling at 10 ft bgs (1 sample per well; 1 total sample).
    - Total depth of CPA-MW05I and sample depth at 30 ft. Low-flow sampling at 20 ft bgs (1 sample per well; 1 total sample).
  - Six (6) new MW clusters for a total of 12 MWs (CPA-MW01S/I through CPA-MW04S/I, [CPA-MW04S/I is optional], CPA-MW06S/I, and CPA-MW07S/I).
    - Low-flow sampling at 10 ft bgs for shallow wells (1 samples per well; 6 total samples)
    - Low-flow sampling at 20 ft bgs for intermediate wells (1 samples per well; 6 total samples)
- Collect a total of 92 groundwater samples from 14 sampling locations, over a 1-year period including 56 groundwater grab samples and 36 QC samples for four quarterly events (10% FD [8 samples], 5% FB [4 samples], one [1] EB sample per field day for 4 days of sampling per event [16 total RB samples], 5% MS [4 samples], and 5% MSD [4 samples]).
- Assume an average depth to groundwater of approximately 5 ft bgs.
- Assume average sample depths of 10 ft bgs (shallow wells) and 20 ft bgs (intermediate wells).
- Analyze 92 groundwater samples using DoD ELAP-accredited laboratories for parameters listed in Note 11 to comply with Town of New Windsor/NYSDEC requirements and the following parameters:
  - PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version),
  - VOCs by USEPA Method 8260,
  - SVOCs by USEPA Method 8270,
  - total petroleum hydrocarbons (TPH; gasoline range organics [GRO] and diesel range organics [DRO]) by USEPA Method 8015,
  - metals by USEPA Methods 6010 and 6020,
  - mercury by USEPA Method 7470, and

  - groundwater quality parameters:
    - TOC by USEPA Method 9060,
    - TSS by USEPA Method 2540,
    - TDS by USEPA Method 2540,
    - alkalinity by USEPA Method 130.1,
    - hardness by USEPA Method 130.2,
    - cations (e.g., iron, manganese, calcium, magnesium), total and dissolved, by ASTM Method D6919, and
    - anions (e.g., chloride, nitrate, sulfate) by USEPA Method 9056 and bicarbonate by USEPA Method 2320.
- Assume a total of approximately 476 gal of purge water will be generated during MW sampling activities over a 1-year period (approximately 119 gals per quarterly event x four [4] quarters).
- Transport IDW to approved staging area and dispose of in accordance with waste disposal requirements as outlined in Section 3.7.2.

3.5.4. Slug Testing

- Detailed Standard Operating Procedures (SOPs) for slug testing can be found in the September 2022 Remedial Investigation UFP-QAPP.
- Conduct hydraulic conductivity testing in the aquifer with slug tests using a pressure transducer and electronic data-logger in MWs, at 14 locations with the following wells (see Figure 13 for well locations):
  - Twelve newly installed nested well locations (CPA-MW01S/I through CPA-MW04S/I [CPA-MW04S/I is optional], CPA-MW06S/I, and CPA-MW07S/I) located approximately 25 ft near the southern Installation boundary along the extraction trench.
  - One (1) newly installed single MW (CPA-MW05I) paired with existing shallow well MW-113.
  - One (1) existing well MW-113 located near the southern Installation boundary along the extraction trench.
- Provide one (1) rental submersible datalogging pressure transducer (e.g., Solinst Levelogger®5 or equivalent) and associated materials to measure groundwater level response (rising-head and falling-head testing) for slug testing. The data logger with associated cable will be used to test the shallow and intermediate saturated zones. Assume one transducer is used for slug testing in each well cluster at a time. This is to avoid conducting slug tests concurrently from two (2) wells per cluster at a time.
- Measure the initial water levels in the MWs in an upgradient to downgradient sequence, if available.
- Emplace a transducer logger and cable in the well screen interval of each of the selected wells to depths of approximately 15 ft bgs and approximately 25 ft bgs to monitor aquifer response during the slug tests.
- Place an approximately 5-ft solid cylinder in each of the target well screen interval.
- Wait until the water table stabilizes after lowering the cylinder in the well casing and measure and document the depth to the static groundwater table prior to removal of the cylinder.

- Once water table stabilizes, remove the solid cylinder from the testing well as quickly as possible for falling-head tests to instantaneously displace water column.
- Continue measuring and recording depth-time measurements until the groundwater level stabilizes to equilibrium conditions.
- Triplicate the testing (i.e., 3 times) per testing well to collect representative hydraulic conductivity data.
- Retrieve the pressure transducer data logger from test well, decontaminate the datalogger prior to placing it in the next well.
- After completing the testing, download the data to estimate hydraulic conductivity using the Hvorslev method or Bouwer and Rice method.
- Document the summary of slug test results in a technical memorandum.
- Prepare and submit a technical memorandum in draft and final.

3.5.5. Extraction Trench Zone of Pumping Influence

- Evaluate the zone of pumping influence during operation of the pilot system at 17 locations with the following wells (see Figure 13 for well locations):
    - Twelve newly installed nested well locations (CPA-MW01S/I through CPA-MW04S/I, CPA-MW06S/I, and CPA-MW07S/I located approximately 25 ft near the southern Installation boundary along the extraction trench.
    - One (1) newly installed single MW (CPA-MW05I) paired with existing shallow well MW-113.
    - Two (2) existing wells MW-113 and MW-113BR located near the southern Installation boundary along the extraction trench. Transducer in MW-113BR will be used to assess potential response in fractured bedrock due to pumping in the glacial till.
    - Two (2) SS slotted sumps.
- Provide 15-psi-rated submersible datalogging transducers and associated material to continuously record groundwater level response (drawdown and recovery) during pumping on/off cycles. Assume 17 transducers are needed during testing.
- Emplace 17 pressure transducers in the screen interval of the selected 15 MWs and two (2) SS slotted sumps (e.g., see CPA Phase 1 report Figure 13) near the bottom of each MW and sump at depths of approximately 15 and 30 ft bgs depending on location to monitor aquifer response during the aquifer testing.
- Coordinate testing with extraction and treatment system operation for planning the zone of influence pumping test. Conduct variable (step) rate and constant rate drawdown to determine hydraulic properties (e.g., transmissivity, hydraulic conductivity, and storage coefficients).
- Assume a three-day test over a five-day period to allow for a rest period for aquifer prior to performing the various tests.
    - First day will consist of the step rate test. Test three (3) flow rates during the step test at 10, 20, and 40 gpm. These rates may be adjusted based on operating rates of the pilot system. Assume each step test will take approximately two (2) hours.

  - The second day tests will commence after 48 hours and will consist of a constant rate test for a period of eight (8) hours depending on the flow rate selected (e.g., 20 gpm) for testing based on results of the step rate test.
  - The third day of testing consists of recording recovery in groundwater elevations over a period of two-to-three days after the constant rate test, or until water elevations recover to about 80% of the baseline static levels.
- Collect transducer data over a period of six (6) months to assess extraction system influence over a range of flows during routine system operation and rate of formation recharge to the trench.
  - Containerize approximately 220 gal of pilot system influent water during first month of system operation for the purpose of bench-scale treatability testing.
    - Assume eight (8) 30-gal new HDPE containers for pre-treatment and batch/column testing (see Section 3.6.1).
    - Keep the water sample refrigerated at a treatability testing laboratory facility during the treatability testing.
- Document the summary of zone of influence test results in a technical memorandum.
- Prepare and submit a technical memorandum in draft, draft final, and final form.

3.6. Bench-Scale Treatability Test

- Assume a period of four (4) months will be required for bench-scale TSs, including pre-treatment testing, rapid small-scale column tests (RSSCTs), and reporting.
- Collect and transport approximately 220 gal (eight [8] 30-gal HDPE drums of groundwater, or two [2] drums from each sump discharge) from the extraction and transport to a SAFF®20 treatability laboratory up to 500 miles away from the site. Groundwater from the pilot-scale SAFF®20 and Polishing Treatment System is to be used for TS testing based on influent baseline characterization data described in Section 3.6.1.
- Assume approximately 240 hours of effort for a Junior Chemist/Laboratory Technician, approximately 120 hours of effort for a mid-level chemist or engineer, approximately 24 hours of effort for a project manager, and approximately 24 hours of effort for a Senior/Principal Engineer.
- A TS Work Plan and Sampling and Analysis Plan in draft, draft final, and final version will be submitted for review prior to conducting bench-scale testing.

3.6.1. Bench-Scale Influent Pre-treatment Testing

- Perform baseline characterization of groundwater. Assume four (4) groundwater samples (two [2] sample of groundwater collected from each sump discharge) will be analyzed for the following for baseline characterization:
  - PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version),
  - VOCs by USEPA Method 8260,
  - SVOCs by USEPA Method 8270,
  - pesticides by USEPA Method 8081,

- herbicides by USEPA Method 8151,
- PCBs by USEPA Method 8082,
- total and dissolved metals (iron, manganese, calcium, magnesium) by USEPA Method 6020,
- mercury by USEPA Method 7470,
- total oxidizable precursors (TOP) assay using LC-MS-MS,
- total organic fluorine (TOF) by combustion ion chromatography (CIC),
- TPH-GRO and TPH-DRO by USEPA Method 8015,
- oil and grease by USEPA Method 1664A,
- TSS by USEPA Method 2540, and
- Measure the following standard field parameters using an in-line multiparameter sonde such as a YSI ProDSS multimeter (or equivalent) per guidance in USGS Series 09-A6.8:
  - pH,
  - temperature,
  - conductivity,
  - DO,
  - ORP, and
  - turbidity.
- Water quality parameters:
  - TOC by USEPA Method 9060,
  - TSS by USEPA Method 2540,
  - TDS by USEPA Method 2540,
  - alkalinity by USEPA Method 130.1,
  - hardness by USEPA Method 130.2,
  - cations (e.g., total and dissolved iron, manganese, calcium, magnesium) by ASTM Method D6919, and
  - anions (e.g., chloride, nitrate, sulfate) by USEPA Method 9056 and bicarbonate by USEPA Method 2320.

- Evaluate analytical results and use the worst-case sample data to develop decision logic for TSs and design a bench-scale treatability testing program.
- Evaluate pre-treatment options for TPH in raw groundwater if needed.
  - Include at least two (2) types of organoclay materials, dosages, and contact times.
  - Assume eight (8) experimental samples, one (1) no organoclay control, and one (1) raw groundwater sample will be collected.
  - Analyze 10 samples for PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version).
  - Analyze 10 total samples for TPH-GRO and TPH-DRO by USEPA Method 8015.
  - Oil and grease by USEPA Method 1664.
- Perform pre-treatment bench tests for TOC, TSS, iron, and manganese removal to include, but not be limited to:
  - Filter groundwater through a 100-µm filter membrane to simulate solids removal during bag filtration.

        - Collect and analyze one (1) post-filtration liquid sample to evaluate PFAS removal following simulated bag filtration for the following:
            - PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version),
            - metals by USEPA Method 6020,
            - mercury by USEPA Method 7470A,
            - TOC by USEPA Method 9060 or equivalent,
            - TOP assay using LC-MS-MS,
            - TOF by CIC, and
            - TSS by SM 2540C or equivalent.
        - Collect solids from the filter membrane and analyze one (1) sample for the following parameters:
            - PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version).
            - Perform the TCLP by USEPA Method 1311 then analyze the extracted liquid for the following:
                - ◊ RCRA 8 Metals (arsenic, barium, cadmium, chromium, lead, selenium, and silver) by USEPA Method 6010 and 6020 and mercury by USEPA Method 7470,
                - ◊ corrosivity (pH soil and waste) by USEPA Method 9045,
                - ◊ ignitability (Flash point) by USEPA Method 1010, and
                - ◊ reactivity (sulfide and cyanide).
    - Use 100-µm filtered groundwater to independently evaluate the following three (3) pre-treatment approaches:
        - Aeration (simulated primary foam fractionation with foamate collection; operated in the presence and absence of pH adjustment [adjustment to pH 7–8]).
            - Assume testing at two (2) different pH levels (between 7 and 8) prior to aeration.
            - Two (2) additional experimental runs will be performed with the addition of a cationic surfactant (or similar material) at two (2) different pH levels.
            - One (1) control will be run in the absence of pH adjustment prior to aeration.
        - Coagulation/flocculation.
            - Assume three (3) different doses of coagulant (or similar amendments) will be tested.
        - Oxidant amendment (e.g., potassium permanganate, sodium hypochlorite, or similar).
            - Assume three (3) different doses of oxidant will be tested.

- Assume a strategy for post-aeration off-gas capture (e.g., vapor phase GAC) post-capture gas analysis (e.g., SUMMA® canister followed by impingers and a column adsorber) to ensure potential VOC and PFAS emissions are minimized.
- Assume a total of six (6) samples to be analyzed according to the following methods:
    - VOCs in Air (USEPA Method TO-15, SUMMA® canister).
    - Selected PFAS from Stationary Sources (USEPA Other Test Method [OTM]-45).
    - Extraction and analysis of a sample of GAC media used for off-gas treatment. Sample will be analyzed for:
        - PFAS by USEPA Method 1633, and
        - VOCs by USEPA Method 8260.
- Independently filter effluents from the three (3) pre-treatment configurations (listed above) through greensands, pyrolusite, or manganese dioxide catalytic media. Subject each filtrate to chemical dechlorination (e.g., sodium bisulfite; assume three [3] chemical dechlorination doses will be tested).
- Analyze 33 post-treatment liquid samples for reduction in iron and manganese concentrations by USEPA Methods 6020/7470 or equivalent, TSS by USEPA Method 2540, and TOC by USEPA Method 9060.
    - Aeration pre-treatment testing: Assume 15 samples (five [5] experimental runs with three [3] dechlorination doses).
    - Coagulation/flocculation: Assume nine (9) samples (three [3] coagulant doses with three [3] dechlorination doses).
    - Oxidant amendment: Assume nine (9) samples (three [3] coagulant doses with three [3] dechlorination doses).
- Perform particle size analysis (ASTM Method D422) on solids produced during bench-scale pre-treatment testing.
    - Assume 11 solids samples will be collected following catalytic media filtration (prior to dechlorination) and subjected to particle size analysis according to ASTM Method D422.
    - Analyze PFAS in various size fractions identified. Assume 33 samples will be analyzed according to USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version), (11 solids samples by three [3] fractions).
- Subject liquid samples from the experimental group that demonstrated the highest observed solids precipitation and maximum removal of TOC, TSS, iron, and PFAS to GAC treatment to remove residual chlorine from greensand- or manganese dioxide-treated groundwater (post sodium bisulfite treatment).
- Assume up to three (3) samples will be analyzed for residual chlorine (SM 4500-Cl or equivalent) following GAC treatment.
- Construct an additional pre-treatment study to optimize retention times for aeration/foam fractionation.
    - Using the same pre-treatment conditions that yielded the greatest removal of TOC, TSS, iron, and PFAS in the previous study, test two (2) different hydraulic residence times (HRTs) to evaluate conditions supporting the highest rates of

PFAS removal during aeration/foam fractionation. Assume four (4) samples per retention time tested (eight [8] samples total) will be analyzed according to USEPA Method 1633, TOP assay using LC-MS-MS, and TOF by CIC.

- Pass individual effluent volumes of 250 milliliters (mL) from each HRT tested through two separate 0.45-µm filters to capture and assess amounts of solids and solids-bound PFAS entering a downstream liquid-phase sorption process.
- Assume one (1) 250 mL volume per filter, corresponding to each HRT evaluated.
- Analyze two (2) pre- and post-filtration liquid volumes for PFAS according to USEPA Method 1633 (four [4] samples total).
- Measure pre- and post-filtration filter mass to estimate mass of solids recovered from the post-aeration effluent samples.
- Collect all treated effluent and use for a downstream RSSCT polishing study (described in Section 3.6.2).

- Use data generated in the pre-treatment tests to support the design of a foam fractionation/aeration process, coagulation/flocculation process coupled to foam fractionation/aeration, or oxidant-amended pre-treatment process coupled to foam fractionation/aeration for pilot treatment scenario with anticipated design throughput. Data from the manganese dioxide, pyrolusite, and/or greensand filtration experiments should be used to support a pilot-scale pre-treatment system.
- Use the data generated from bench-scale testing to estimate the amount of TSS and iron/manganese sludge generated for a pilot-scale pre-treatment scenario.

3.6.2. Bench-Scale RSSCT for Effluent Polishing

- Evaluate residual PFAS removal performance in four (4) RSSCTs (two [2] single use AERs, one [1] regenerable AER, and one [1] GAC) tested in parallel.
  - Assume bench-scale TS columns are 0.7-centimeter diameter x 5.0-centimeter height, or similar size.
  - Assume EBCTs for RSSCTs are a minimum of 10 minutes for GAC and three (3) minutes or longer for AER/regenerable AER. Adjust influent flow rates accordingly.
  - Assume RSSCTs will operate for roughly one month to evaluate PFAS removal performance between different sorption media.
  - Collect a total of 100 liquid samples from bulk influent and column effluents from the 4 columns:
    - Influent water samples are to be collected from the influent container during every effluent sampling event. Assume 20 bulk influent samples will be collected and analyzed during the RSSCTs.
    - Assume effluent samples will be collected over 20 events from four (4) different columns for 80 total effluent samples.
  - Analyze 125 liquid samples for PFAS during RSSCT, including 25 samples for quality assurance/QC (25% of samples).
    - Assume at least 30% of liquid samples (38 samples) will be analyzed according to USEPA Method 1633, and the remaining 87 samples may be screened for PFAS according to USEPA Method 8327.

    - Perform TOP assay using LC-MS-MS and analyze for TOF by CIC on two (2) bulk influent samples and eight (8) effluent samples.
        - Assume 10 samples total will be analyzed via TOP assay using LC-MS-MS.
        - Assume 10 samples total will be analyzed for TOF by CIC.
    - Analyze eight (8) liquid samples (four [4] effluent samples each at initial and final sampling events) for BOD5, chemical oxygen demand, TKN, TOC, phosphorus, sodium, and chloride.
    - If PFAS breakthrough is not observed during the RSSCTs, use available pore surface diffusion model and/or correlations, and/or utilize field operating experience from similar site conditions to predict media performance.
- Evaluate breakthrough and exhaustion data (if available) from RSSCT to develop design parameters, approximate time until breakthrough, and sorbent usage rates.

3.6.3. Bench-Scale Treatability Study Reporting

- Document PFAS TS results and influent pre-treatment studies. At a minimum, reports should include analysis and supporting data related to the following:
    - Levels of PFAS removal during aeration/foam fractionation.
    - Effective pre-treatment conditions for TOC, TSS, iron, and manganese removal from groundwater samples.
    - Estimated TSS, iron, and manganese sludge volumes that may be produced during pilot pre-treatment.
    - PFAS sorption capacities on each resin or sorbent tested, PFAS breakthrough and exhaustion curves (if possible), estimated sorbent/resin changeout frequencies.
- Prepare and submit a TS report in draft, draft final, and final versions using standard professional labor.

3.7. POS IDW Management

3.7.1. Temporary Storage and Disposal of Drill Cuttings

- Coordinate with Installation personnel to determine the staging area location for temporary storage of IDW until hazardous waste characteristics are determined.
- Collect a total of 23 grab samples from 23 containers (23 55-gal drums; one [1] grab sample per drum) and submit to a DoD ELAP certified off-site laboratory for the following parameters:
    - Perform the TCLP by USEPA Method 1311 then analyze the extracted liquid for the following:
        - VOCs by USEPA Method 8260, and
        - SVOCs by USEPA Method 8270.
- Collect a total of 23 composite samples from containers of drill cutting/soils collected from POS activities (one [1] sample per container x 23 total containers: 23 55-gal drums) for hazardous waste characterization
- Analyze the 23 composite samples for the following parameters and submit to a DoD ELAP-certified offsite laboratory for analyses of:

  - PFAS by USEPA Method 1633, using LC-MS-MS, compliant with Table B-24 of DoD QSM Version 5.4 (or latest version).
  - Perform the TCLP by USEPA Method 1311 then analyze the extracted liquid for the following:
    - VOCs by USEPA Method 8260,
    - SVOCs by USEPA Method 8270,
    - pesticides by USEPA Method 8081,
    - herbicides by USEPA Method 8151,
    - PCBs by USEPA Method 8082,
    - RCRA 8 Metals (arsenic, barium, cadmium, chromium, lead, selenium, and silver) by USEPA Method 6010 and 6020, and
    - mercury by USEPA Method 7470.
  - corrosivity (pH soil and waste) by USEPA Method 9045,
  - ignitability (Flash point) by USEPA Method 1010,
  - reactivity (sulfide and cyanide).
- Containerize, manifest, transport, and dispose of POS IDW soil from well installation as follows:
  - Assume eight (8) 55-gal drums of drill cuttings generated from MW installation will be disposed of at an off-site RCRA Subtitle C licensed facility 1,000 miles away.
  - Assume 15 55-gal drums of drill cuttings generated from MW installation will be disposed of an off-site RCRA Subtitle D licensed facility located 200 miles away.

3.7.2. Handling of Liquid IDW

- Coordinate with Installation personnel to determine the staging area location for temporary storage of liquid IDW prior to treatment.
- Assume the following waste summary calculations:
  - Approximately 592 gal of purge water generated from all groundwater characterization activities.
    - Approximately 116 gal of purge water generated from MW development.
    - Approximately 476 gal of purge water generated from MW quarterly sampling (approximately 119 gal per quarterly event).
- Containerize liquid IDW:
  - From MW development into three (3) 55-gal drums.
  - From quarterly sampling into three (3) 55-gal drums for each event.
- Empty drum contents (liquid IDW) into the pilot-scale groundwater extraction system equalization tank for treatment.
- Treat MW development/purge water through pilot groundwater extraction treatment system and collect treated effluent samples for analysis for monthly discharge monitoring purposes as described in Section 3.4.1.
- Confirm treated water meets sanitary sewer Town of New Windsor/NYSDEC requirements and then discharge treated water.

3.8. Pilot System Optimization Study Project Management and Reporting

- Prepare a POS report summarizing the results of the various components of the POS in draft, draft final, and final versions with standard professional labor management.
- Assume three (3) meetings (one [1] scoping meeting, one [1] review meeting, and one [1] regulatory meeting).
- Submit well construction information in accordance with State requirements.
- Data Management:
    - Perform data evaluation/validation, including Stage 2b/Stage 4 laboratory data review (see Note 7).
    - Assume standard turnaround time.
    - Submit data electronically to the ERPIMS within 90 days once the data has been validated.