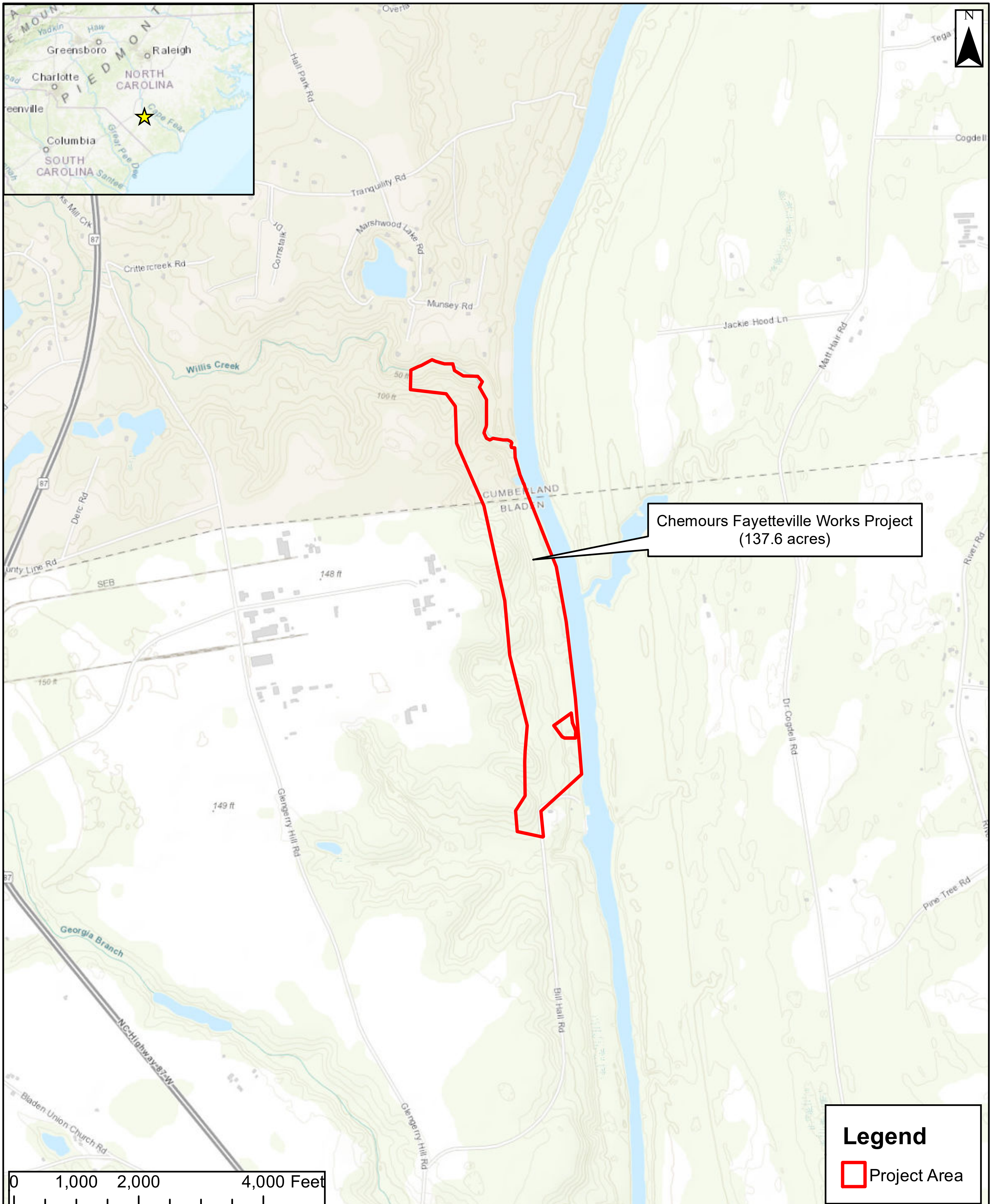
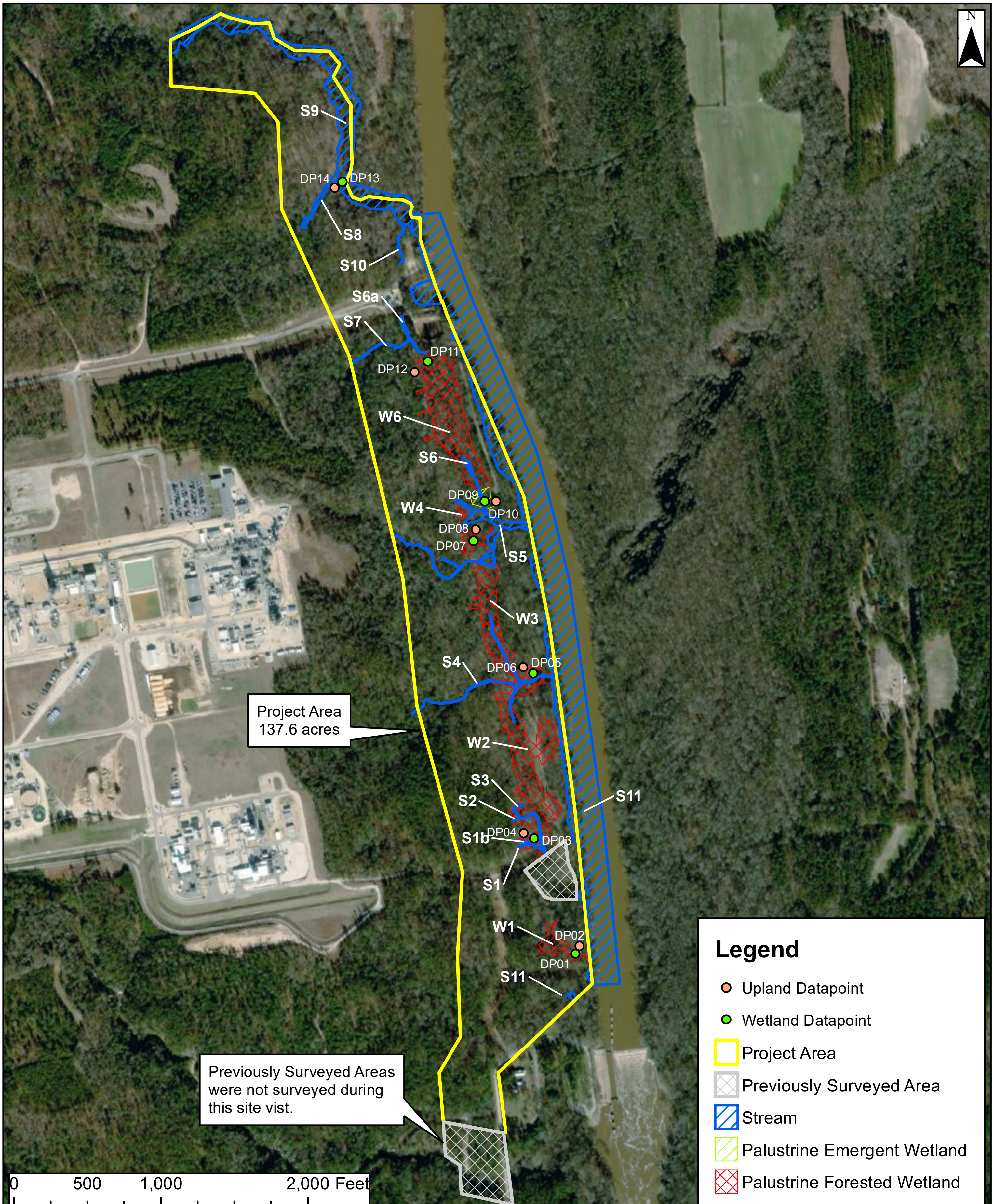
FIGURES



Geosyntec consultants Geosyntec Consultants of NC, P.C. NC License No.: C-3500 and C-295	Chemours™	**USGS SITE LOCATION MAP** Chemours Fayetteville Works Project Chemours Fayetteville Works Cumberland/Bladen County, North Carolina	**Date:** 10/21/2020	**Scale:** 1 in:2,000 ft	**Drawn By:** NSW	**Applicant No.:**
			Reference: WORLD TOPOGRAPHIC MAP PROVIDED BY ESRI			**Figure No.** 1



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AERIAL IMAGERY MAP

Chemours Fayetteville Works Project
Chemours Fayetteville Works
Cumberland/Bladen County, North Carolina

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Reference:	Figure No.
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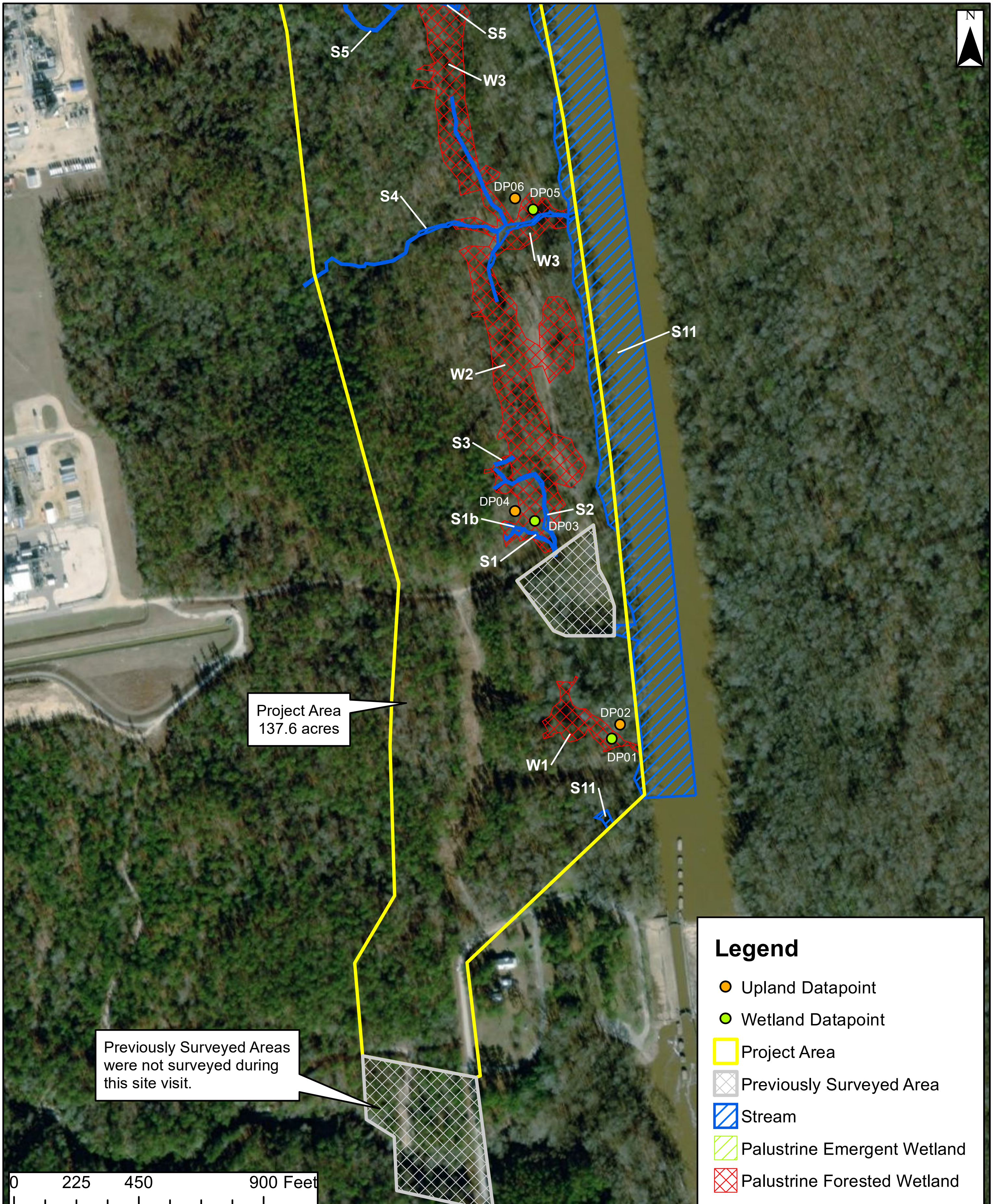

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Chemours

AERIAL IMAGERY MAP

Chemours Fayetteville Works Project
Chemours Fayetteville Works
Cumberland/Bladen County, North Carolina

Date:	Scale:	Drawn By:	Applicant No.:
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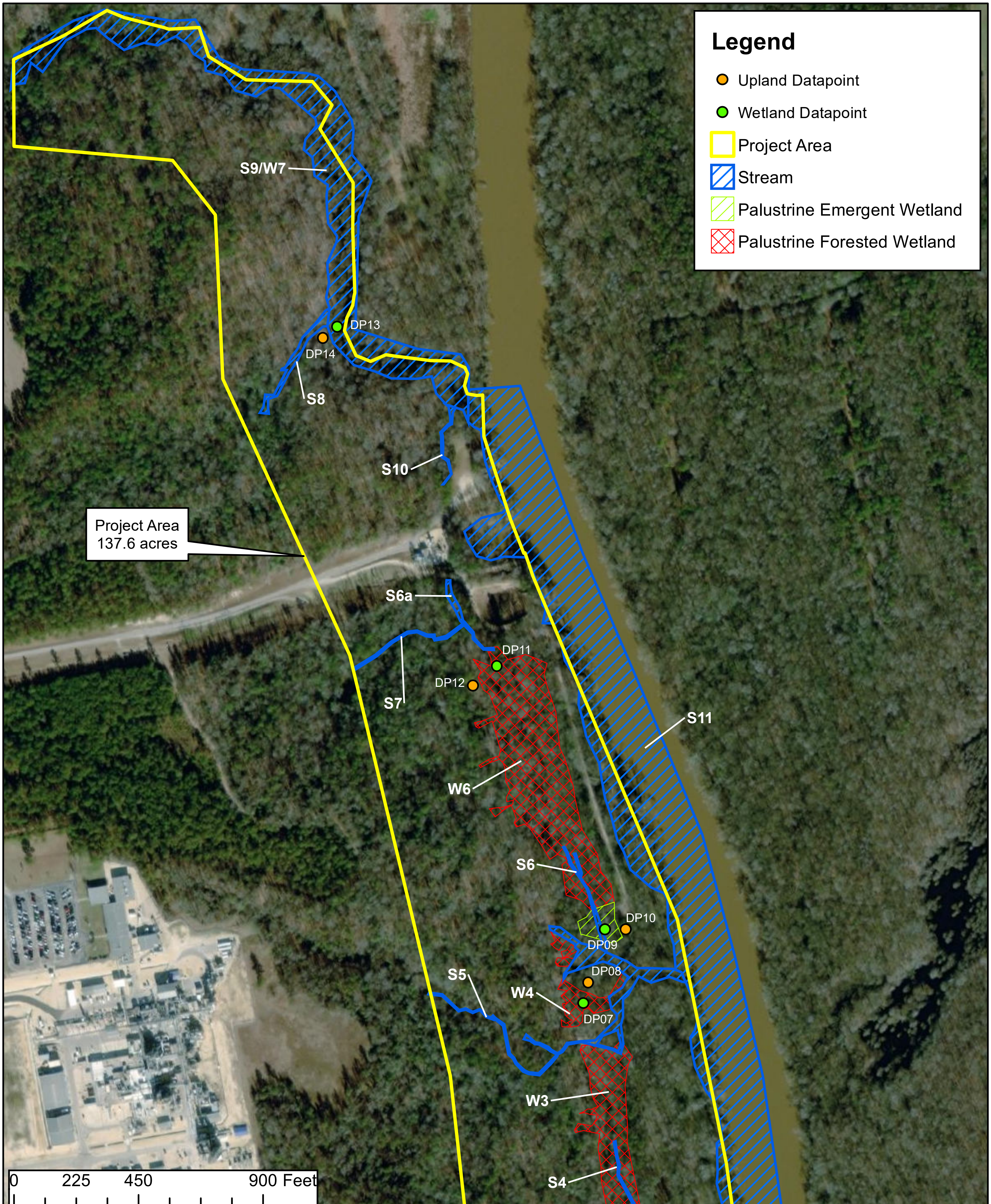
Reference: AERIAL IMAGERY PROVIDED BY ESRI, DATED 1/8/2020.

Figure No. 2A



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AERIAL IMAGERY MAP

Chemours Fayetteville Works Project
Chemours Fayetteville Works
Cumberland/Bladen County, North Carolina

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Reference: AERIAL IMAGERY PROVIDED BY ESRI, DATED 1/8/2020

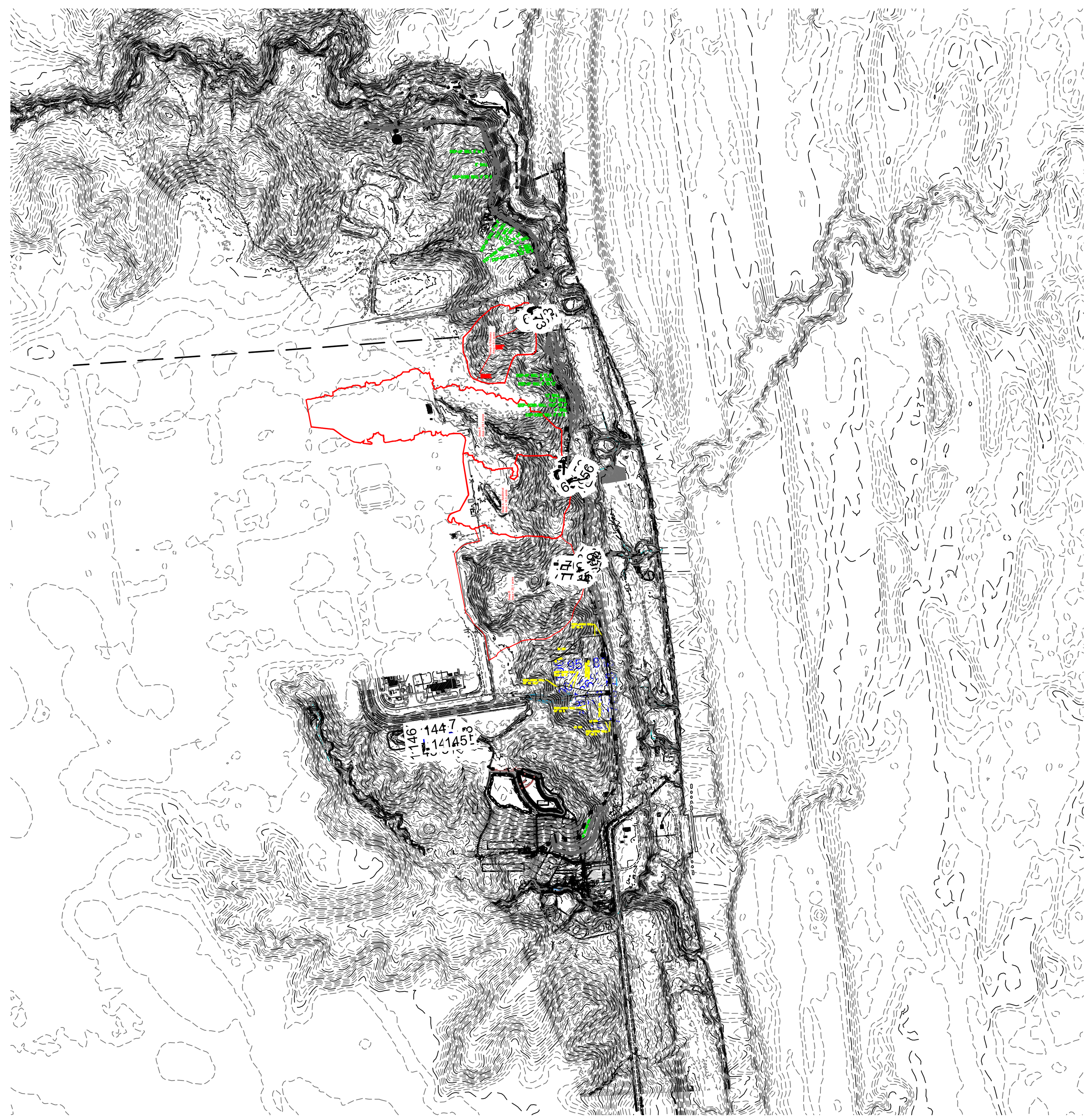
Figure No. 2B

The Chemours Company

Fayetteville, North Carolina

Ex-Situ Seep Capture Design Plans

December 14, 2021



DRAWING INDEX

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Cover Sheet

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
BB	DKK
DESIGNED BY: BB	APPROVED BY:

SCALE: AS SHOWN

DATE: December 14, 2021

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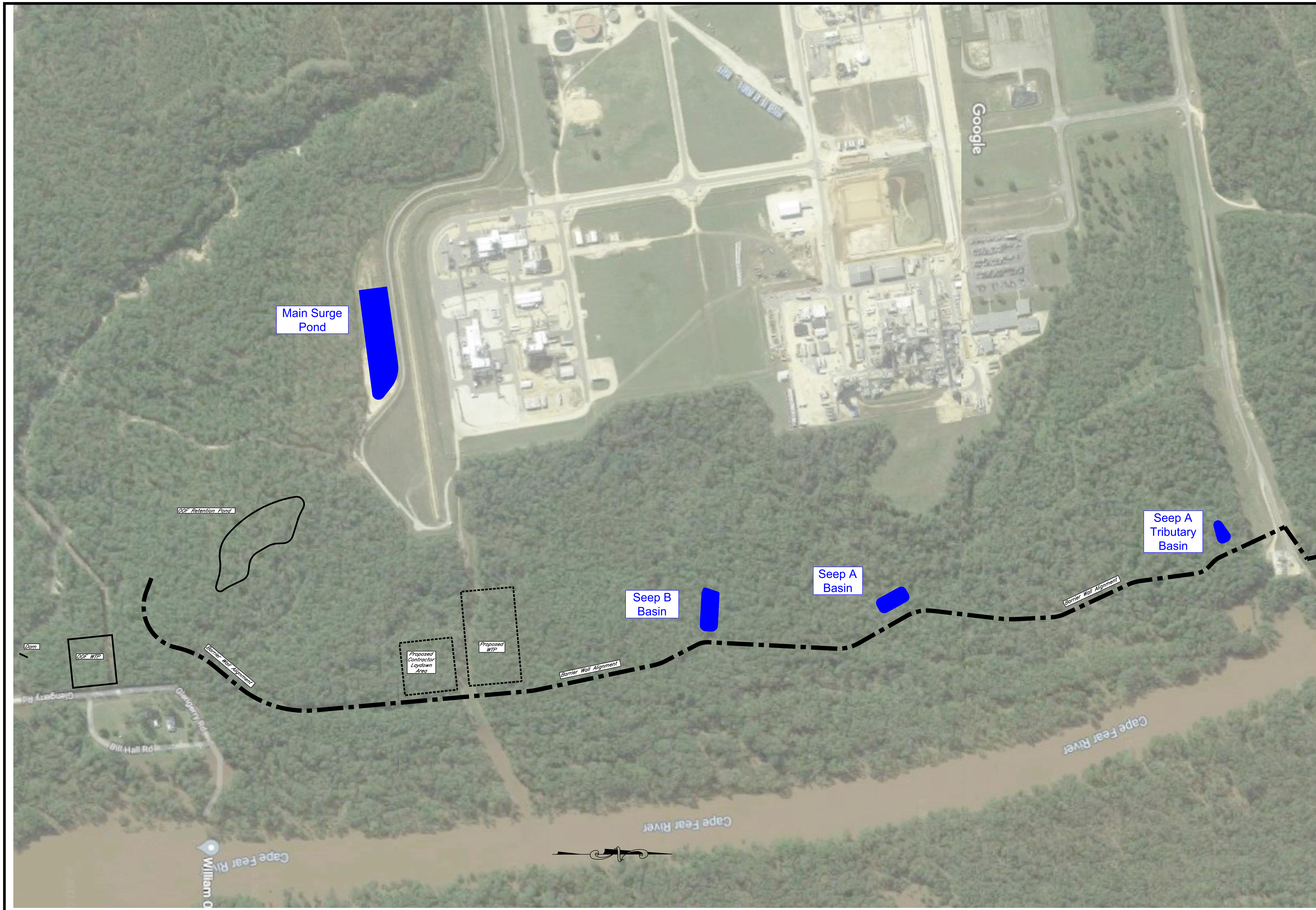
PROJECT NUMBER: 45-20803



1 SC-0.1 Seep Capture – Location Plan

SCALE: 1" = 200'
0' 200' 400'

Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Location Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
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DRAWING: SC-0.1

PROJECT NUMBER: 45-20803

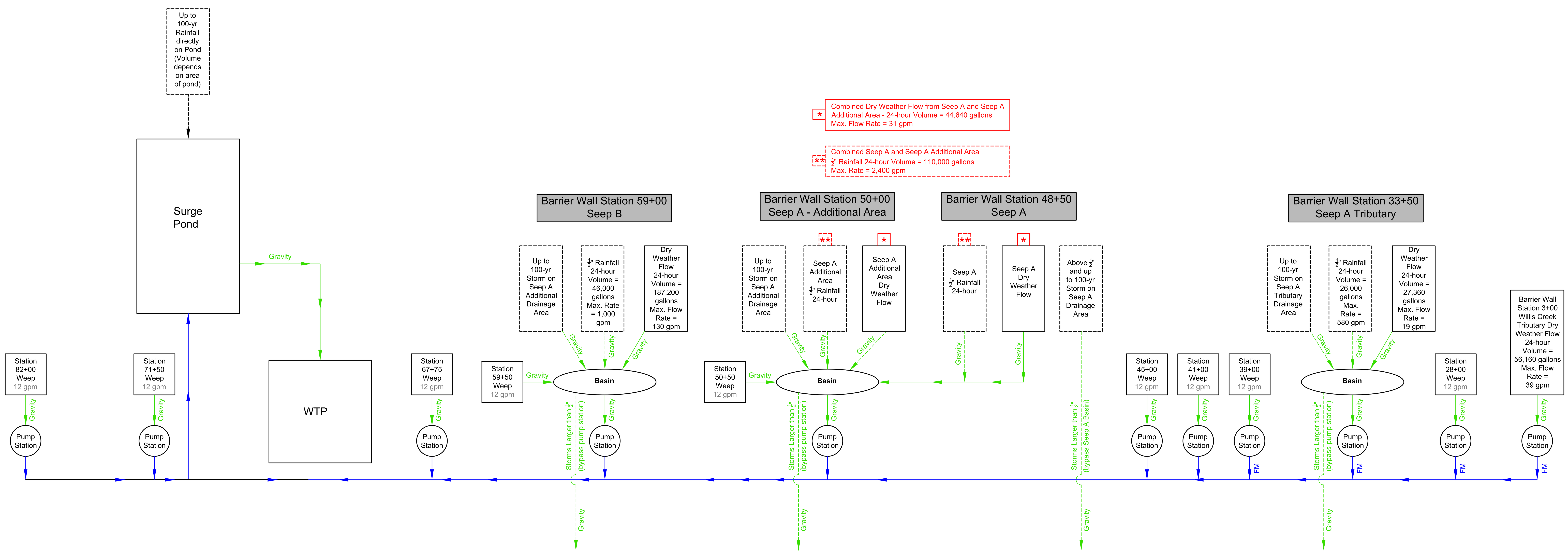
24-Hour Dry Weather Volume to Surge Pond	
Seep A	44,640 gallons
Seep B	187,200 gallons
Seep A Tributary	27,360 gallons
Willis Creek Tributary	56,160 gallons
Weeps (9 @ 12 gpm each)	155,520 gallons
Total Dry Weather Volume to Surge Pond	470,880 gallons

$\frac{1}{2}$" Rainfall Volume to Surge Pond	
Seep A	110,000 gallons
Seep B	46,000 gallons
Seep A Tributary	26,000 gallons
Willis Creek Tributary	N/A
Weeps (9 @ 12 gpm each)	N/A
Total $\frac{1}{2}$" Rainfall Volume to Surge Pond	182,000 gallons

Surge Pond Total Volume Requirements	
48-Hour Dry Weather Volume (2 x 24-hour)	941,760 gallons
48-Hour $\frac{1}{2}$" Rainfall Volume (2 x 24-hour)	364,000 gallons
Direct Rainfall onto Surge Pond (100-year storm - 8.65 inches over Surge Pond Area of 70,000 s.f.)	377,428 gallons
Total Surge Pond Volume Required	1,683,188 gallons

Note: Actual Flow Rate into Surge Pond will vary based on water surface levels in each of the Seep Basins (pumps on or off) and the flow into the pump stations from each weep.

1 SC-0.2 *Surge Pond – Volume Requirement Calculations*



2 SC-0.2 *Surge Pond – Schematic Flow Diagram*

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Ex-Situ Seep Capture Design Plans
Surge Pond - Schematic Flow Diagram

Chemours Fayetteville Works
Fayetteville, North Carolina

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DESIGNED BY: BB	APPROVED BY:
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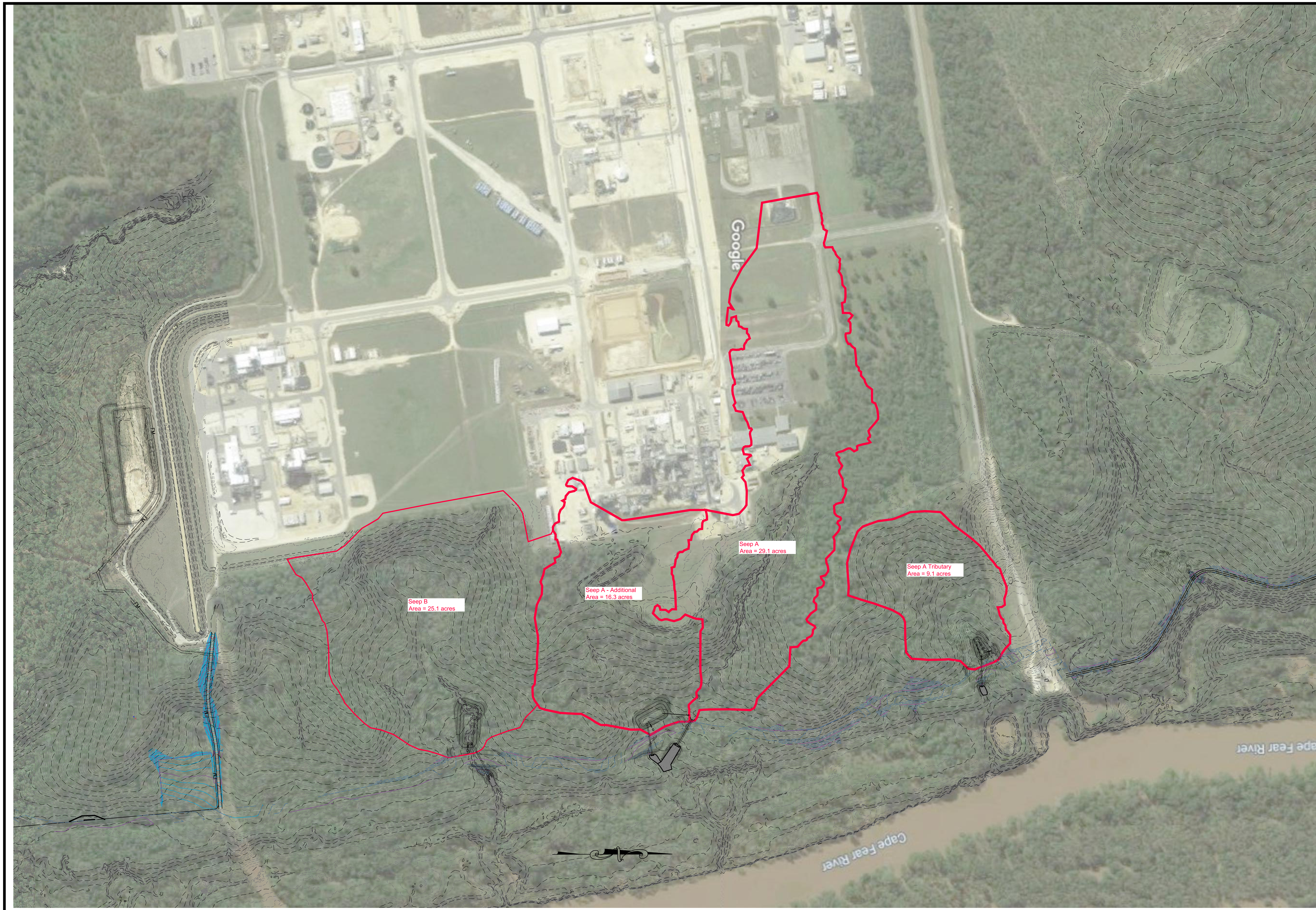

1 SC-0.1 Seep Capture – Location Plan

SCALE: 1" = 200'
0' 200' 400'

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Drainage Areas

Chemours Fayetteville Works
Fayetteville, North Carolina

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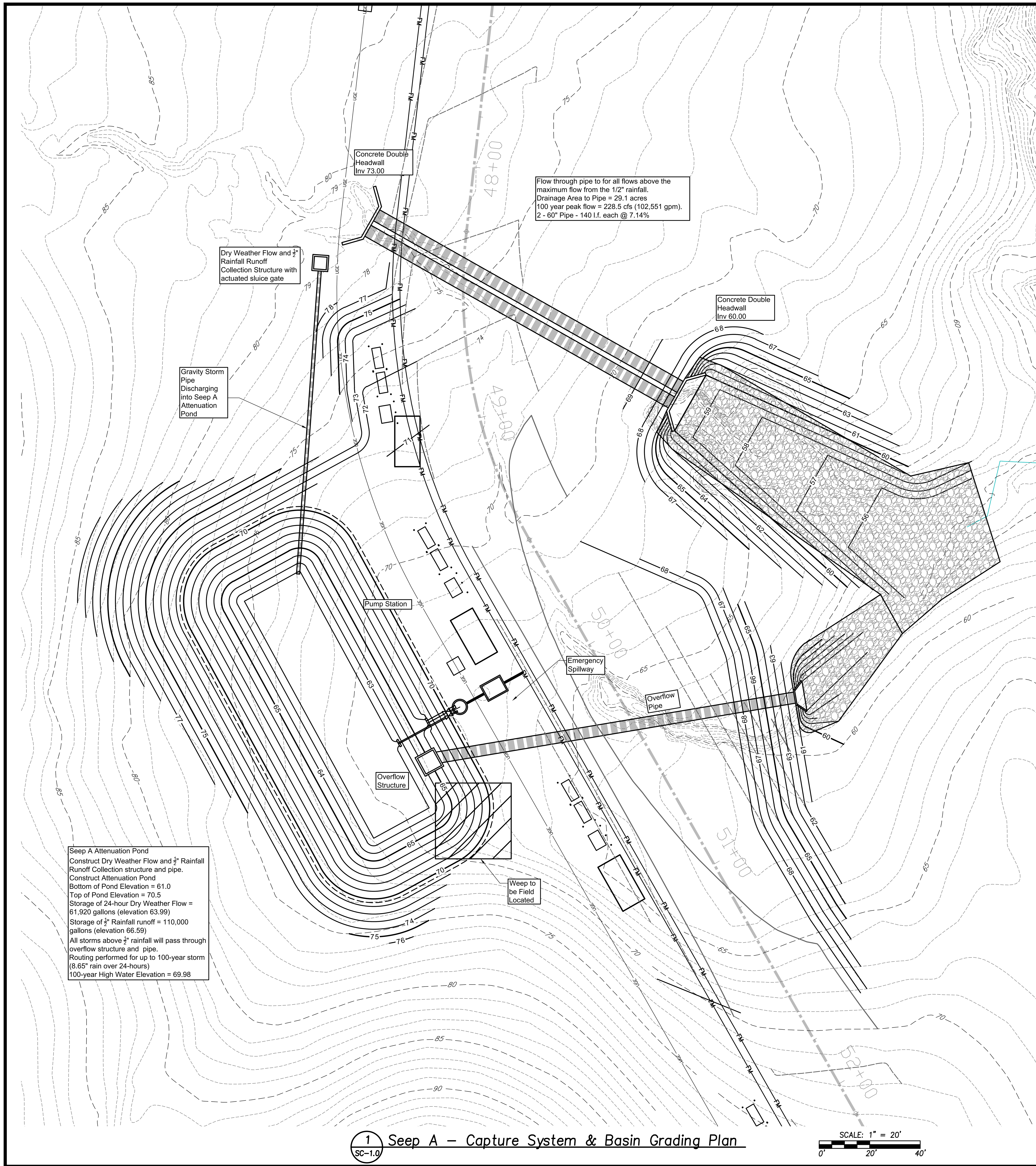

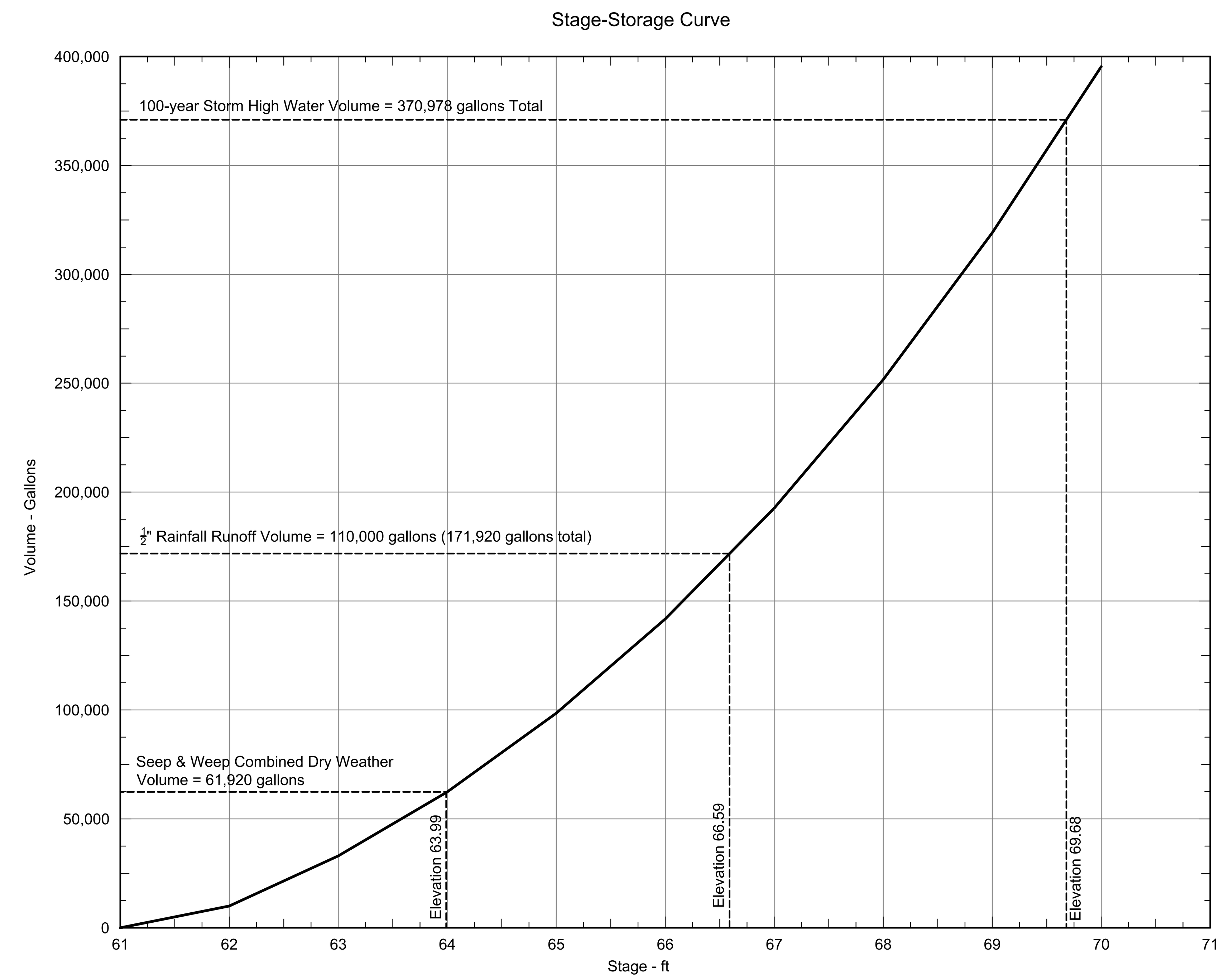

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Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Capture System Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

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DESIGNED BY: BB	APPROVED BY:
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DATE: December 14, 2021	

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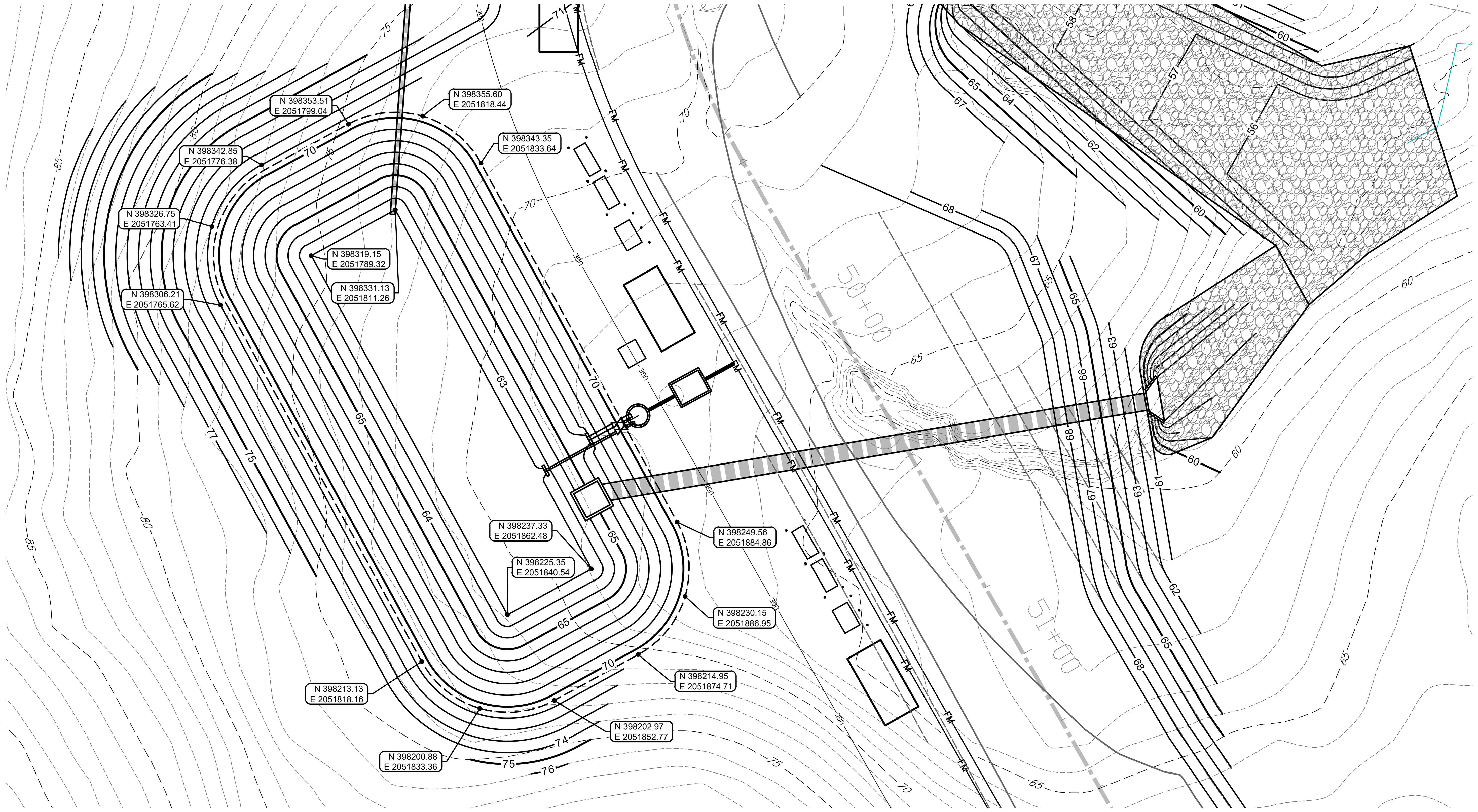
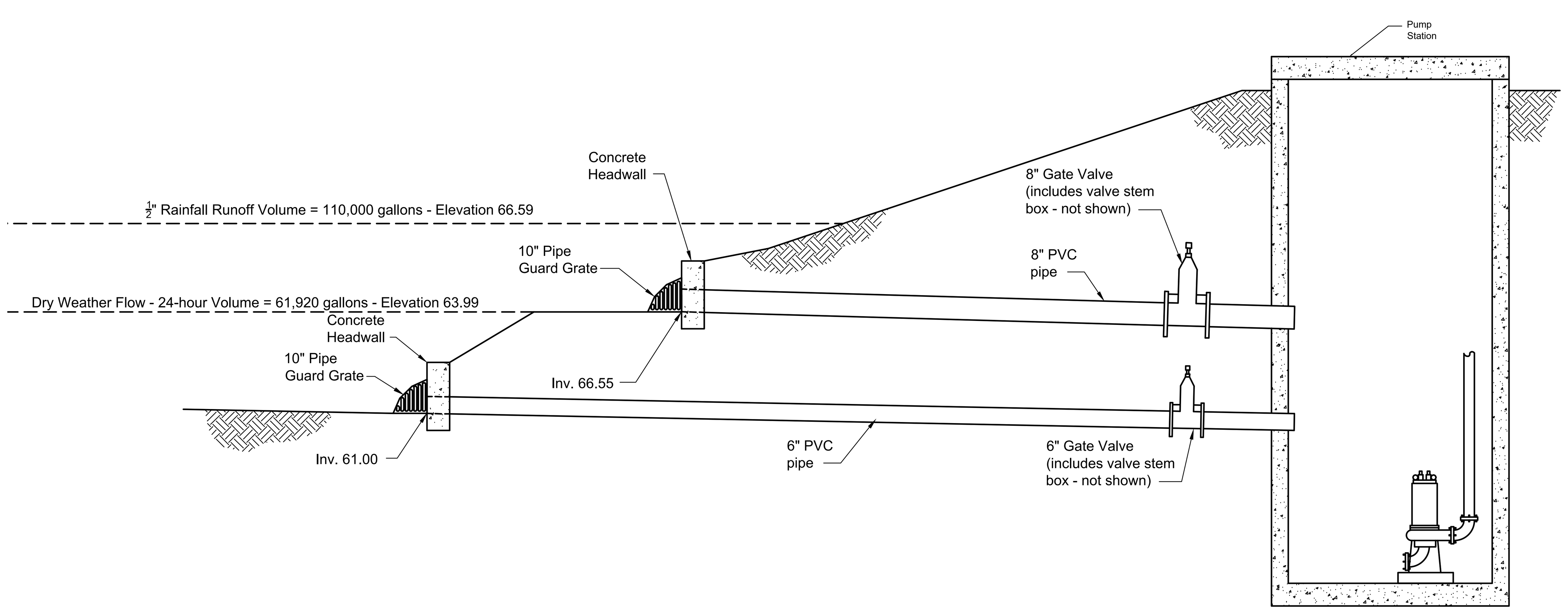


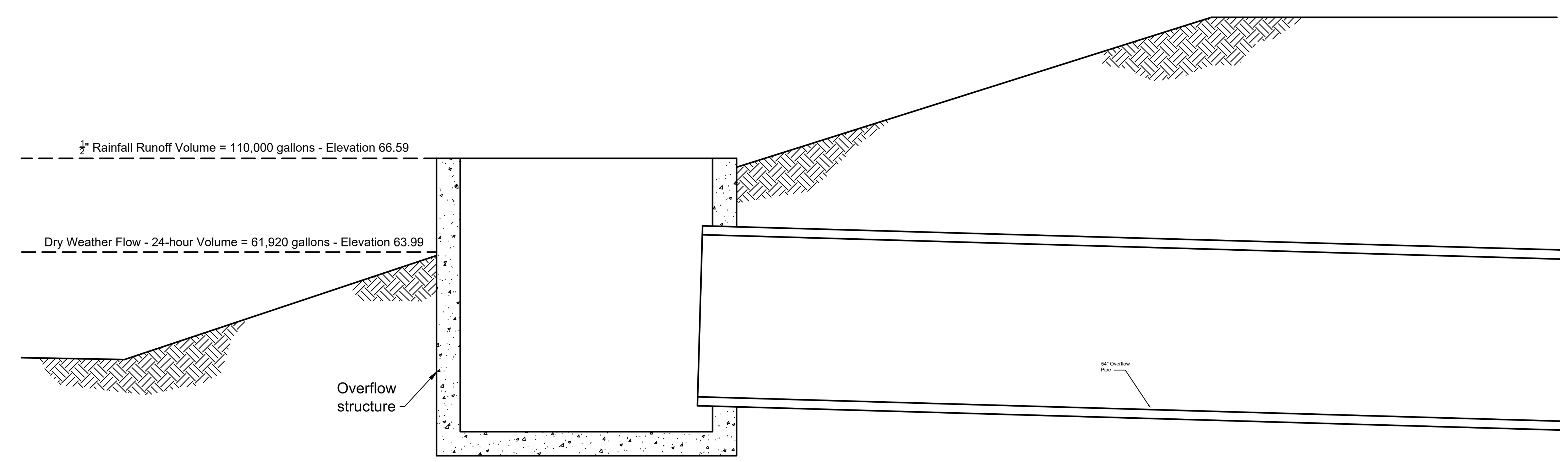
2 SC-1.1 Seep A Basin – Grading Plan

Seep A - Pond Notes

1. The existing elevation of the seep channel at the Barrier Road Crossing Location is higher than the adjacent low elevation of a portion of the drainage area to Seep A. Therefore, the pond for Seep A is located in the lower area and the Dry Weather Flow and the $\frac{1}{2}$" Rainfall Runoff from Seep A will be piped to the pond.
2. Shape and volume of pond, elevations of structures and pipes are critical to operation of the pond. The intent of the pond is to capture the Dry Weather Flow from Seep A and Weep at 50+00 and to capture the runoff from the $\frac{1}{2}$" rainfall from Seep A.
3. The grades and elevations shown are final grades and elevations. The entire area shall include 3" topsoil. Thus subgrade shall be 3" lower than grades shown on plan.
4. The entire basin and all 3:1 slopes shall include permanent seeding and erosion control matting.
5. The outlet structure is sized to allow discharge of the 100-year storm while maintaining a maximum surface water elevation of 69.68.



2 SC-1.1 Seep A Basin – Schematic Section View at Pump Station



3 SC-1.1 Seep A Basin – Schematic Section View at Overflow Structure

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Ex-Situ Seep Capture Design Plans
Seep A Capture System - Grading Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

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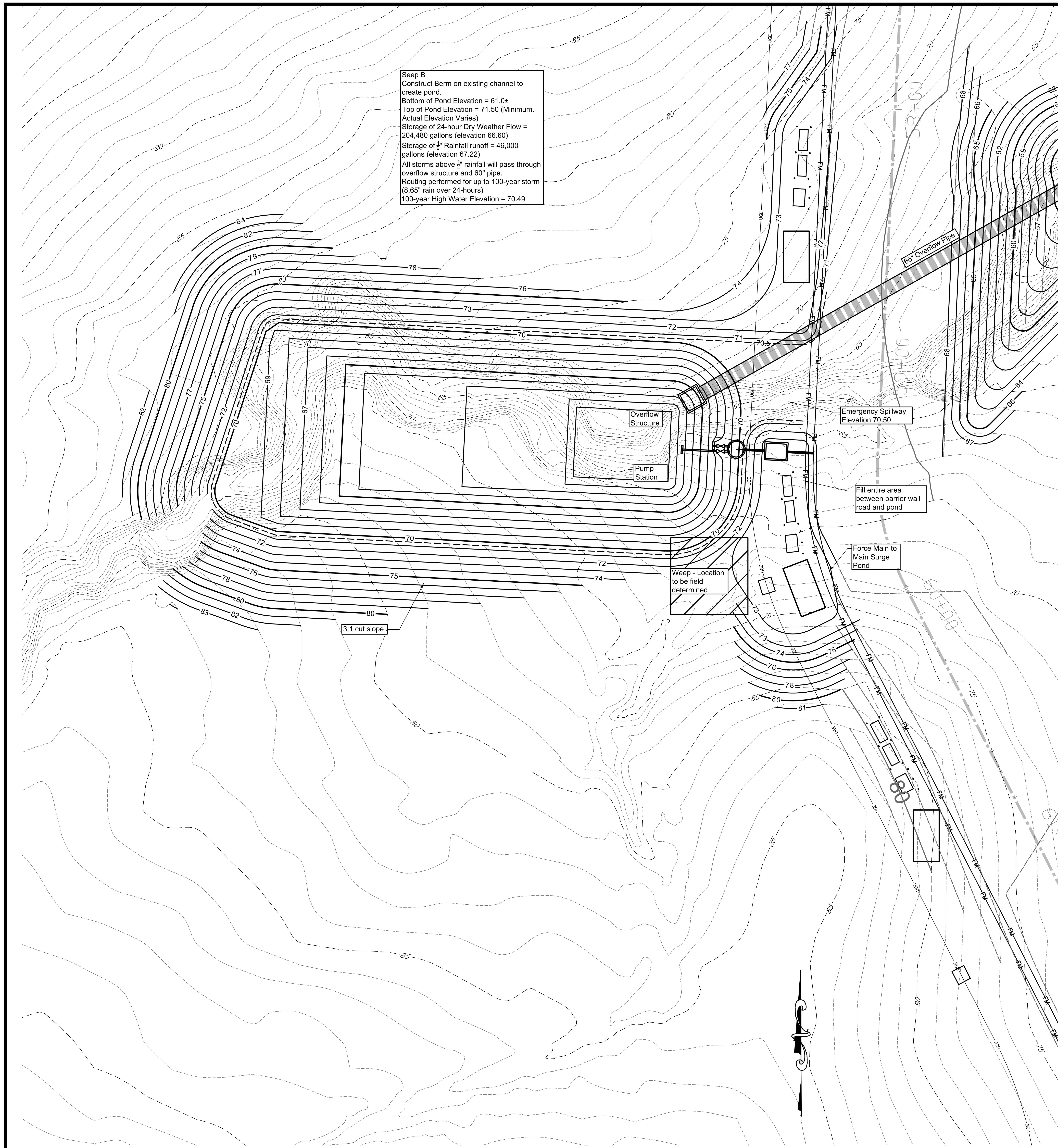
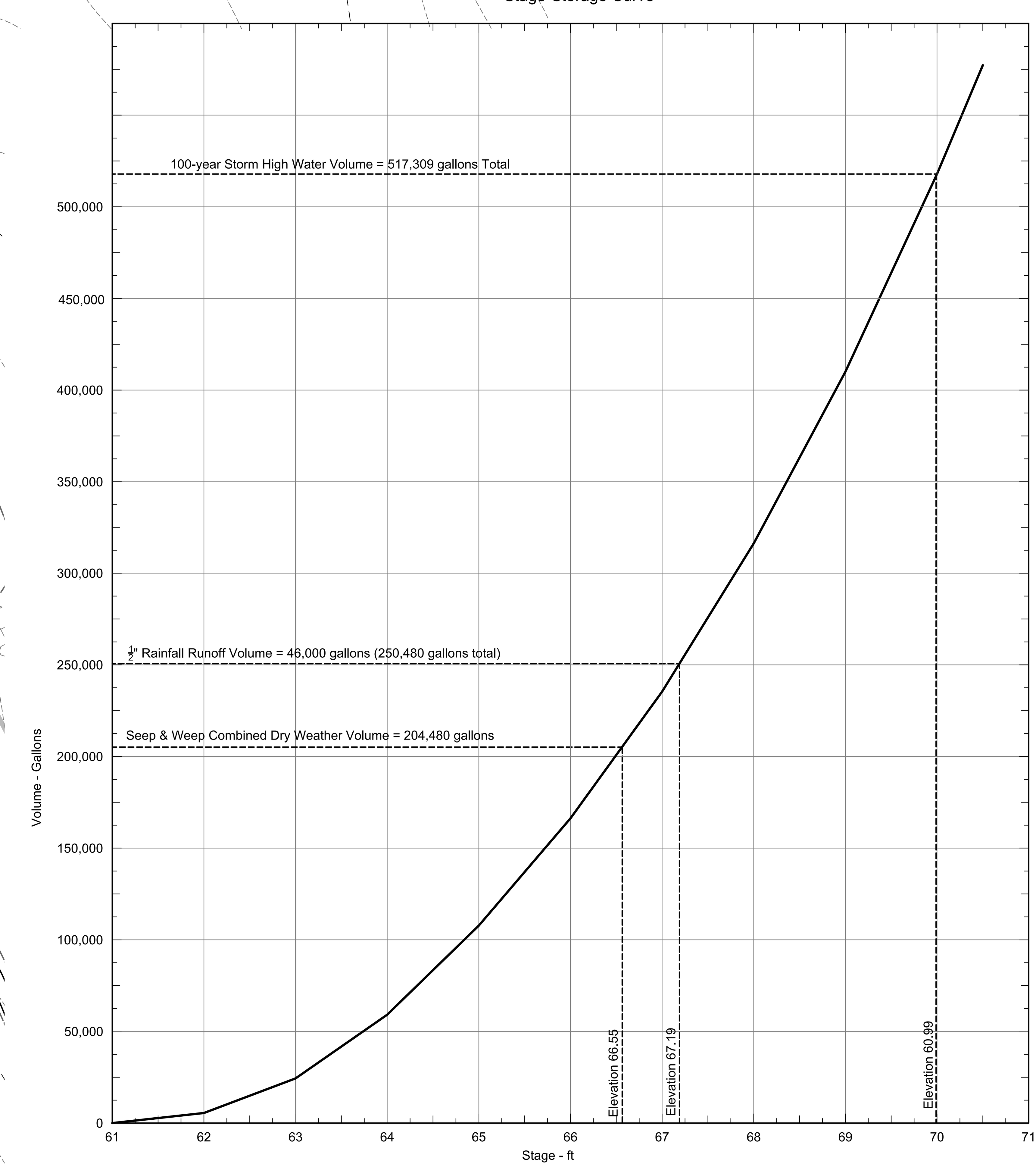
PROJECT NUMBER: 45-20803



1 SC-2.0 *Seep B – Capture System & Basin Grading Plan*

SCALE: 1" = 20'
0' 20' 40'

Stage-Storage Curve



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Ex-Situ Seep Capture Design Plans
Seep B Capture System Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

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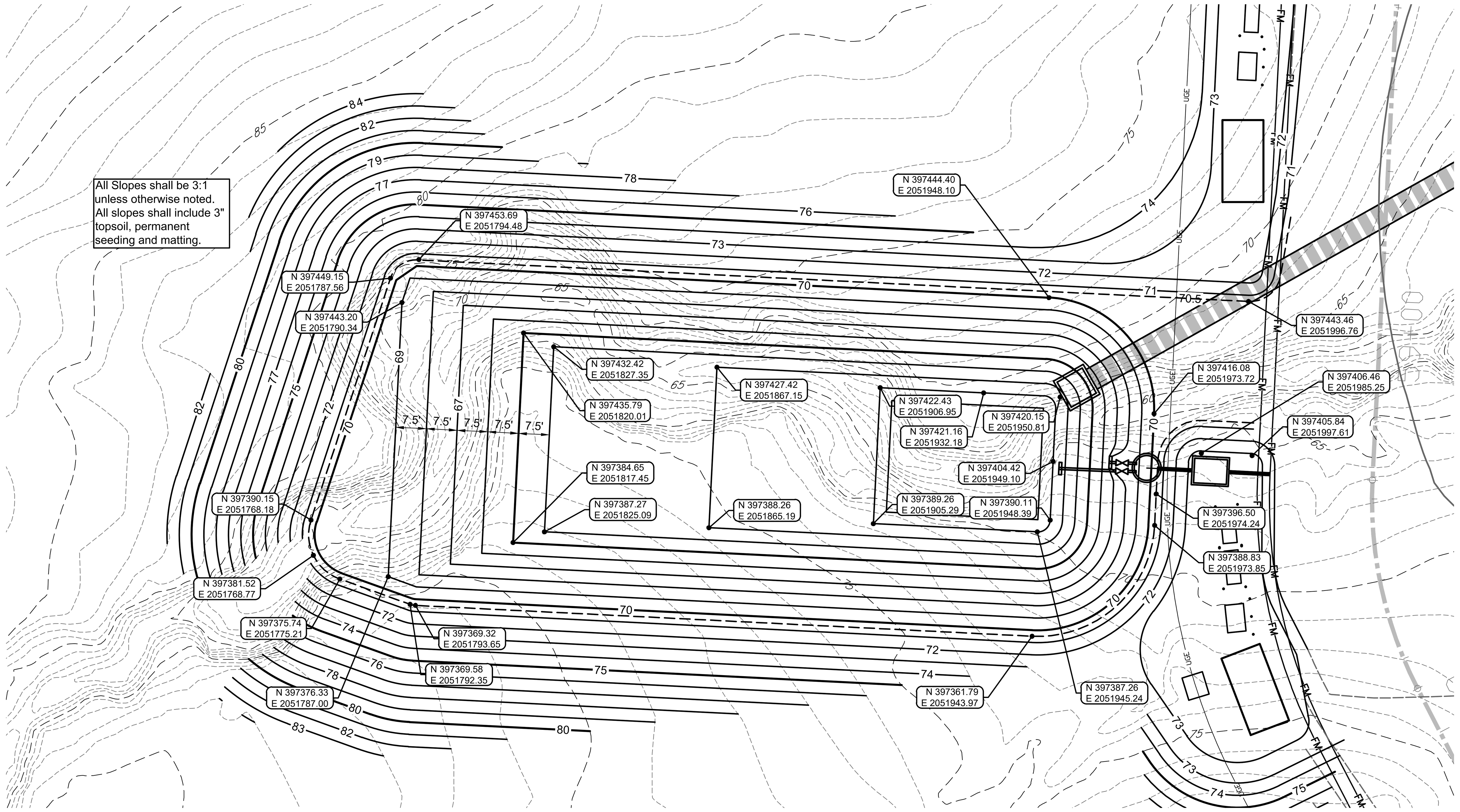
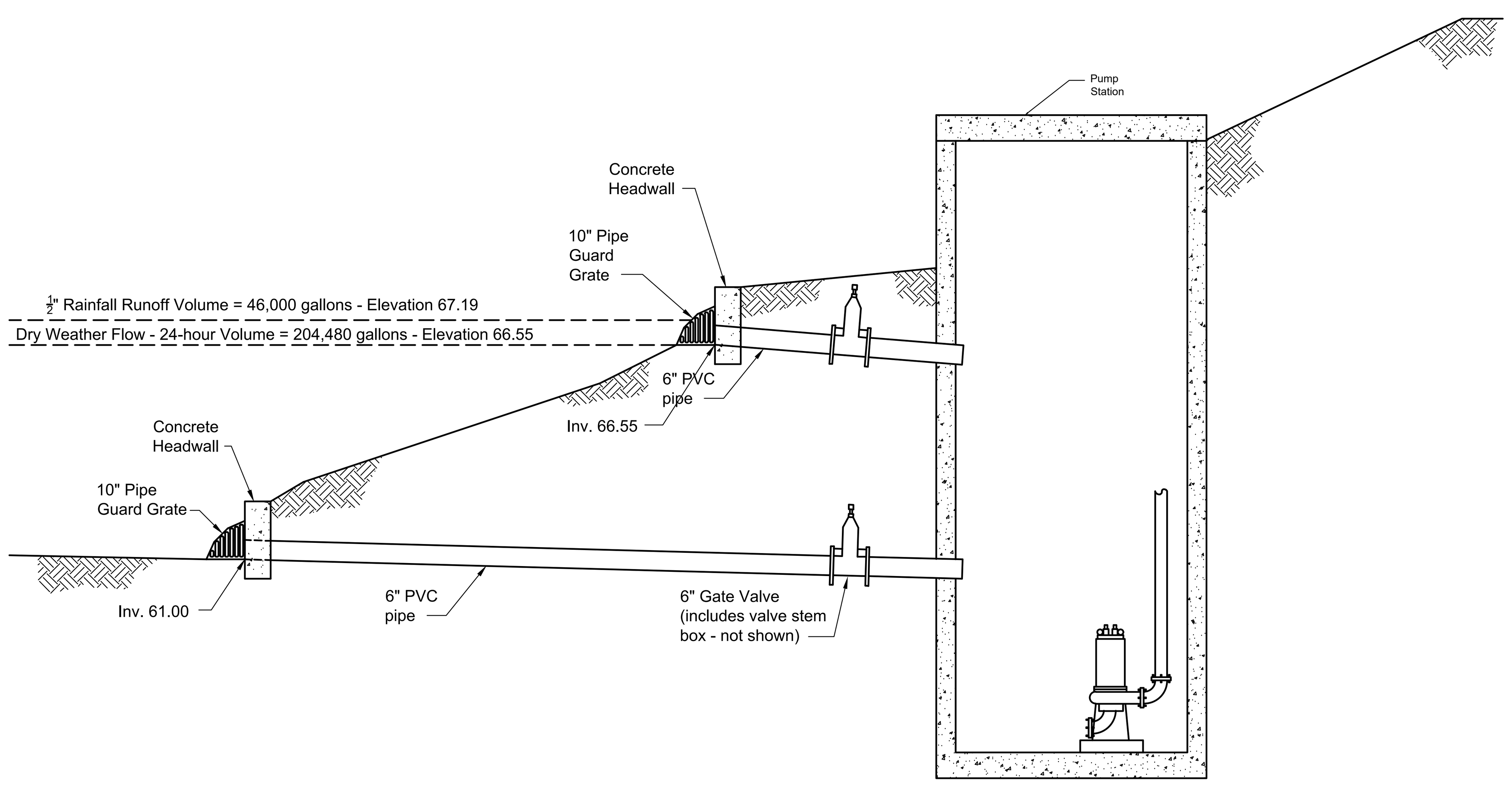


1 SC-2.1 Seep B – Capture System & Basin Layout Plan

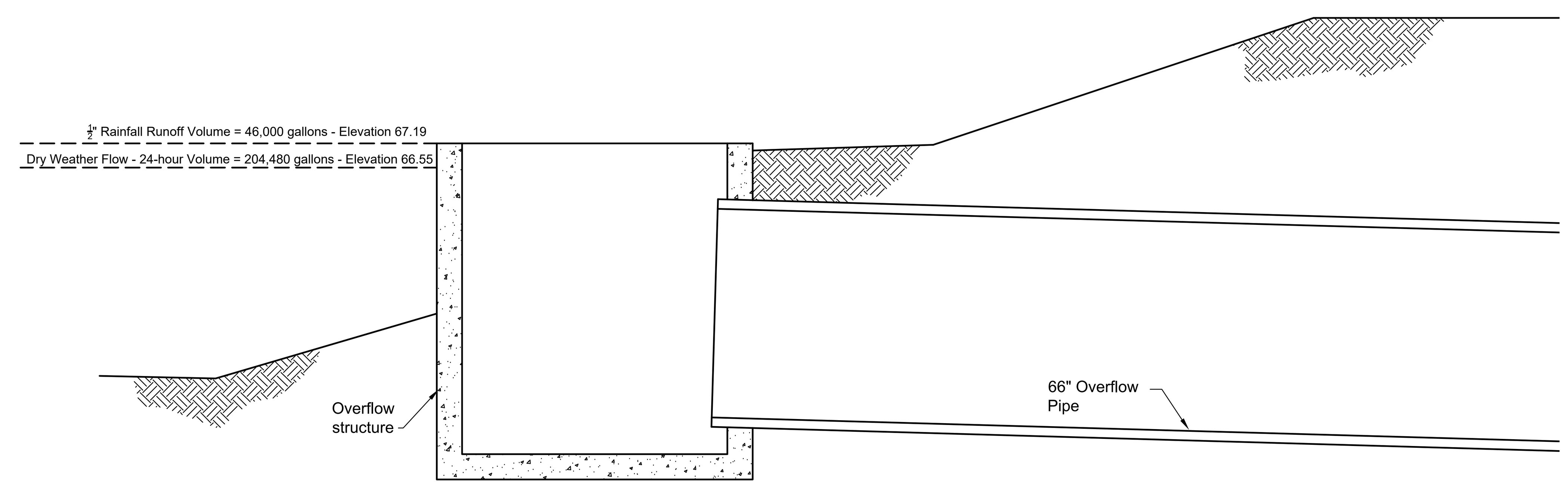
SCALE: 1" = 20'
0' 20' 40'

Seep B - Pond Notes

1. Shape and volume of pond, elevations of structures and pipes are critical to operation of the pond. The intent of the pond is to capture the Dry Weather Flow from Seep B and Weep at 60+00 and to capture the runoff from the $\frac{1}{2}$" rainfall.
2. The grades and elevations shown are final grades and elevations. The entire area shall include 3" topsoil. Thus subgrade shall be 3" lower than grades shown on plan.
3. The entire basin and all 3:1 slopes shall include permanent seeding and erosion control matting.
4. The outlet structure is sized to allow discharge of the 100-year storm while maintaining a maximum surface water elevation of 69.00 (1.5' below the emergency spillway).



2 SC-2.1 Seep B Basin – Schematic – Section View at Pump Station



3 SC-2.1 Seep B Basin – Schematic – Section View at Overflow Structure

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Ex-Situ Seep Capture Design Plans
Seep B Capture System Grading Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

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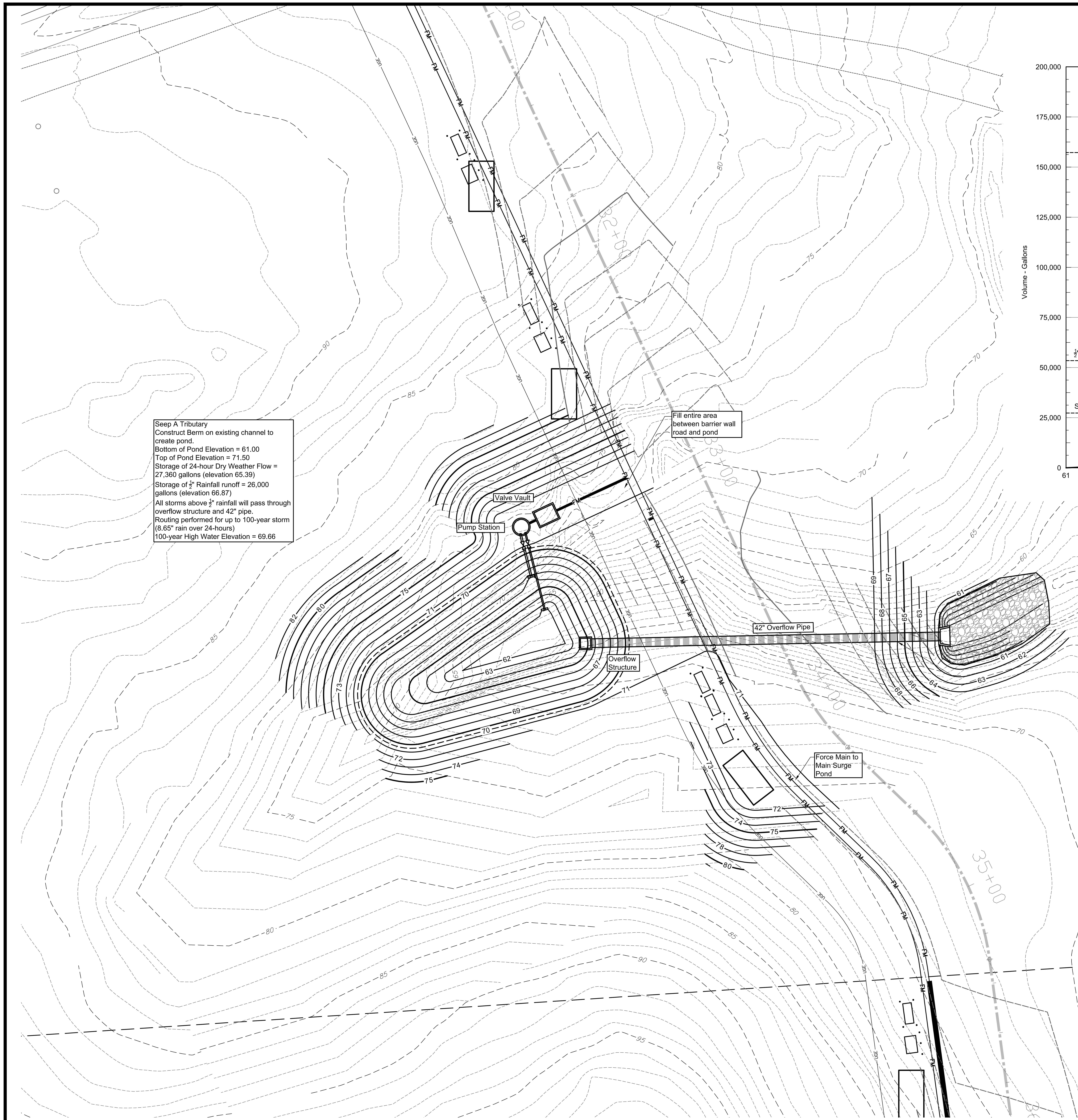

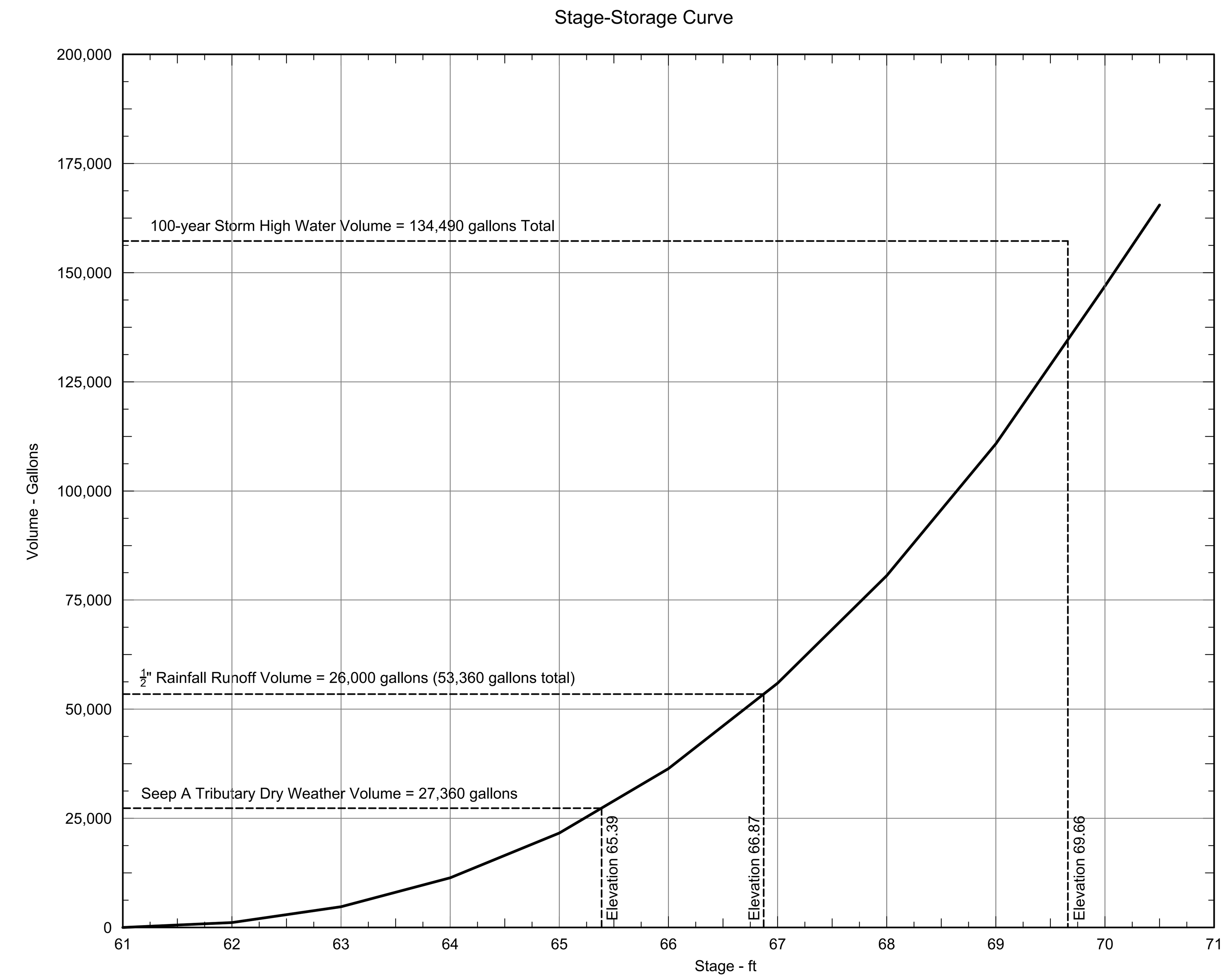

1 SC-3.0 Seep A Tributary – Capture System & Basin Grading Plan

SCALE: 1" = 20'
0' 20' 40'

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Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Tributary Capture System Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

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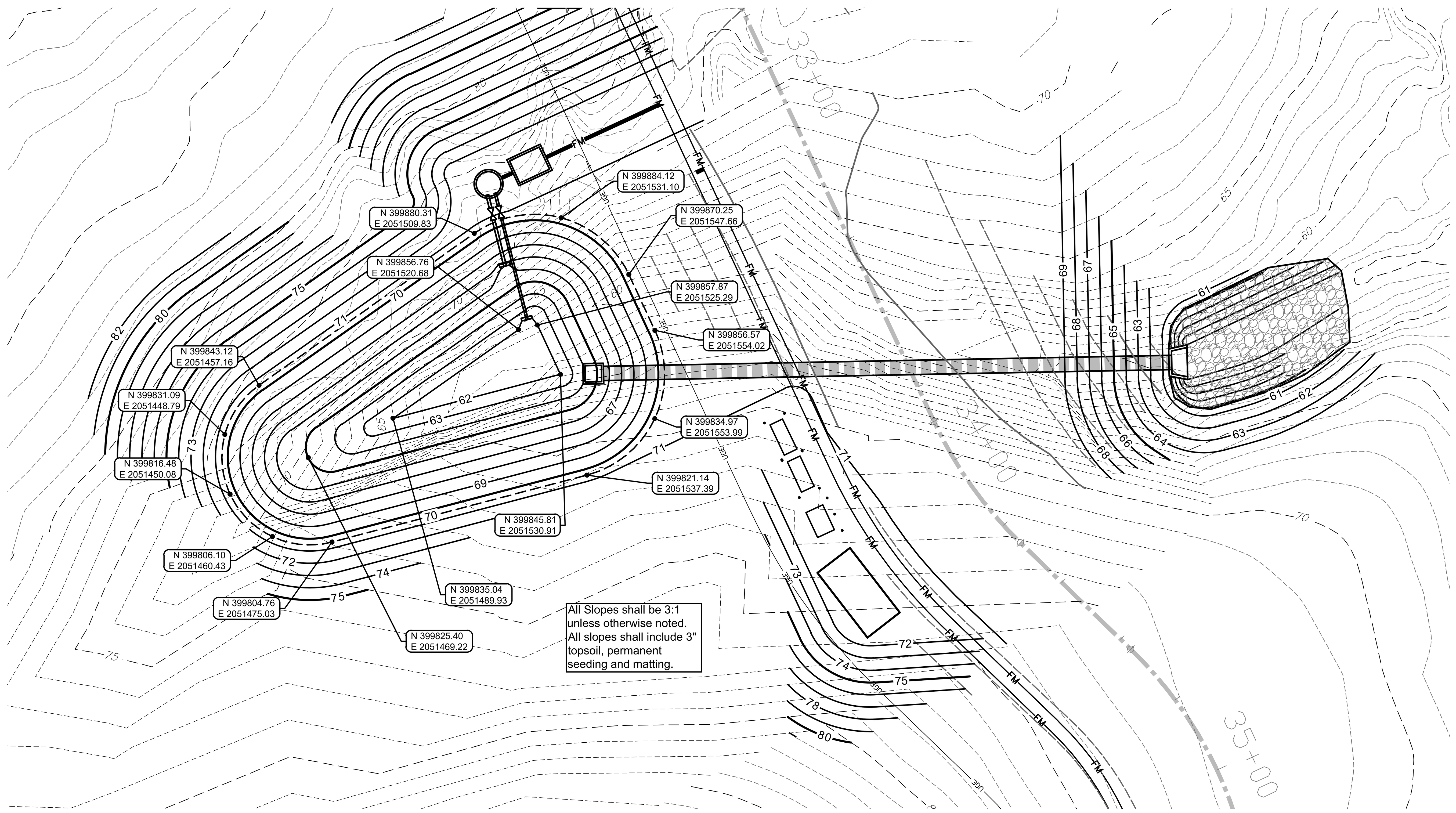
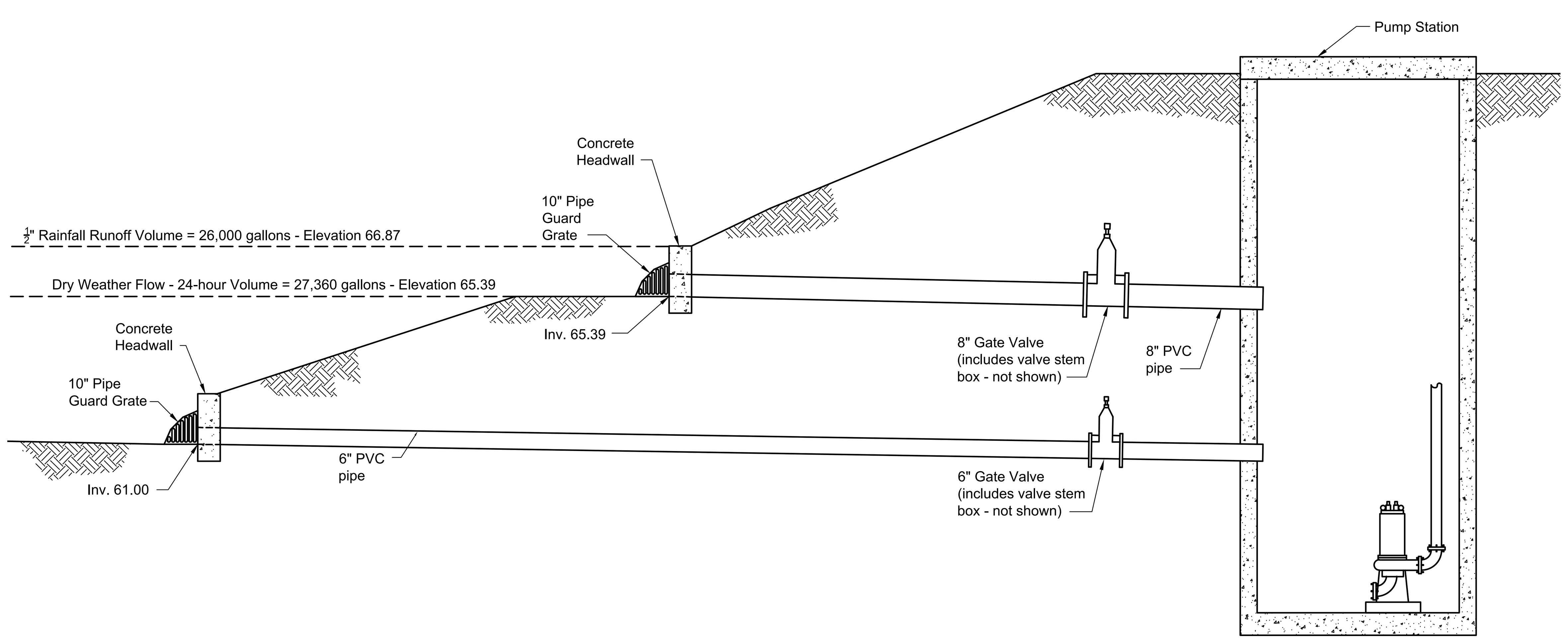


1 SC-2.1 Seep A Tributary – Capture System & Basin Layout Plan

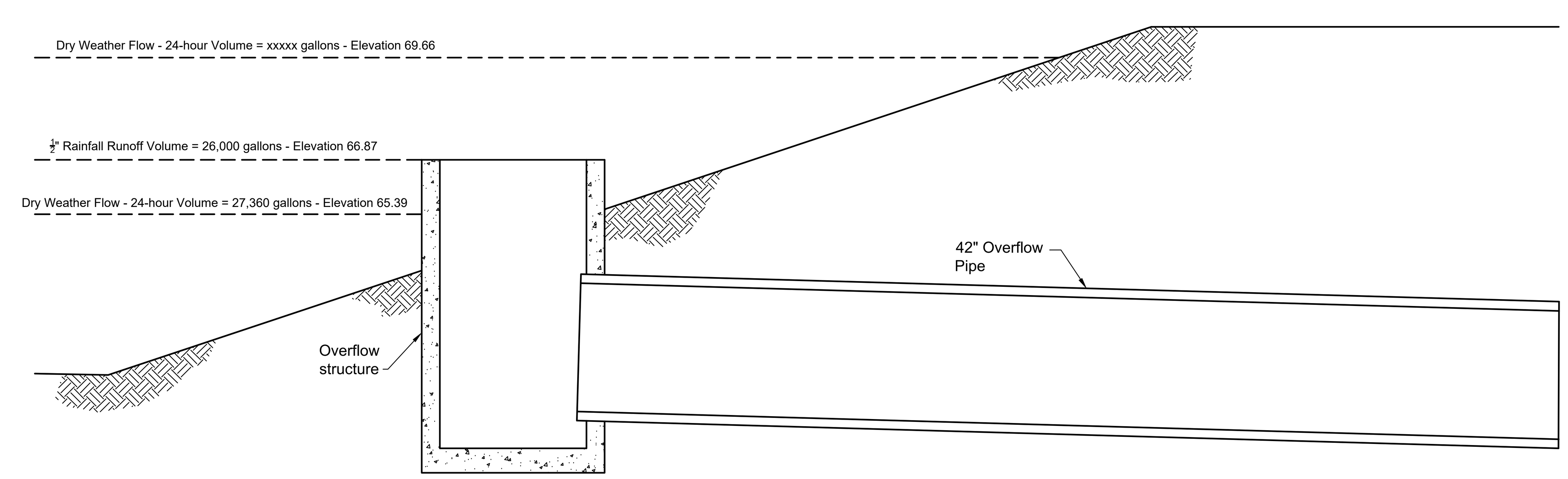
SCALE: 1" = 20'
0' 20' 40'

Seep A Tributary - Pond Notes

1. Shape and volume of pond, elevations of structures and pipes are critical to operation of the pond. The intent of the pond is to capture the Dry Weather Flow from Seep A Tributary and to capture the runoff from the $\frac{1}{2}$" rainfall.
2. The grades and elevations shown are final grades and elevations. The entire area shall include 3" topsoil. Thus subgrade shall be 3" lower than grades shown on plan.
3. The entire basin and all 3:1 slopes shall include permanent seeding and erosion control matting.
4. The outlet structure is sized to allow discharge of the 100-year storm while maintaining a maximum surface water elevation of 70.49. Note that this assumes the tailwater on the outlet pipe is at elevation 68.00 (the 100-year Flood Elevation of the Cape Fear River. This is a very conservative estimate as it assumes the Cape Fear River is at 100-year stage for the entire storm and thus there is no outflow from the pond until the water surface elevation in the pond rises above elevation 68.00.



2 SC-3.1 Seep A Tributary Basin – Schematic Section View at Pump Station



3 SC-3.1 Seep A Tributary Basin – Schematic Section View at Overflow Structure

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Ex-Situ Seep Capture Design Plans
Seep A Tributary Capture System Grading Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

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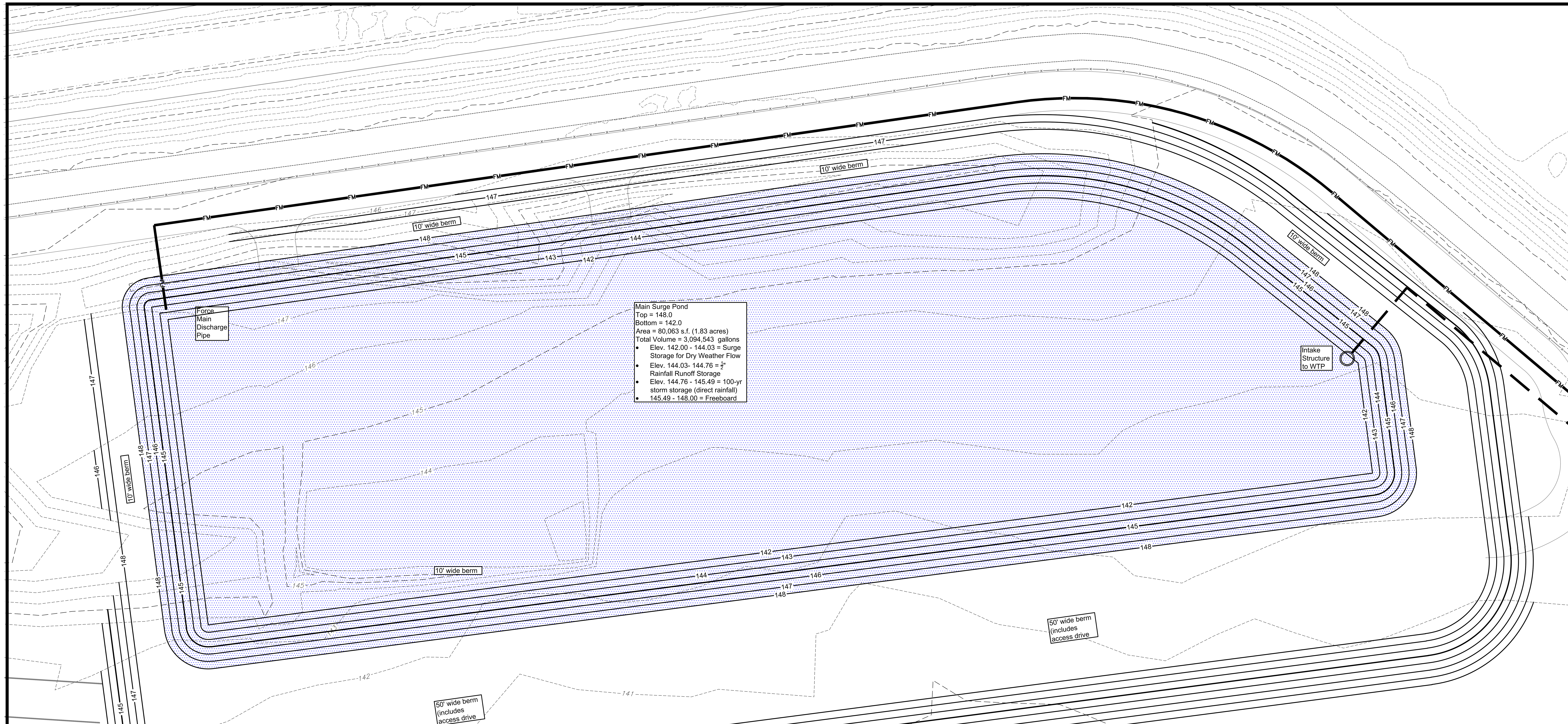

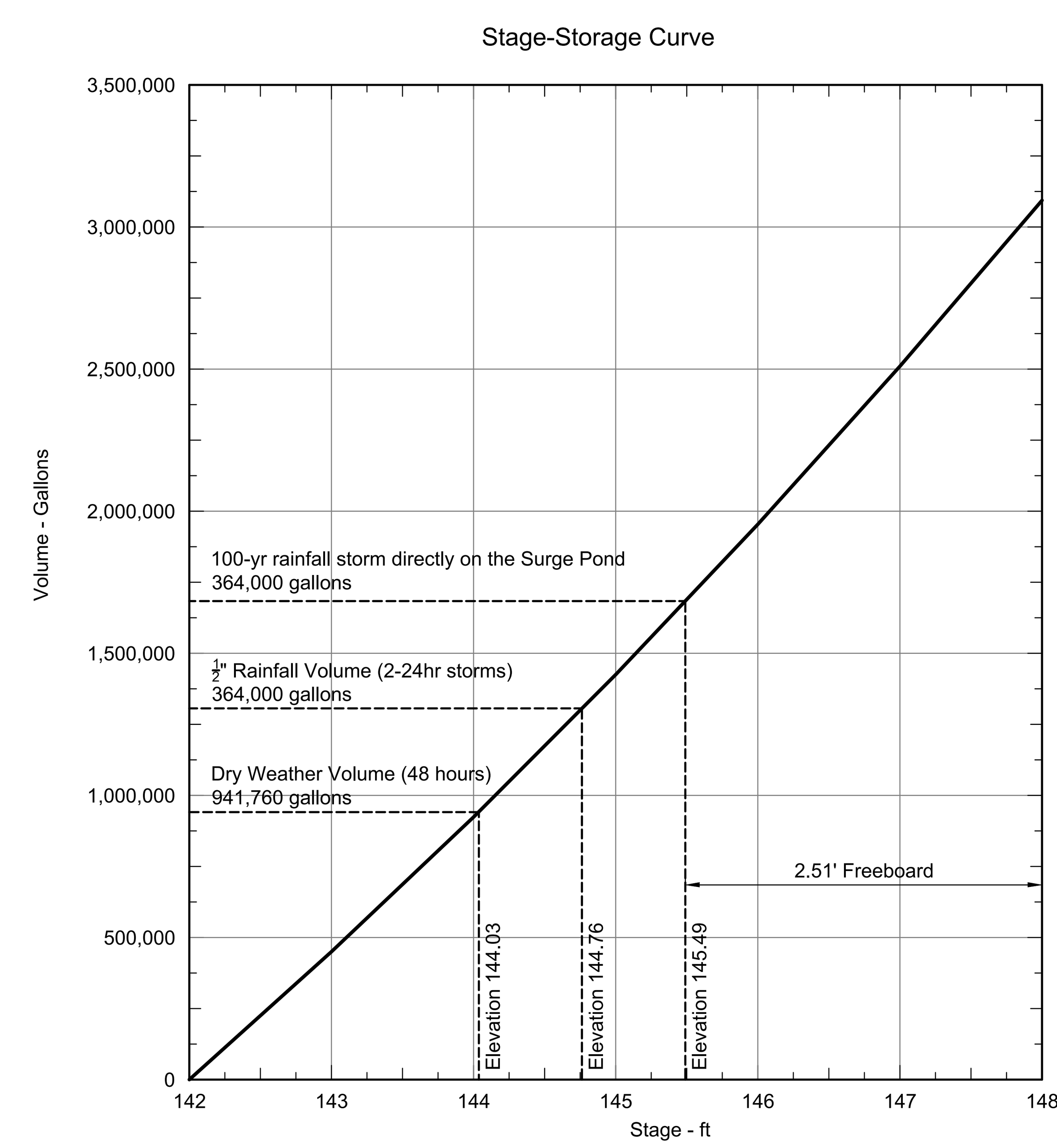

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Ex-Situ Seep Capture Design Plans
Main Surge Pond

Chemours Fayetteville Works
Fayetteville, North Carolina

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DESIGNED BY: BB	APPROVED BY:
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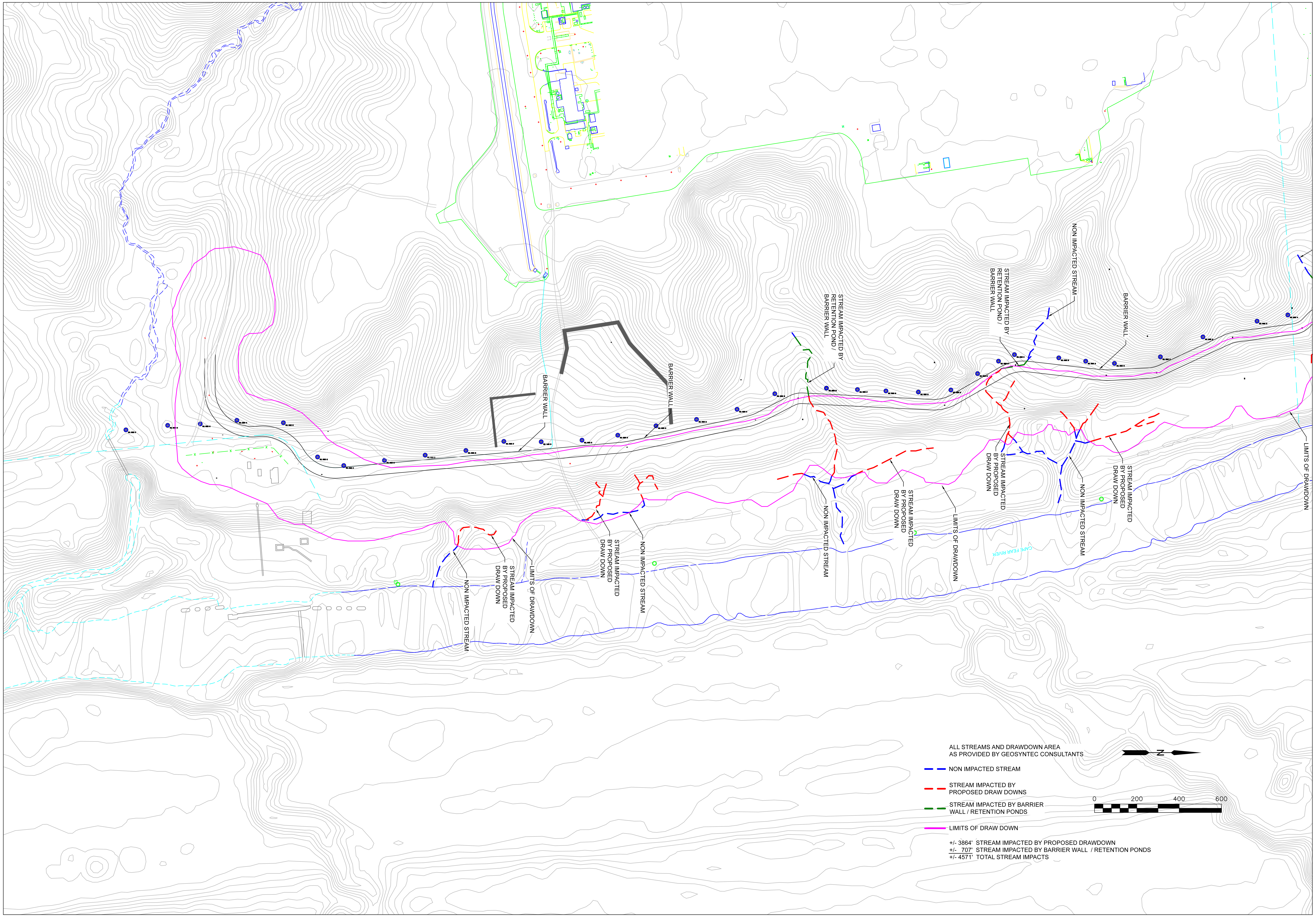

GEOS
GEOServices, LLC-Geotechnical and Materials Engineers
2561 Willow Point Way
Knoxville, Tennessee 37931
Seymour, Tennessee 37865
Office: 865-539-8242
Fax: 865-573-6132

STREAM IMPACT DRAWING

THE CHEMOURS COMPANY
FAYETTEVILLE, NORTH CAROLINA

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DESIGNED BY:
REVIEWED BY:
APPROVED BY:
PROJECT NUMBER: 45-20803A
SCALE: AS SHOWN
DATE: 01-13-2022

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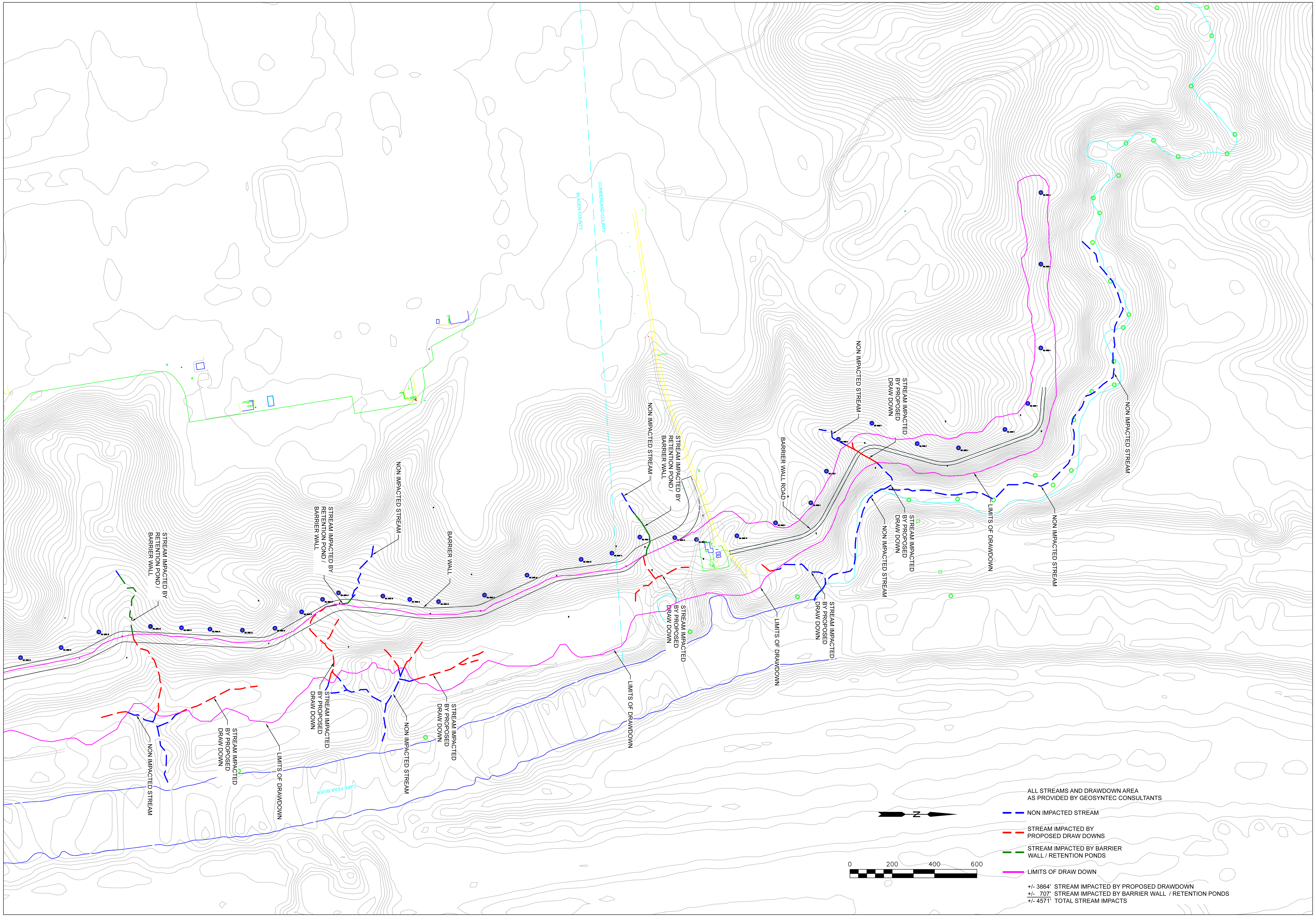
Figure 1



GEOServices, LLC-Geotechnical and Materials Engineers
2561 Willow Point Way
Knoxville, Tennessee 37931
Seymour, Tennessee 37865
Office: 865-539-8242
Fax: 865-573-6132

STREAM IMPACT DRAWING

THE CHEMOURS COMPANY

FAYETTEVILLE, NORTH CAROLINA

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APPROVED BY:
PROJECT NUMBER: 45-20803A
SCALE: AS SHOWN
DATE: 01-13-2022

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Geosyntec consultants
Geosyntec Consultants of NC, P.C.

2501 Blue Ridge Road, Suite 430
Raleigh, NC 27607
PH 919.870.0576
www.geosyntec.com

Memorandum

Date: 11 January 2022

To: Chemours

Copies to: GeoServices

From: Geosyntec Consultants

Subject: Groundwater Model Simulated Water Table Assessment
SAW-2019-0026 Chemours

INTRODUCTION

This memorandum was prepared by Geosyntec Consultants of NC, P.C. (Geosyntec) for The Chemours Company FC, LLC, to support the evaluation of wetland impacts from the remedial system implementation at the Chemours Fayetteville Works property located at 22828 NC Highway 87, Fayetteville NC 28306 (the Site). A numerical groundwater model was developed to simulate groundwater flow conditions at the Site. The primary objectives for developing the model included: 1) gaining a better understanding of the groundwater flow system and associated parameters; and 2) using the model as a tool for projecting groundwater flow conditions into the future based on proposed remedial design.

The groundwater flow model was developed and calibrated to simulate groundwater flow conditions at the Site during the pre-remedial development stage (baseline) and to form the basis of design for the remedial system implementation. By extension, the simulated model results can be used to assess the potential groundwater area of remedy influence (lowering of groundwater in response to the remedy) downgradient of the barrier wall associated with the remedial system implementation.

GROUNDWATER FLOW MODEL

A three-dimensional (3D) transient-state finite element numerical groundwater flow model was developed to simulate groundwater flow at the site and allow for testing the effectiveness of different remedial scenarios. The model was constructed in FEFLOW® version 7.2 (DHI-WASY), and incorporates field-observed parameters, which were interpolated to approximate aquifer conditions across the model domain and assumed to be representative in between measured locations.

The 3D flow model was calibrated to 139 Site Wells: 60 wells in the perched zone, 32 wells in the Surficial Aquifer and 47 wells in the Black Creek Aquifer. The calibration results and statistics show the flow model is well calibrated, based on a reasonable agreement between the observed and calculated heads and flows. A model is considered to be well calibrated when the normalized root mean square (NRMS) is below 10%. The RMS for the Surficial aquifer was 5.65 ft; the NRMS was 6.4% and the RMS for the Black Creek Aquifer was 4.58 ft; the NRMS was 5.2%. Detailed information regarding the model construction, and calibration is presented in the 3-Dimensional Groundwater Flow Model report which was prepared for the Chemours Fayetteville Works 60% Design Report and is provided as Attachment A to this memorandum.

POST REMEDIAL IMPLEMENTATION DESIGN AND RESULT

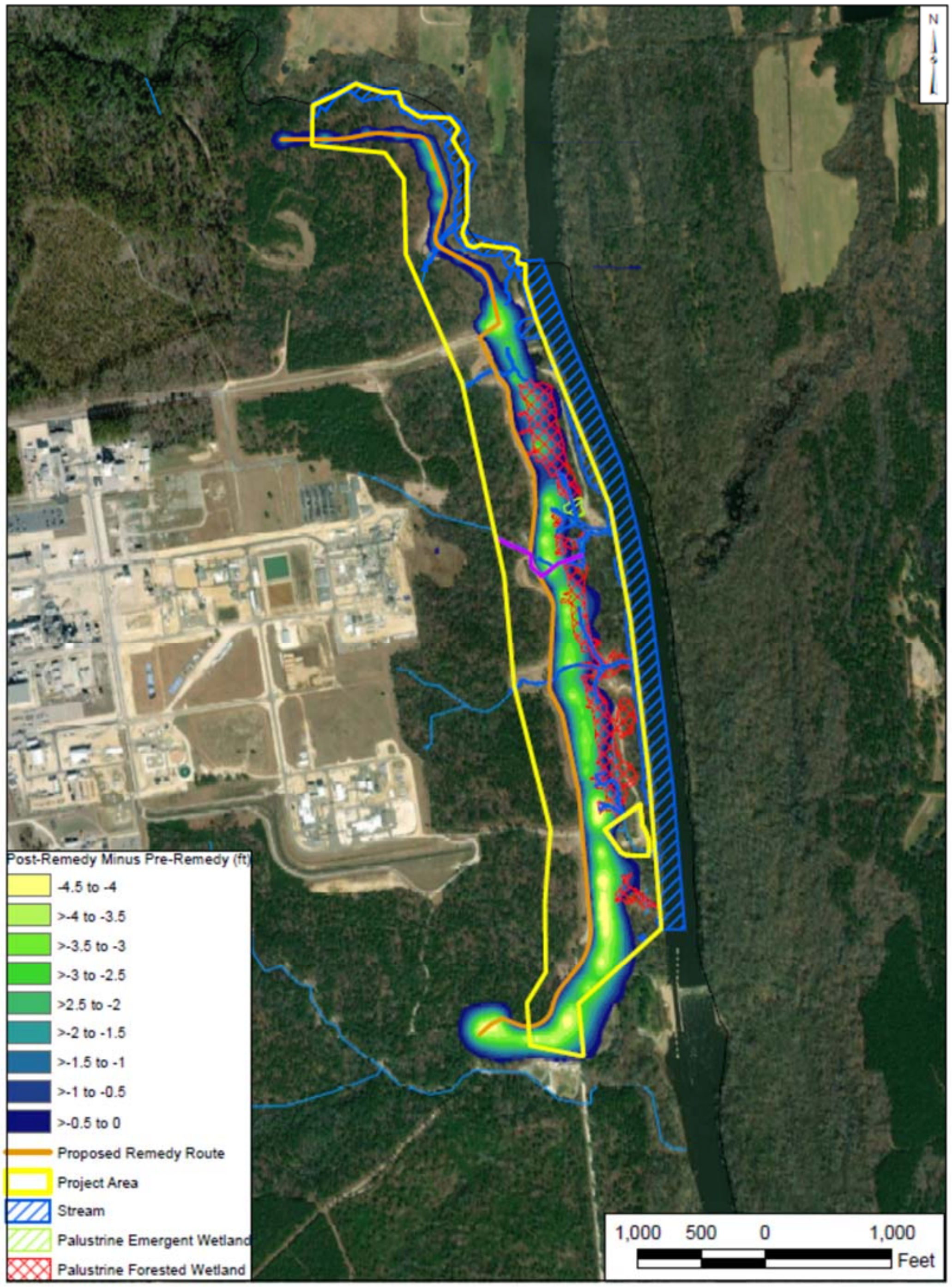
The pre-remedial development model (baseline) was used to provide the initial condition for the post remedial system implementation simulated over a 5-year time period. The stresses applied (recharge) for the projected simulation were the same stresses applied during the last calibration stress period (2018-2020) of the baseline model.

The simulated water table post remedy indicates cones of depression develop outwards from each of the extraction wells and overall water elevation slightly increased upgradient of the barrier. The area downgradient of the barrier wall simulated water table elevations decreased for up to 500 feet from the barrier wall toward the Cape Fear River.

MODEL REMEDY INFLUENCE CALCULATION

The post remedy implementation projected water table elevations were compared to the pre-remedy water table elevations in the area downgradient of the remedy. The post remedy model simulated water table surface was subtracted from the pre-remedy water table surface to assess the magnitude and location of projected changes in the water table after remedy implementation; see Figure 1. The area immediately downgradient of the barrier wall shows a water table elevation decrease of up to a maximum of 4.5 ft and then this decreases downgradient of the wall to reach pre-remedy water levels.

Figure 1: Simulated Water Table Elevation Changes Post Remedial System Implementation



Attachment A: 60% Design 3-Dimensional Groundwater Flow Model Chemours Fayetteville Works

* * * * *

Geosyntec consultants

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GEOServices, LLC, Geotechnical and Materials Engineers

Appendix B
Groundwater Flow Model Report

Geosyntec consultants

engineers | scientists | innovators

3-Dimensional Groundwater Flow Model
Chemours Fayetteville Works

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Table of Contents

List of Tables

List of Figures

Acronyms and Abbreviations

α	alpha
δ	delta
λ	lambda
θ	unsaturated-flow porosity
3D	three-dimensional
CAP	Corrective Action Plan
cm/s	centimeter per second
CO	Consent Order
COA	Addendum to Consent Order Paragraph 12
CPT	piezoCone Penetration Tests
ft	feet
ft/d	feet per day
ft^2	feet square
gpm	gallons per minute
HPT	hydraulic profiling tool
K	hydraulic conductivity
LiDAR	Light Detection and Ranging
NRMS	normalized root mean square
P_c	capillary pressure
PDI	Predesign Investigation
PFAS	per- and polyfluoroalkyl substances
ROI	radii of influence
RMS	root mean square
S_r	residual wetting phase saturation
S_s	specific storage
S_w	wetting phase saturation
USGS	United States Geological Survey

1. Introduction and Objectives

This groundwater modeling report was prepared by Geosyntec Consultants of NC, P.C. (Geosyntec) for The Chemours Company FC, LLC (Chemours) to describe the numerical groundwater model used to develop the basis of design for the groundwater remedy to be implemented pursuant to paragraph 3 of the Addendum to Consent Order Paragraph 12 (COA) among Chemours, the North Carolina Department of Environmental Quality and Cape Fear River Watch. Geosyntec initially developed a three-dimensional (3D) numerical groundwater transient flow model in the Corrective Action Plan (Geosyntec, 2019). The model has been further refined to incorporate results of the Pre-Design Investigation (PDI) efforts (Geosyntec, 2021). The updated model incorporates refinements of the hydrostratigraphic units and aquifer properties that were completed in 2020. The model was used as the basis of design for the groundwater remedy including preparing estimates the amount of collected water that would require treatment. Modeling objectives included:

- Simulate the capacity of a vertical physical barrier parallel to the Cape Fear River to control discharge of groundwater to the River.
- Simulate capacity of a groundwater extraction system, upgradient of the vertical barrier to control discharge of groundwater to the River.
- Utilize the model to evaluate possible optimal combinations of groundwater extraction and physical barrier scenarios that would sufficiently control discharge of groundwater to Cape Fear River, which would inform the basis of design for the overall remedy.

1.1 Scope of Work

The scope of work to achieve the above objectives included modifications to the model and the incorporation of data acquired during the PDI. The majority of the changes to the model focused on the area surrounding the proposed vertical barrier and extraction well network. The scope of work included:

- Refining the grid cell spacing near the vertical barrier.
- Modifying the recharge zonation to better simulate site conditions.
- Modifying the hydraulic conductivity zonation based on data collected during the PDI.
- Examining and modifying the river stages in the various simulated surface water bodies in the model.
- Re-calibrating the modified model to October 2019 and November 2020 measured groundwater elevations.

The current conditions base model was calibrated using statistical analysis and used as the basis for several predictive scenarios. Each scenario was sequentially constructed to be able to assess the performance of the hydraulic containment required in accordance with the objectives set forth in COA Paragraph 3 (NCDEQ, 2020).

1.2 Report Organization

The remainder of this report includes the following subsections:

- Section 2 – Groundwater model software selection
- Section 3 – Groundwater model setup
- Section 4 – Groundwater model calibration
- Section 5 – Remedial design simulations
- Section 6 – Summary
- Section 7 – References

2. Groundwater Model Software Selection

The 3D model was constructed using FEFLOW, version 7.2 (DHI-WASY), which incorporates the Richards' equation, the conservation of mass, and nonlinear relationships between capillary pressure (P_c) and wetting phase saturation (S_w) and between S_w and hydraulic conductivity (K) to solve for hydraulic heads. The model was constructed using field-observed parameters, which were interpolated to approximate aquifer conditions across the model domain and assumed to be representative in between measured locations.

2.1 Model Limitations

Simulation of groundwater flow involves using specific measured data (e.g., groundwater elevation, hydraulic conductivity) and regional data (e.g., recharge) that are used to develop site-wide fields of hydraulic heads. By nature, the groundwater model is an approximation based on a limited number of data points, and thus in a complex environment, there are unavoidable uncertainties. The groundwater model was constructed based on field-observed parameters, which were then interpolated to approximate aquifer conditions across the model domain and assumed to be representative in between the measured points. Numerical groundwater flow models, therefore, are approximations of real-world hydrogeological systems. Nevertheless, models are commonly used as a means of representing the available data on a specific groundwater system and evaluating groundwater remedial design alternatives.

The model calibration was conducted for the purpose of the simulating potential groundwater remedies pursuant to COA paragraph 3. Therefore, the primary importance of calibration results was placed on the flow features salient to the simulation of groundwater flow within the vicinity between the bluff and the Cape Fear River where the vertical barrier and extraction well network are proposed.

The validity and applicability of the model for purposes other than the stated objectives must be independently evaluated based on the professional judgment of the model user.

3. Groundwater Model Setup

The original groundwater flow model developed in 2019 as part of the Corrective Action Plan (CAP) was designed to represent the major physical and hydraulic features of the flow system in the Site Aquifers (Perched, Surficial, and Black Creek) in and around the Chemours Fayetteville Site. Construction and calibration of the original CAP groundwater model are described in Appendix H of the CAP report (Geosyntec, 2019).

Portions of the PDI focused on collecting data for further refining the groundwater model. The scope items included aquifer testing at five locations, a high-resolution cross section, and assessment of per- and polyfluoroalkyl substances (PFAS) chemistry in groundwater along the remedy alignment. This section describes the current version of the model developed for vertical barrier depth design and extraction well network evaluation, and where appropriate, how the model has been modified since inception.

3.1 Model Domain and Grid

The model domain covers an area of 72,690,473 feet square (ft^2) (2.61 square miles). The revised grid consists of 2,099,240 nodes and 4,154,656 elements and 7 model hydrostatigraphic units. The number of nodes and elements were increased to refine the model domain from the edge of the bluff to Cape Fear River. The model domain and grid location are presented in Figure B.01.

The model uses 7 hydrostratigraphic units to represent, from surface downward, the Floodplain deposits, Perched Zone, Perched Clay, Surficial aquifer, Black Creek Confining unit, Black Creek aquifer, and Cape Fear Confining unit. The model varies in thickness from about 170 feet (ft) near the plant to 55 ft at the base of the bluff adjacent to the Cape Fear River.

The Light Detection and Ranging (LiDAR) elevation model prepared by the North Carolina Department of Public Safety was imported to represent ground surface topography (NC DPS, 2015), which was corrected with ground survey data, where available, in areas that could impact performance of the model. The topography of the underlying model layers were based on lithostratigraphic data obtained from Site monitoring wells, soil borings, hydraulic profiling tool (HPT), and piezoCone Penetration Tests (CPT) contained in the three-dimensional visualization model, EVS™.

3.2 Flow Boundary Conditions

Boundary conditions are used to simulate flow of water into and out of a model domain. Upgradient regional conditions, river and recharge boundaries are used in the updated model to simulate Site conditions. Figure B.02 presents the locations of the boundary conditions within the model domain. The numerical model extent was closely tied to the boundary conditions chosen for the model:

Top Boundary: Established as the ground surface, taken from a combination of LiDAR data and topographic surveys performed along Willis Creek and the Outfall. Boundary conditions on the top boundary were either constant flux (to simulate rainfall recharge) or constant head equal to elevation (with a no inward flow constraint) to simulate seepage faces on the bluffs. Initial rainfall recharge values were selected with reference to the annual precipitation and evapotranspiration estimates for the Mid-Atlantic Coastal Plain (United States Geological Survey [USGS], 2005).

Bottom Boundary: Chosen as flat at an elevation of -20 ft above MSL which is located within the Upper Cape Fear confining unit. A no-flow hydraulic condition was applied to the entire bottom boundary of the model.

Northern Boundary: Willis Creek forms a hydraulic boundary north of the model domain. The creek is treated as a spatially-varying constant hydraulic head boundary from the northwest model corner to the outflow to the Cape Fear River located at the northeast model corner. The uppermost active nodes in the mesh along the Willis Creek boundary were linearly interpolated, from west to east along the creek, from a hydraulic head equal to the ground surface elevation at the western most part of Willis Creek to a hydraulic head equal to the constant hydraulic head boundary value of the Cape Fear River. Application of this constant head condition to only the upper nodes in the mesh forces all groundwater flowing towards the boundary to discharge into the creek (as all nodes below the upper nodes were assigned a no-flow condition).

Eastern Boundary: The Cape Fear River forms a hydraulic boundary east of the model domain. The river is treated as a constant hydraulic head boundary in the uppermost active nodes with an elevation representative of a daily median water elevation in the river, as measured at the W.O. Huske Dam (USGS, 2105500). The river wraps partially around the northeast and southeast corners of the model. Application of this constant head condition to only the uppermost nodes in the mesh forces all groundwater flowing towards the boundary to discharge into the river.

Southern Boundary: The model domain southern extent was chosen to represent a flow line from the western boundary to the eastern boundary. This selection was based on the available measured hydraulic head data and professional judgment (Geosyntec, 2019). A no-flow condition was applied to the southern boundary.

Western Boundary: The western model boundary is not bounded by any clearly defined hydraulic features and maybe a flow divide beneath a topographic high. This boundary was chosen as parallel to the Cape Fear River as limited hydraulic information was available to make a more refined choice. This boundary is located more than a quarter mile from the manufacturing area of the Site. Spatially-varying constant hydraulic head boundary conditions were applied linearly ranging from 125 ft (in the shallower portion of the domain) or 122 ft (in the deeper portion of the domain) at the southern end of the boundary to the elevation of Willis Creek at the northern end of the boundary.

3.3 Hydraulic Parameters

The model parameters were chosen based on the available field data, such as CPT, HPT, and aquifer test data collected from 2018 to 2020. Where ranges in data existed, mid-points of the ranges were chosen as the initial set of parameters.

Hydraulic conductivity, specific storage (S_s), unsaturated-flow porosity (θ), residual wetting phase saturation (S_r), and Brooks-Corey-Burdine P_c-S_w-K constitutive parameters (alpha (α), lambda (λ), delta (δ)) are the main hydraulic parameters in the model. The distribution and assignment of these parameters are based on the conceptual model hydrostratigraphy. Hydraulic parameter distribution in the model was uniform across individual hydrostratigraphic units. The parameter values for each hydrostratigraphic unit were determined during the flow model calibration process (Section 3) and presented in Table 1.

Table *1: Calibrated Model Hydraulic Parameters For Each Hydrostratigraphic Unit*

Hydrostratigraphic Unit	K (ft/day)	S_s (m^{-1})	θ	S_r (-)	α (m^{-1})	λ (-)	δ (-)
Floodplain Deposits	1.4	1.0×10^{-8}	0.32	0.2	0.5	0.15	25
Perched Zone	2.6	1.0×10^{-3}	0.3	0.1	11.5	0.56	7.3
Perched Clay	0.0014	1.0×10^{-8}	0.5	0.2	0.5	0.15	25
Surficial Aquifer	25 to 72	1.0×10^{-3}	0.33	0.1	11.5	0.56	7.3
Black Creek Confining Unit	0.43	1.0×10^{-8}	0.55	0.2	0.5	0.15	25
Black Creek Aquifer	3.8 to 102	5.1×10^{-5}	0.34	0.1	11.5	0.56	7.3
Cape Fear Confining Unit	1.1	1.0×10^{-8}	0.28	0.2	0.5	0.15	25

S_r and the Brooks-Corey-Burdine (α, λ, δ) constitutive parameters for each hydrostratigraphic unit were selected based on the soil textural class and the estimated model parameters reviewed from Madi et al. (2018), Matlan et al. (2014), and Shao and Irannejad (1999). These parameter assignments were simplified for the model by separating the hydrostratigraphic units as either aquifers or aquitards after performing the first set of flow model calibration runs where each hydrostratigraphic unit was assigned distinct parameter sets. Aquifer units were assigned S_r and Brooks-Corey-Burdine constitutive parameters representative of sands; aquitard units were assigned S_r and Brooks-Corey-Burdine constitutive parameters representative of sandy clay, silty clay, and clay soil types.

4. Groundwater Model Calibration

Model calibration is an iterative process where the initial parameters values (e.g., hydraulic conductivities, boundary conditions, recharge) are adjusted incrementally to produce a better match between simulated and observed water level elevations.

Site-wide synoptic water level rounds (July 2020 and December 2020) were collected that incorporated newly installed wells during the PDI.

A total of 96 monitoring well points were used to calibrate the model. Table 2 provides the wells, coordinates, hydrostratigraphic unit, observed and predicted hydraulic heads, and the residual heads. The residual head for each monitoring point is the calculated hydraulic head minus the observed hydraulic head ($X_{cal} – X_{obs}$). Figure B.03 presents the locations of the monitoring wells used to calibrate the base model.

Figure B.04 presents the calibration statistics and a graph of the calculated heads versus observed heads. Calibration statistics presented include the range of residuals, residual mean, absolute residual mean, the standard error of the estimate, the root mean squared error, the normalized root mean squared error, and the flow mass balance.

The maximum residual (difference between observed and calculated head) occurs in the Perched zone at MW-27 (8.52 ft), Surficial aquifer at SMW-09 (13.5 ft), and in the Black Creek at PW-10R (10.27 ft). The residual mean is a measure of the average residual head because it is possible that over-calculated and under-calculated values will negate each other thus producing a residual mean value closer to zero (which is ideal), it is preferable to use the absolute residual mean as an indicator of model calibration. The residual mean was -0.66 ft; the absolute residual mean was 2.94 ft.

The root mean square (RMS) is a statistical measure of the magnitude of the residual and is useful as an indicator of error where values are both positive and negative. The normalized root mean square (NRMS) is the RMS divided by the maximum difference in observed head values, expressed in percent (%). A model is considered to be well calibrated when the NRMS is below 10%. The RMS for the Perched zone was 4.34 ft; the NRMS was 23.9%, the RMS for the Surficial aquifer was 5.65 ft; the NRMS was 6.4% and the RMS for the Black Creek Aquifer was 4.58 ft; the NRMS was 5.2%. The Perched zone NRMS value exceeds 10%, but is unconfined and thin, and the perched zone can be significantly influenced by small scale local recharge patterns making calibration more difficult. The primary targets of the remedy are the Surficial and Black Creek aquifers, not the perched, so calibration does not need to be as refined.

The flow mass balance is a measure of the volume and rates of water entering and leaving the system through the flow boundary conditions, and from aquifer storage at the end of each stress period (in the case of transient simulations). Ideally, the flow balance should be as close as practicable to a discrepancy of 0%. The flow mass balance in this model has a discrepancy of 0.78%.

Figure B.05 presents the simulated equipotential head contours for the Surficial aquifer and Black Creek aquifer layers in the calibrated base model. Field-measured groundwater elevation contours are also included for comparison. Although the focus during model calibration was the area where the vertical barrier and extraction wells will be installed, the model is adequately simulating the groundwater within the plant area.

5. Remedial Design Simulations

The remedial design for Site groundwater includes the installation of a vertical barrier and a groundwater extraction and treatment system to control discharge of PFAS containing groundwater to the Cape Fear River.

The following describes a summary of the conclusions from the PDI and the model results for consideration into the vertical barrier design and groundwater extraction system remedy. The Site geology is highly variable along the groundwater remedy alignment. Consistent with the interpretation of a deltaic depositional environment, the Black Creek aquifer along the alignment is a mixture of high-energy channel sands and lower-energy mud flats. Geosyntec prepared a high-resolution cross section along the groundwater remedy alignment using a combination of data collected during the PDI and previous investigations (Figure is located in PDI document in Appendix A) (Geosyntec, 2021). Three distinct sections of the groundwater remedy alignment are described as follows. Black Creek aquifer soils in the northern portion of the groundwater remedy alignment are dominated by more fine-grained materials indicative of a transition to a low-energy deposition environment. The central portion of the alignment is characterized by higher-energy channel sands and correlates to the locations of a majority of the seeps. The southern portion is similar to the central portion of the alignment but is hydraulically influenced by the Old Outfall.

Particle tracking was incorporated to display flow direction and magnitude between the Site and Cape Fear River under baseline conditions and after the addition of the vertical barrier and the groundwater extraction network. Particle tracking starting locations were released from the Plant Area upgradient of the proposed remedy area.

Particle track and water budget analyses have been completed for various scenarios to quantify groundwater discharge between the Site and the Cape Fear River. This was accomplished using particle tracking and the rate budget analyzer within FEFLOW to assess the groundwater discharge to the Cape Fear River. Groundwater discharge was first estimated under baseline conditions (i.e., Scenario 1, the base case model). As the subsequent scenarios were developed, the particles discharged to Cape Fear River were compared to baseline conditions to evaluate the scenario's control of groundwater flow.

5.1 Scenario 1: Baseline Conditions

The base case model is equivalent to the model calibration conducted during the PDI where the model was adjusted to simulate current conditions prior to remedy implementation.

Figure B.06 presents particle-tracking results for Scenario 1 which uses a 5-year model run time and releases particles from the Plant Area. Under these conditions, particles released from the perimeter of the plant migrate horizontally, then eventually discharge to Cape Fear River.

5.2 Scenario 2: Vertical Barrier Alone

In this scenario, a five-year model simulation, the vertical barrier parallel to the Cape Fear River (shown by the green line in Figure B.07) is simulated to the top of the Upper Cape Fear Confining unit by creating a zone to represent the vertical boundary. The length of the barrier is approximately 9,000 ft, and the depth embeds five feet into the Upper Cape Fear Confining unit. Approximate depth of the barrier ranges from approximately 60 to 80 ft. The barrier is assigned a thickness of 1.6 ft (0.5-meter) and a hydraulic conductivity of 2.8 x 10^{-3} feet per day (ft/d) (1.0 x 10^{-6} centimeter per second [cm/s]). Figure B.08 presents the particle-tracking results for Scenario 2. In this five-year simulation, many of the particles released from the Site pass over, around, and through the vertical barrier, and eventually discharge to the Cape Fear River. Specifically, in the area near Seep A and B where there is high transmissivity, particles migrate over, around and through the barrier and discharge to Cape Fear River at a relatively high rate.

Results from the particle tracking and flow analysis indicated that the physical barrier wrap-around flow occurred at the barrier edges after 7 days, breakthrough occurs in multiple locations along the barrier, and groundwater discharges to surface. Specifically, in the areas near Seeps A and B, particles migrate over, around, and through the barrier and discharge to Cape Fear River.

5.3 Scenario 3: Hydraulic Barrier Alone

In Scenario 3, a hydraulic barrier alone was simulated using a groundwater extraction network between the bluff and the Cape Fear River (shown by the wells in Figure B.09). This simulation used 64 extraction wells (10 wells located in the surficial aquifer and 54 wells located in the Black Creek aquifer) to mitigate groundwater discharge to the Cape Fear River.

The simulated extraction well flow rates ranged from 5 to 35 gallons per minute (gpm) depending on location and the total cumulative flow rate for the extraction well network simulated was 980 gpm. Well spacing is generally 200 ft apart; well spacings are closer where there is higher groundwater flux, particularly in the vicinity of Seeps A and B, and along the southern end near the Old Outfall 002. Figure B.10 presents the particle-tracking results for Scenario 3. In this simulation, the particles are released from the Site in the plant area and many are contained by the extraction system. However, some particles are ultimately discharged to the Cape Fear River. Specifically, in the areas near Seeps A and B, particles migrate between some of the extraction wells and discharge to Cape Fear River. An evaluation of the extraction well network indicated insufficient overlap of the radii of influence (ROI) for the extraction wells in many areas of the hydraulic barrier remedy. This results in incomplete capture in the areas where there is increased groundwater flow due to the presence of highly transmissive material.

Additional extraction wells and increased pumping would allow for sufficient overlapping ROI, however, the resulting cone of depression is of sufficient size to begin drawing in Cape Fear River water with limited additional capture of groundwater, reducing overall efficiency. Sensitivity analysis was performed to optimize the well placement and well density along the proposed remedy route. In addition to the spacing specified in the above figures, simulations with a well spacing of 100 ft apart with tighter spacing of 25 feet apart (total of 135 wells) near Seep A, Seep B and near Outfall 003 (higher transmissible areas) were assessed. In the highly transmissive areas, particles from the plant area were still not fully captured by the groundwater extraction well network. Site conditions are such that groundwater from under the plant facility cannot be fully captured without also capturing some portion of Cape Fear River water. It was determined pumping alone could not match the performance of a combination pumping with a physical barrier, Scenario 4 below, with respect to capture.

Notably, in the northern area of the site, where the overall hydraulic conductivity is lower, the ROI of the extraction wells in this area sufficiently overlap and allows for capture of groundwater over the area. Evaluation of the two stand-alone approaches demonstrate that the barrier wall only or pumping only is not sufficient to meet overall Consent Order (CO) objectives. However, the simulation also demonstrated that pumping alone near Willis Creek controls the discharge to surface water in the northern portion.

5.4 Scenario 4: Optimized Scenario

In scenario 4, the vertical barrier and a hydraulic barrier containing 64 extraction wells (10 wells located in the surficial aquifer and 54 wells located in the Black Creek aquifer) were combined and simulated to assess performance of remedy (shown by the wells in Figure B.11).

Attachment 5 to the COA identified that the barrier wall could extend along Willis Creek in the northern alignment. Based on the favorable simulated performance of pumping only (see section 5.3 above) along the northern section and the identified constructability considerations along the northern section (section 3.2.4 of the 60% Design Report), the length of the barrier wall was set to approximately 6,000 ft from near the intake road to near the Old Outfall. The depth of the barrier extends into the upper five ft of the Upper Cape Fear Confining unit, for a total depth of approximately 60 to 80 ft. The barrier is assigned a 1.6-ft (0.5-meter) thickness and hydraulic conductivity of 2.8×10^{-3} ft/d (1.0×10^{-6} cm/s).

The simulated extraction well flow rates range from 5 to 35 gpm depending on location, and the total cumulative flow rate for the extraction well network simulated was 980 gpm. The presence of the vertical barrier effectively reduces overall hydraulic conductivity over the alignment where the barrier wall is present. As a result, the effective ROI of the wells is generally extended to allow sufficient overlap to capture groundwater flow. In those areas where a 200-ft spacing is not sufficient to capture released particles, spacing was tightened to provide adequate overlap of the ROI. Spacing is tighter at the northern and southern ends of the barrier wall and in the vicinity of the Seeps A and B where overall transmissivity is higher and to reduce potential for wrap around.

Figure B.12 presents the particle-tracking results for Scenario 4. In this simulation, the particles released from the Site in the plant area are controlled by the combination vertical and hydraulic barrier. Effectiveness of the simulated remedy was largely equal for both the surficial aquifer above the barrier wall and the Black Creek Aquifer. Groundwater that is present downgradient of the remedy after startup becomes largely stagnant; over time, continuing rainwater recharge and fluctuation of the Cape Fear river slowly drives remaining water present downgradient of the wall toward the Cape Fear River.

Additional sensitivity analyses were performed during the PDI to determine the impacts of key variables on the remedial design; see Appendix A. In addition, precipitation and Cape Fear River model inputs were simulated at the upper range of the observed data to develop upper range of the cumulative flow rates for the extraction well network.

6. Summary

The original groundwater model developed during the CAP and the PDI from 2019 through 2021 was updated to include water level, hydraulic conductivity, and hydrostratigraphic unit elevation data collected during the PDI in 2020/2021. The model was also further discretized vertically and horizontally to allow a more complex simulation of site conditions, simulate potential remedies and help provide a basis for remedy design.

The model was calibrated to synoptic groundwater data collected from 2018 to 2020 by adjusting the hydraulic conductivity distribution, boundary conditions, and recharge. Model calibration statistics indicate a root mean square result of 5.65 ft and a normalized root mean square of 6.4% for the surficial Aquifer and a root mean square result of 4.58 ft and a normalized root mean square of 5.2% for the Black Creek Aquifer and, indicating a well calibrated model. The calibrated model was validated by effectively simulating the pump tests for EW-1, EW-2, EW-3, and EW-4 conducted during the PDI in 2020.

Several model scenarios were completed to assess basis of design for the remedy:

- Scenario 1 simulates the current conditions base model updated with PDI data.
- Scenario 2 simulates a vertical barrier only.
- Scenario 3 simulates a hydraulic barrier via an extraction system only.
- Scenario 4 simulates an optimized remedy that takes advantages of the strengths of both the vertical barrier and hydraulic barrier via an extraction system.

The modeling results indicate that the groundwater in the northern alignment portion can be intercepted using extraction wells alone and that a barrier wall is not required. Particle tracking of the scenario simulations indicate that surficial aquifer to the seeps east of the barrier wall and the Black Creek Aquifer to the Cape Fear River controls groundwater and meets CO objectives under Scenario 4, the optimized solution.

Based on these model results, Scenario 4 was selected as a suitable option for limiting the groundwater discharge to the Cape Fear River and forms the basis of design for the groundwater remedy. Scenario 4 demonstrates that to provide adequate hydraulic containment, 64 extraction wells (10 wells located in the surficial aquifer, and 54 wells located in the Black Creek aquifer) and a vertical barrier wall installed through the central and southern sections of the alignment successfully reduce the groundwater discharging to the Cape Fear River. The estimated cumulative flow rates for the extraction well network is about 980 gpm.

7. References

Diersch, H.J.G. 2014. FEFLOW: Finite Element Modeling of Flow, Mass and Heat Transport in Porous and Fractured Media. Springer-Verlag Berlin Heidelberg. 2014.

Geosyntec, 2019. On and Offsite Assessment Report, Chemours Fayetteville Works. Geosyntec Consultants of NC, PC. September 30, 2019.

Geosyntec, 2021. Pre-Design Investigation Summary. Chemours Fayetteville Works. June 29, 2021

Madi, R., de Rooij, G.H., Mielenz, H., & Mai, J. 2018. Parametric soil water retention models: critical evaluation of expressions for the full moisture range. Hydrology and Earth System Sciences, 22. 2018.

Matlan, S.J., Mukhlisin, M., & Taha, MR. 2014. Performance Evaluation of Four-Parameter Models of the Soil-Water Characteristic Curve. The Scientific World Journal, 2014(569851). 2014.

NCDEQ, 2007. Groundwater Modeling Policy, North Carolina Department of Environmental Quality. May 31, 2007.

NCDEQ, 2019. Addendum to Consent Order Paragraph 12. General Court of Justice Superior Court Division. State of North Carolina. County of Bladen. February 25, 2019.

Parsons, 2018. Additional Site Investigation Report, Chemours Fayetteville Works Site, RCRA Permit No. NCD047368641-R1. March 30, 2018.

Shao, Y., & Irannejad, P. 1999. On The Choice of Soil Hydraulic Models in Land-Surface Schemes. Boundary-Layer Meteorology, 90(1). 1999.

USGS. A Surficial Hydrogeologic Framework for the Mid-Atlantic Coastal Plain, Professional Paper 1680. 2005.

Tables

Table B.02: Calibration Results: Observed vs Model Predicted Hydraulic Head Data

Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
BCA-01	Black Creek Aquifer	Oct-19	87.38	83.58	-3.80
BCA-02	Black Creek Aquifer	Oct-19	74.55	81.52	6.97
BCA-04	Black Creek Aquifer	Oct-19	121.55	114.41	-7.14
BCA-03R	Black Creek Aquifer	Oct-19	101.27	101.05	-0.22
PW-10R	Black Creek Aquifer	Oct-19	48.15	54.43	6.28
PW-12	Black Creek Aquifer	Oct-19	92.65	100.70	8.05
LTW-02	Black Creek Aquifer	Oct-19	42.19	39.36	-2.83
LTW-05	Black Creek Aquifer	Oct-19	42.35	42.42	0.07
PIW-2D	Black Creek Aquifer	Oct-19	64.55	64.30	-0.25
PIW-3D	Black Creek Aquifer	Oct-19	35.8	39.02	3.22
PIW-4D	Black Creek Aquifer	Oct-19	41.68	50.02	8.34
PIW-7D	Black Creek Aquifer	Oct-19	42.69	45.68	2.99
PIW-8D	Black Creek Aquifer	Oct-19	41.11	43.33	2.22
PIW-9D	Black Creek Aquifer	Oct-19	42.08	49.40	7.32
PW-09	Black Creek Aquifer	Oct-19	52.24	47.48	-4.76
PW-11	Black Creek Aquifer	Oct-19	39.6	40.57	0.97
PW-13	Black Creek Aquifer	Oct-19	119.79	117.30	-2.49
PW-14	Black Creek Aquifer	Oct-19	86.86	84.49	-2.37
PW-15R	Black Creek Aquifer	Oct-19	76.96	77.63	0.67
PZ-22	Black Creek Aquifer	Oct-19	44.06	43.02	-1.04
SMW-12	Black Creek Aquifer	Oct-19	33.44	38.88	5.44
LTW-01	Floodplain Deposits	Oct-19	37.3	40.33	3.03
LTW-03	Floodplain Deposits	Oct-19	39.71	39.06	-0.65
LTW-04	Floodplain Deposits	Oct-19	42.55	43.63	1.08
PIW-1S	Floodplain Deposits	Oct-19	32.59	35.56	2.97
PIW-6S	Floodplain Deposits	Oct-19	38.6	41.90	3.30
PIW-7S	Floodplain Deposits	Oct-19	42.51	50.33	7.82
PIW-7S	Floodplain Deposits	Oct-19	42.51	43.21	0.70
MW-13D	Surficial Aquifer	Oct-19	104.33	99.89	-4.44
MW-14D	Surficial Aquifer	Oct-19	109.67	107.09	-2.58
MW-16D	Surficial Aquifer	Oct-19	113.02	106.38	-6.64
MW-17D	Surficial Aquifer	Oct-19	117.09	114.11	-2.98
MW-18D	Surficial Aquifer	Oct-19	87.28	87.89	0.61
MW-19D	Surficial Aquifer	Oct-19	88.24	86.19	-2.05
MW-20D	Surficial Aquifer	Oct-19	89.51	85.37	-4.14
MW-21D	Surficial Aquifer	Oct-19	105.71	102.86	-2.85
MW-22D	Surficial Aquifer	Oct-19	113.82	110.93	-2.89
PIW-1D	Surficial Aquifer	Oct-19	32.81	32.17	-0.64
PIW-5S	Surficial Aquifer	Oct-19	60.46	48.36	-12.10
PW-02	Surficial Aquifer	Oct-19	90.05	82.82	-7.23
PW-05	Surficial Aquifer	Oct-19	121.25	121.37	0.12

Table B.02: Calibration Results: Observed vs Model Predicted Hydraulic Head Data
Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
MW-15DRR	Surficial Aquifer	Oct-19	103.37	101.34	-2.03
PW-03	Surficial Aquifer	Oct-19	105.57	95.39	-10.18
SMW-03B	Surficial Aquifer	Oct-19	93.4	100.72	7.32
SMW-05P	Surficial Aquifer	Oct-19	105.31	106.23	0.92
SMW-06B	Surficial Aquifer	Oct-19	103.15	102.07	-1.08
SMW-08B	Surficial Aquifer	Oct-19	108.29	106.71	-1.58
SMW-09	Surficial Aquifer	Oct-19	85.2	71.65	-13.55
SMW-10	Surficial Aquifer	Oct-19	46.69	53.70	7.01
SMW-11	Surficial Aquifer	Oct-19	57.87	54.34	-3.53
SMW-04B	Surficial Aquifer	Oct-19	102.94	100.42	-2.52
FTA-02	Perched Zone	Oct-19	133.61	131.69	-1.92
MW-1S	Perched Zone	Oct-19	132.9	130.81	-2.09
MW-2S	Perched Zone	Oct-19	130.69	129.30	-1.39
MW-9S	Perched Zone	Oct-19	130.36	124.57	-5.79
MW-11	Perched Zone	Oct-19	132.81	132.54	-0.27
MW-23	Perched Zone	Oct-19	131.61	128.04	-3.57
MW-24	Perched Zone	Oct-19	133.93	140.50	6.57
MW-26	Perched Zone	Oct-19	133.29	133.17	-0.12
MW-28	Perched Zone	Oct-19	131.99	123.47	-8.52
MW-31	Perched Zone	Oct-19	130.2	124.77	-5.43
MW-33	Perched Zone	Oct-19	132.36	128.58	-3.78
NAF-03	Perched Zone	Oct-19	139.43	139.36	-0.07
NAF-06	Perched Zone	Oct-19	139.99	139.05	-0.94
NAF-08A	Perched Zone	Oct-19	138.92	136.52	-2.40
NAF-09	Perched Zone	Oct-19	138.54	142.64	4.10
NAF-10	Perched Zone	Oct-19	136.38	141.43	5.05
NAF-11A	Perched Zone	Oct-19	135.76	132.42	-3.34
PZ-11	Perched Zone	Oct-19	133.55	126.63	-6.92
PZ-12	Perched Zone	Oct-19	137.02	130.84	-6.18
PZ-13	Perched Zone	Oct-19	130.74	131.00	0.26
PZ-20R	Perched Zone	Oct-19	135.54	131.57	-3.97
PZ-21R	Perched Zone	Oct-19	135.47	131.66	-3.81
PZ-24	Perched Zone	Oct-19	136.22	132.30	-3.92
PZ-25	Perched Zone	Oct-19	133.36	130.49	-2.87
PZ-27	Perched Zone	Oct-19	134.8	132.63	-2.17
PZ-28	Perched Zone	Oct-19	133.97	130.07	-3.90
PZ-29	Perched Zone	Oct-19	135.14	127.78	-7.36
PZ-32	Perched Zone	Oct-19	130.7	130.14	-0.56
PZ-34	Perched Zone	Oct-19	132.72	126.76	-5.96
SMW-03	Perched Zone	Oct-19	136.32	132.76	-3.56
NAF-13	Perched Zone	Oct-19	133.01	139.18	6.17

Table B.02: Calibration Results: Observed vs Model Predicted Hydraulic Head Data
Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
PZ-17	Perched Zone	Oct-19	135.12	141.51	6.39
SMW-02	Perched Zone	Oct-19	121.81	119.60	-2.21
PZ-12	Perched Zone	Dec-20	132	131.00	1.00
PZ-15	Perched Zone	Dec-20	135.85	141.51	-5.66
PZ-17	Perched Zone	Dec-20	121.85	119.60	2.25
PZ-19R	Perched Zone	Dec-20	137.14	131.57	5.57
PZ-20R	Perched Zone	Dec-20	137.07	131.66	5.41
PZ-21R	Perched Zone	Dec-20	138.62	132.30	6.32
PZ-35	Perched Zone	Dec-20	138.07	132.76	5.31
BCA-01	Black Creek Aquifer	Dec-20	84.43	83.58	0.85
BCA-02	Black Creek Aquifer	Dec-20	75.07	81.52	-6.45
BCA-03R	Black Creek Aquifer	Dec-20	101.29	101.05	0.24
BCA-04	Black Creek Aquifer	Dec-20	122.38	114.41	7.97
EW-1	Perched Zone	Dec-20	60.15	65.66	-5.51
EW-2	Perched Zone	Dec-20	43.35	44.10	-0.75
EW-3	Perched Zone	Dec-20	61.55	57.17	4.38
EW-4	Perched Zone	Dec-20	50.57	48.39	2.18
EW-5	Perched Zone	Dec-20	45.38	43.41	1.97
FTA-01	Perched Zone	Dec-20	134.14	131.69	2.45
FTA-02	Perched Zone	Dec-20	132.88	136.39	-3.51
FTA-03	Perched Zone	Dec-20	133.68	130.81	2.87
LTW-01	Floodplain Deposits	Dec-20	38.88	40.33	-1.45
LTW-02	Black Creek Aquifer	Dec-20	43.2	39.36	3.84
LTW-03	Floodplain Deposits	Dec-20	41.24	39.06	2.18
LTW-04	Floodplain Deposits	Dec-20	44.19	43.63	0.56
LTW-05	Black Creek Aquifer	Dec-20	42.78	42.42	0.36
MW-11	Perched Zone	Dec-20	125.15	125.90	-0.75
MW-12S	Perched Zone	Dec-20	132.56	128.04	4.52
MW-13D	Surficial Aquifer	Dec-20	104.75	99.89	4.86
MW-14D	Surficial Aquifer	Dec-20	110.29	107.09	3.20
MW-15DRR	Surficial Aquifer	Dec-20	103.21	101.34	1.87
MW-16D	Surficial Aquifer	Dec-20	112.89	106.38	6.51
MW-17D	Surficial Aquifer	Dec-20	117.74	114.11	3.63
MW-18D	Surficial Aquifer	Dec-20	88.79	87.89	0.90
MW-19D	Surficial Aquifer	Dec-20	90.03	86.19	3.84
MW-1S	Perched Zone	Dec-20	131.34	129.30	2.04
MW-20D	Surficial Aquifer	Dec-20	90.88	85.37	5.51
MW-21D	Surficial Aquifer	Dec-20	106.77	102.86	3.91
MW-22D	Surficial Aquifer	Dec-20	113.64	110.93	2.71
MW-23	Perched Zone	Dec-20	134.33	140.50	-6.17
MW-24	Perched Zone	Dec-20	128.92	134.53	-5.61

Table B.02: Calibration Results: Observed vs Model Predicted Hydraulic Head Data
Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
MW-25	Perched Zone	Dec-20	134.11	133.17	0.94
MW-26	Perched Zone	Dec-20	136.5	137.05	-0.55
MW-27	Perched Zone	Dec-20	132.44	123.47	8.97
MW-28	Perched Zone	Dec-20	131.29	124.77	6.52
MW-30	Perched Zone	Dec-20	135.1	139.18	-4.08
MW-31	Perched Zone	Dec-20	131.82	135.53	-3.71
MW-32	Perched Zone	Dec-20	132.24	128.58	3.66
MW-33	Perched Zone	Dec-20	132.47	129.72	2.75
MW-34	Perched Zone	Dec-20	132.13	136.43	-4.30
MW-35	Perched Zone	Dec-20	132.21	129.61	2.60
MW-36	Perched Zone	Dec-20	132.29	135.91	-3.62
MW-7S	Perched Zone	Dec-20	137.49	135.52	1.97
MW-8S	Perched Zone	Dec-20	141.94	147.54	-5.60
MW-9S	Perched Zone	Dec-20	133.39	132.54	0.85
NAF-01	Perched Zone	Dec-20	140.95	140.28	0.67
NAF-02	Perched Zone	Dec-20	141.05	139.36	1.69
NAF-03	Perched Zone	Dec-20	140.92	144.15	-3.23
NAF-06	Perched Zone	Dec-20	134.87	131.08	3.79
NAF-07	Perched Zone	Dec-20	140.6	136.52	4.08
NAF-08A	Perched Zone	Dec-20	140.73	142.64	-1.91
NAF-08B	Perched Zone	Dec-20	95.44	100.44	-5.00
NAF-09	Perched Zone	Dec-20	137.93	141.43	-3.50
NAF-10	Perched Zone	Dec-20	138.54	132.42	6.12
NAF-11A	Perched Zone	Dec-20	136.82	139.97	-3.15
NAF-11B	Perched Zone	Dec-20	94.13	99.26	-5.13
NAF-12	Perched Zone	Dec-20	140.15	136.79	3.36
OW-1	Perched Zone	Dec-20	59.78	62.67	-2.89
OW-1	Perched Zone	Dec-20	59.78	65.69	-5.91
OW-10	Perched Zone	Dec-20	59.82	60.49	-0.67
OW-2	Perched Zone	Dec-20	50.34	53.62	-3.28
OW-3	Perched Zone	Dec-20	50.14	48.81	1.33
OW-4	Perched Zone	Dec-20	61.57	62.16	-0.59
OW-5	Perched Zone	Dec-20	61.78	65.79	-4.01
OW-6	Perched Zone	Dec-20	42.8	42.55	0.25
OW-7	Perched Zone	Dec-20	45.35	44.40	0.95
OW-8	Perched Zone	Dec-20	44.6	45.95	-1.35
OW-9	Perched Zone	Dec-20	61.71	57.79	3.92
PIW-10DR	Perched Zone	Dec-20	61.16	60.94	0.22
PIW-10S	Perched Zone	Dec-20	57.93	53.29	4.64
PIW-11	Perched Zone	Dec-20	45.11	40.55	4.56
PIW-12	Perched Zone	Dec-20	35.53	34.75	0.78

Table B.02: Calibration Results: Observed vs Model Predicted Hydraulic Head Data

Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
PIW-13	Perched Zone	Dec-20	36.2	31.75	4.45
PIW-14	Perched Zone	Dec-20	37.01	38.24	-1.23
PIW-15	Perched Zone	Dec-20	35.58	33.96	1.62
PIW-16D	Perched Zone	Dec-20	131.11	135.13	-4.02
PIW-16S	Perched Zone	Dec-20	134.79	136.41	-1.62
PIW-1D	Surficial Aquifer	Dec-20	36.37	32.17	4.20
PIW-1S	Floodplain Deposits	Dec-20	35.35	35.56	-0.21
PIW-2D	Black Creek Aquifer	Dec-20	64.4	64.30	0.10
PIW-3D	Black Creek Aquifer	Dec-20	37.56	39.48	-1.92
PIW-4D	Black Creek Aquifer	Dec-20	42.67	47.23	-4.56
PIW-5S	Surficial Aquifer	Dec-20	61.17	48.36	12.81
PIW-6S	Floodplain Deposits	Dec-20	40.19	41.90	-1.71
PIW-7D	Black Creek Aquifer	Dec-20	43.35	45.96	-2.61
PIW-7S	Floodplain Deposits	Dec-20	43.42	50.33	-6.91
PIW-8D	Black Creek Aquifer	Dec-20	41.55	43.33	-1.78
PIW-9D	Black Creek Aquifer	Dec-20	42.49	49.40	-6.91
PIW-9S	Perched Zone	Dec-20	50.81	47.88	2.93
PW-01	Perched Zone	Dec-20	135.72	126.63	9.09
PW-02	Surficial Aquifer	Dec-20	89.99	82.82	7.17
PW-03	Surficial Aquifer	Dec-20	106.2	95.39	10.81
PW-04	Perched Zone	Dec-20	74.81	78.81	-4.00
PW-05	Surficial Aquifer	Dec-20	123.57	121.37	2.20
PW-06	Perched Zone	Dec-20	128.17	131.47	-3.30
PW-07	Perched Zone	Dec-20	118.6	123.45	-4.85
PW-09	Black Creek Aquifer	Dec-20	53.04	47.48	5.56
PW-10R	Black Creek Aquifer	Dec-20	47.18	54.43	-7.25
PW-11	Black Creek Aquifer	Dec-20	38.66	40.57	-1.91
PW-12	Black Creek Aquifer	Dec-20	93.77	100.70	-6.93
PW-13	Black Creek Aquifer	Dec-20	117.22	117.30	-0.08
PW-14	Black Creek Aquifer	Dec-20	86.49	84.49	2.00
PW-15R	Black Creek Aquifer	Dec-20	67.05	77.63	-10.58
PZ-11	Perched Zone	Dec-20	141.57	130.84	10.73
PZ-13	Perched Zone	Dec-20	138.5	134.75	3.75
PZ-14	Perched Zone	Dec-20	136.36	138.10	-1.74
PZ-22	Black Creek Aquifer	Dec-20	44.7	43.02	1.68
PZ-24	Perched Zone	Dec-20	134.15	130.49	3.66
PZ-26	Perched Zone	Dec-20	136.97	132.63	4.34
PZ-27	Perched Zone	Dec-20	133.16	130.07	3.09
PZ-28	Perched Zone	Dec-20	135.47	127.78	7.69
PZ-29	Perched Zone	Dec-20	133.18	133.94	-0.76
PZ-31	Perched Zone	Dec-20	130.16	130.14	0.02

Table B.02: Calibration Results: Observed vs Model Predicted Hydraulic Head Data

Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
PZ-32	Perched Zone	Dec-20	132.92	138.25	-5.33
PZ-33	Perched Zone	Dec-20	132.67	126.76	5.91
PZ-34	Perched Zone	Dec-20	131.89	127.62	4.27
PZ-36	Perched Zone	Dec-20	132.64	130.52	2.12
PZ-37	Perched Zone	Dec-20	132.8	136.02	-3.22
PZ-38	Perched Zone	Dec-20	131.01	130.93	0.08
PZ-39	Perched Zone	Dec-20	134.26	135.43	-1.17
PZ-40	Perched Zone	Dec-20	134.5	137.68	-3.18
PZ-41	Perched Zone	Dec-20	134.86	132.79	2.07
PZ-42	Perched Zone	Dec-20	134.77	140.74	-5.97
PZ-43	Perched Zone	Dec-20	132.73	134.40	-1.67
PZ-44	Perched Zone	Dec-20	133.27	129.63	3.64
PZ-45	Perched Zone	Dec-20	133.19	135.67	-2.48
PZ-L	Perched Zone	Dec-20	117.82	115.81	2.01
SMW-01	Perched Zone	Dec-20	124.9	127.26	-2.36
SMW-02	Perched Zone	Dec-20	136.55	140.08	-3.53
SMW-02B	Perched Zone	Dec-20	89.2	89.69	-0.49
SMW-03B	Surficial Aquifer	Dec-20	93.84	100.72	-6.88
SMW-04B	Surficial Aquifer	Dec-20	103.26	100.42	2.84
SMW-05	Perched Zone	Dec-20	125.2	121.64	3.56
SMW-05P	Surficial Aquifer	Dec-20	105.5	106.23	-0.73
SMW-06	Perched Zone	Dec-20	125.92	126.41	-0.49
SMW-06B	Surficial Aquifer	Dec-20	103.22	102.07	1.15
SMW-07	Perched Zone	Dec-20	128.15	127.29	0.86
SMW-08	Perched Zone	Dec-20	116.82	119.40	-2.58
SMW-08B	Surficial Aquifer	Dec-20	108.26	106.71	1.55
SMW-09	Surficial Aquifer	Dec-20	85.91	71.65	14.26
SMW-10	Surficial Aquifer	Dec-20	47.37	53.70	-6.33
SMW-11	Surficial Aquifer	Dec-20	59.58	54.34	5.24
SMW-12	Black Creek Aquifer	Dec-20	36.01	38.88	-2.87

Notes:

ft - feet

Obs. - Observed

Calc. - Calculated

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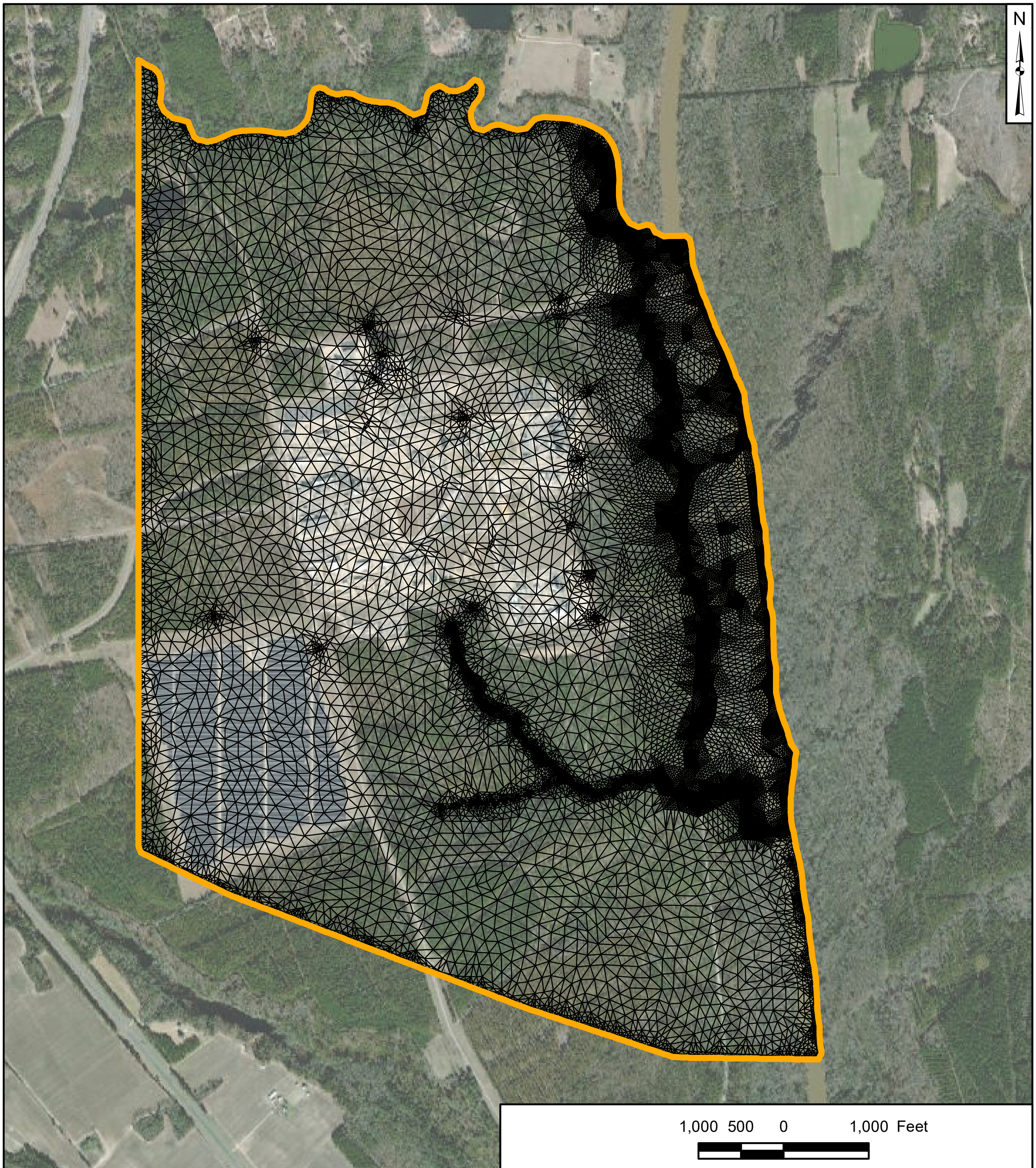
Figures



Legend

Model Boundary

Model Grid

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Model Domain and Grid

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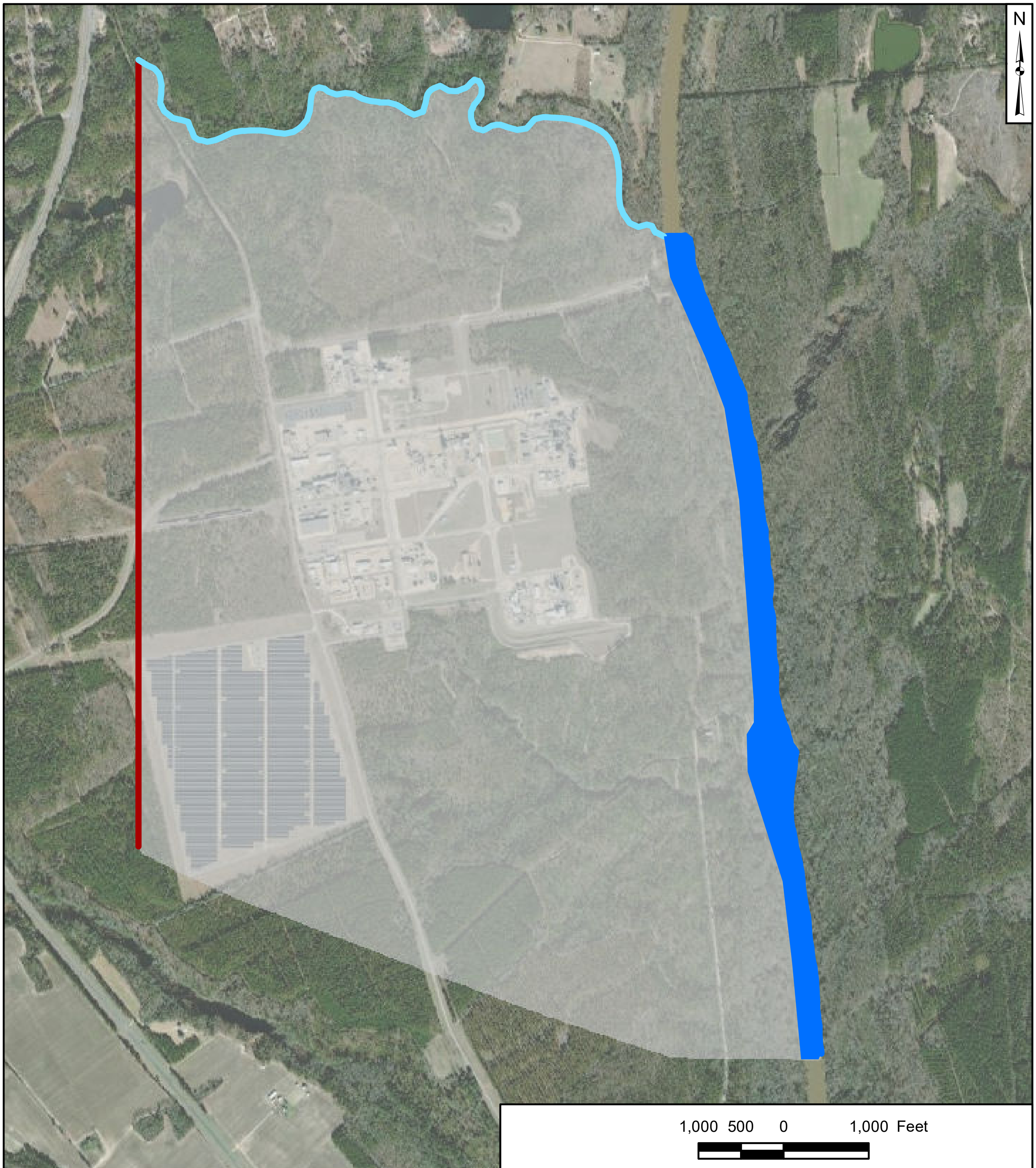
Figure

B.01



Legend

- Constant Head Boundary
- River Boundary (Willis Creek)
- River Boundary (Cape Fear)
- Recharge Area

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Model Boundary Conditions

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Figure

B.02

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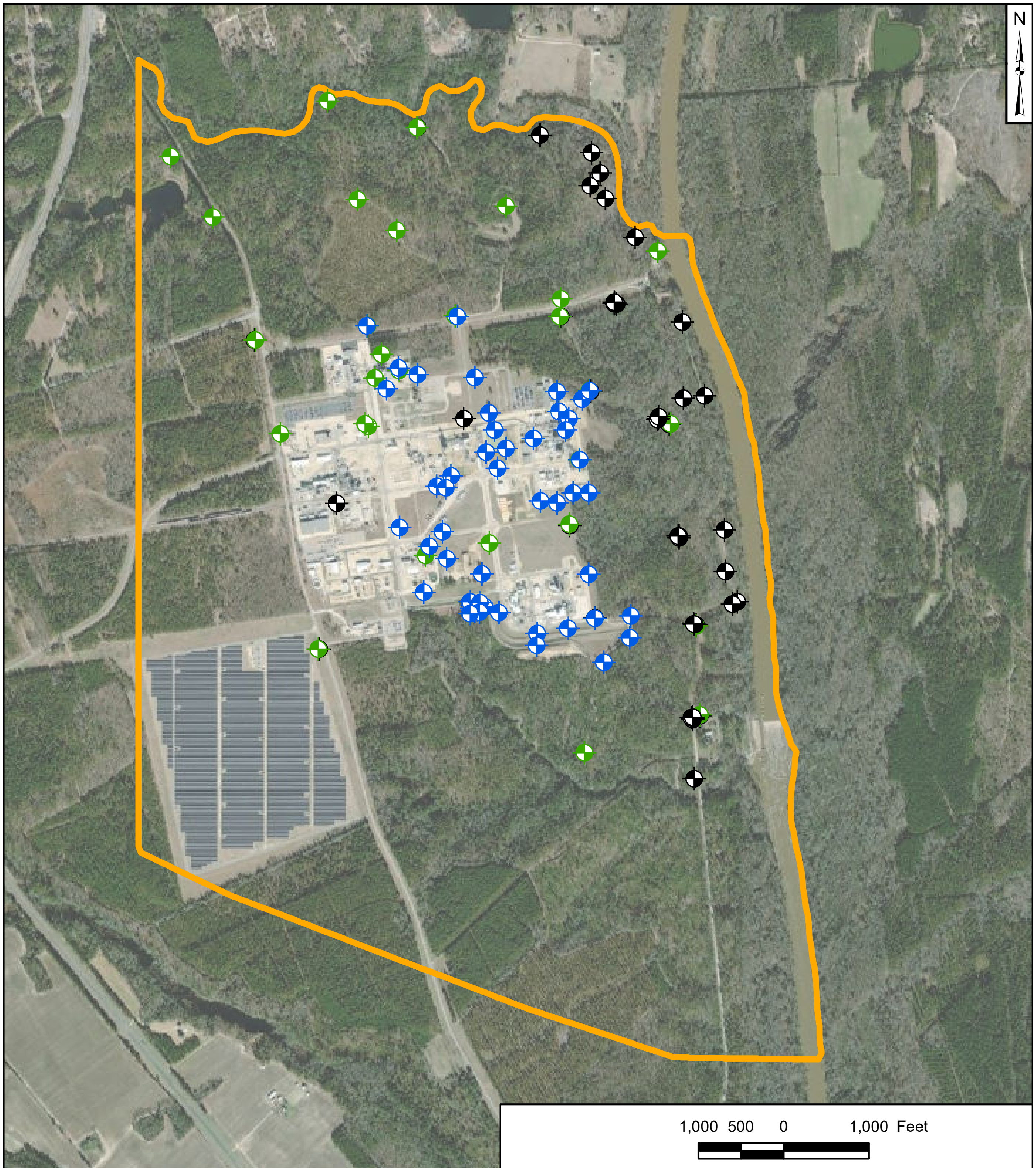

Legend

- Perched Zone
- Surficial Aquifer
- Black Creek Aquifer
- Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Model Calibration Targets

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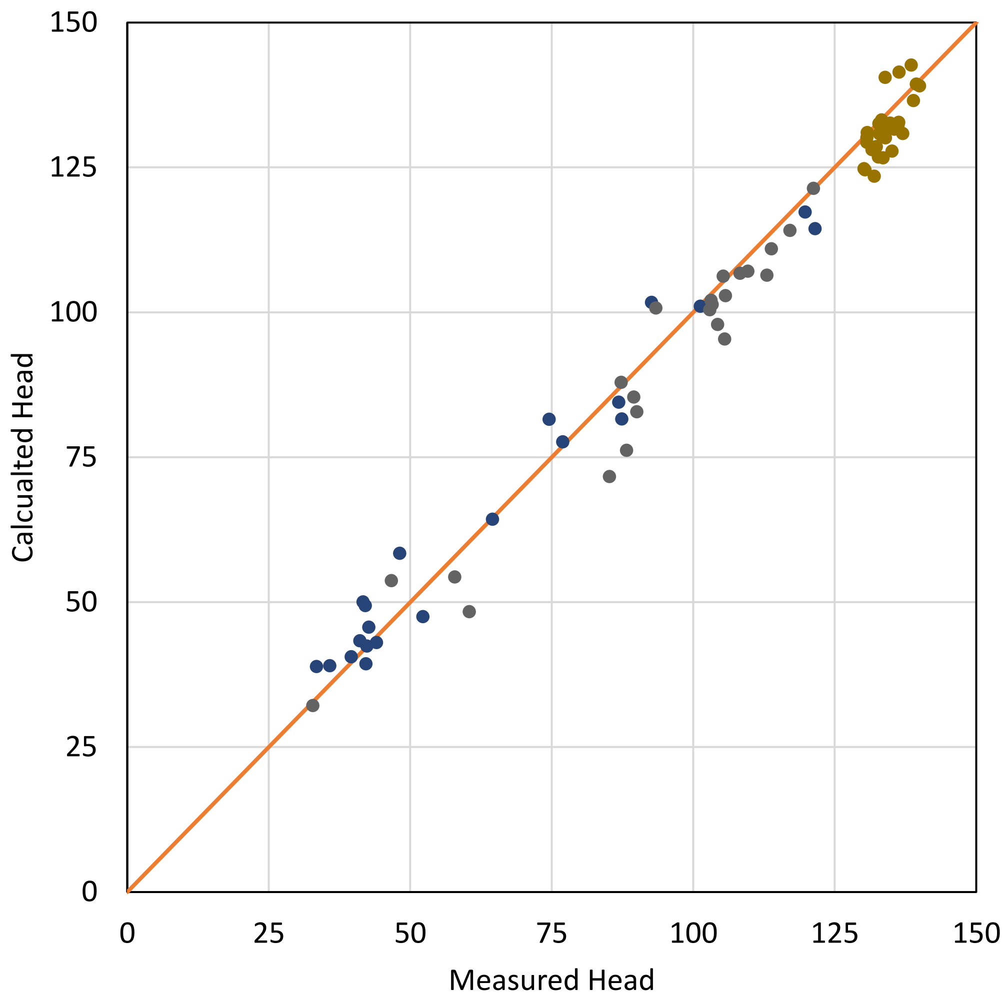
Figure

B.03



Calibration Results	
Correlation Coefficient	0.98
Flow Mass Balance	-0.78%
Normalized RMS	23.9% (Perched zone) 7.1% (Surficial Aquifer) 5.8% (Black Creek)
Maximum Residual	6.57 ft(Perched zone) 7.32 ft (Surficial Aquifer) 10.27 ft (Black Creek)
Minimum Residual	-8.52 ft(Perched zone) -13.54 ft (Surficial Aquifer) -0.007ft (Black Creek)
Residual Mean	-0.66 (ft)
Absolute Residual Mean	2.94 (ft)
Root Mean Square	4.34 ft(Perched zone) 6.24 ft (Surficial Aquifer) 5.08 ft (Black Creek)

Legend

- Black Creek Aquifer
- Surficial Aquifer
- Perched Zone

Flow Model Calibration Results

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Figure

B.04

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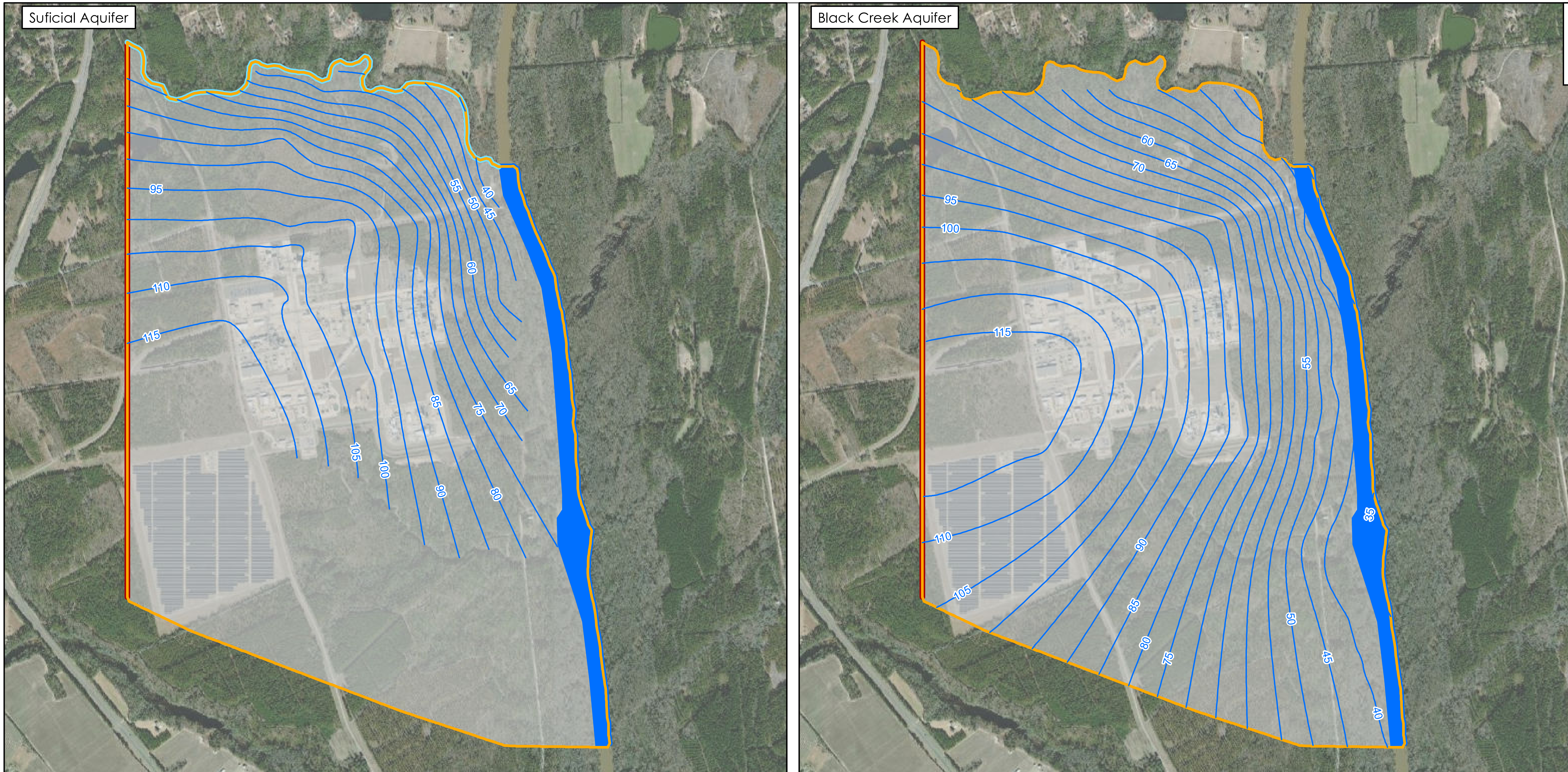

2,000 1,000 0 2,000 Feet

Legend

- Simulated Equipotentials (feet NAVD 88)
- Constant Head Boundary
- Constant Head River Boundary (Willis Creek)
- Transient Head River Boundary (Cape Fear)
- Recharge Area
- Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Flow Model Simulated Equipotentials - Base Model

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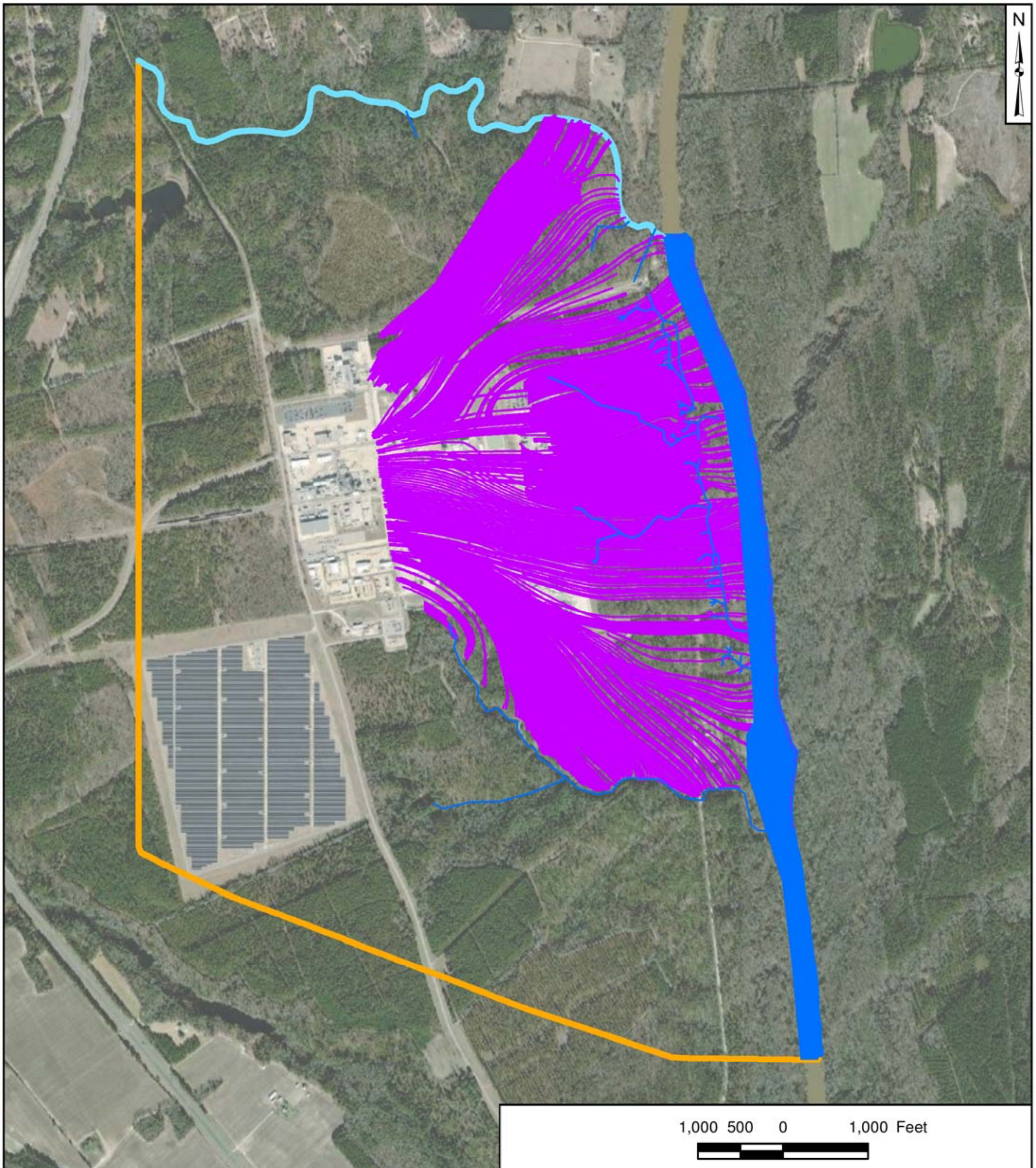
Figure **B.05**



Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 1 - Particle Tracking from Plant Area Ambient Conditions

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Figure **B.06**

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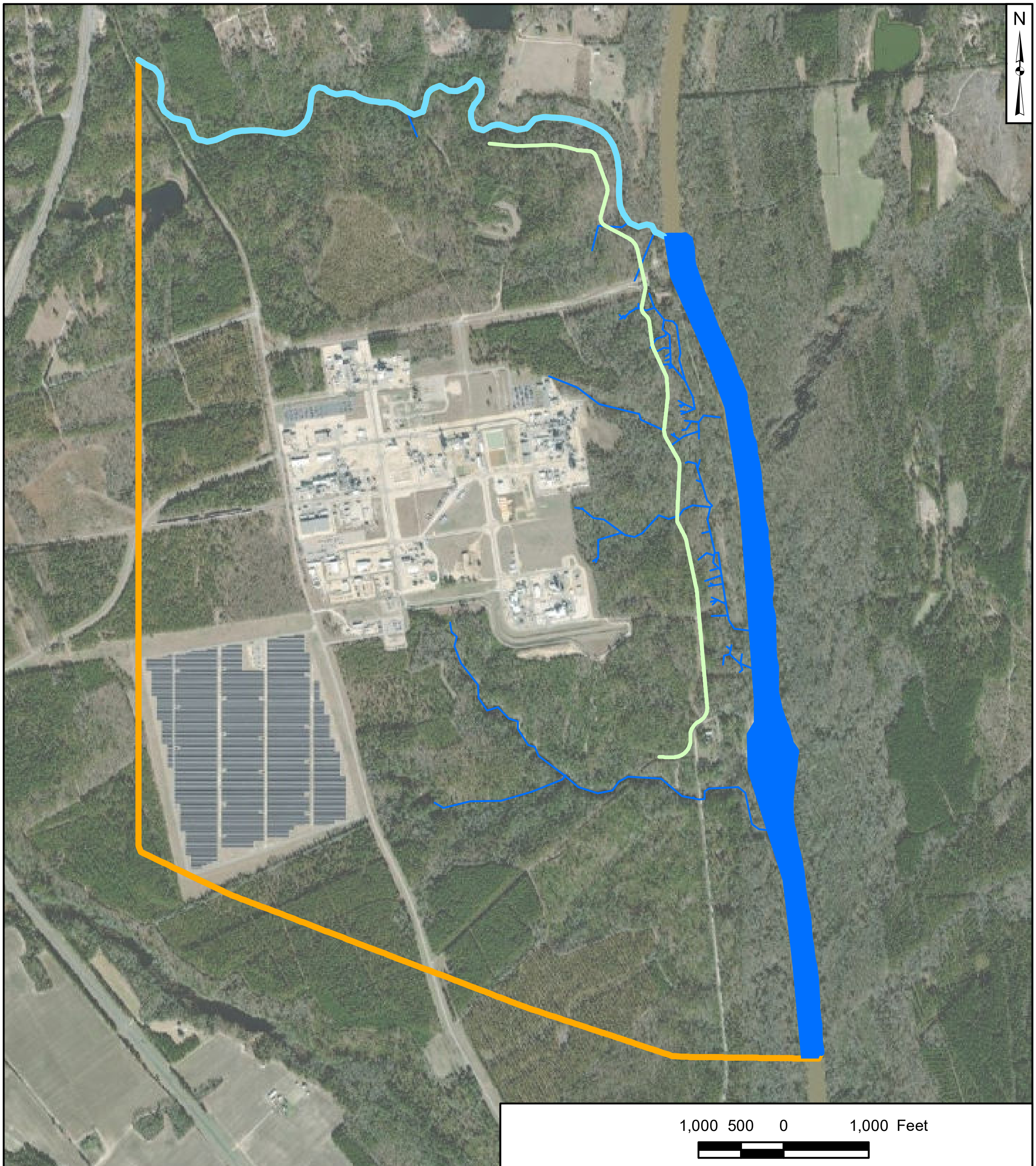

Legend

- Barrier Wall
- River Boundary (Willis Creek)
- River Boundary (Cape Fear)
- Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 2 – Vertical Barrier Remedial Design

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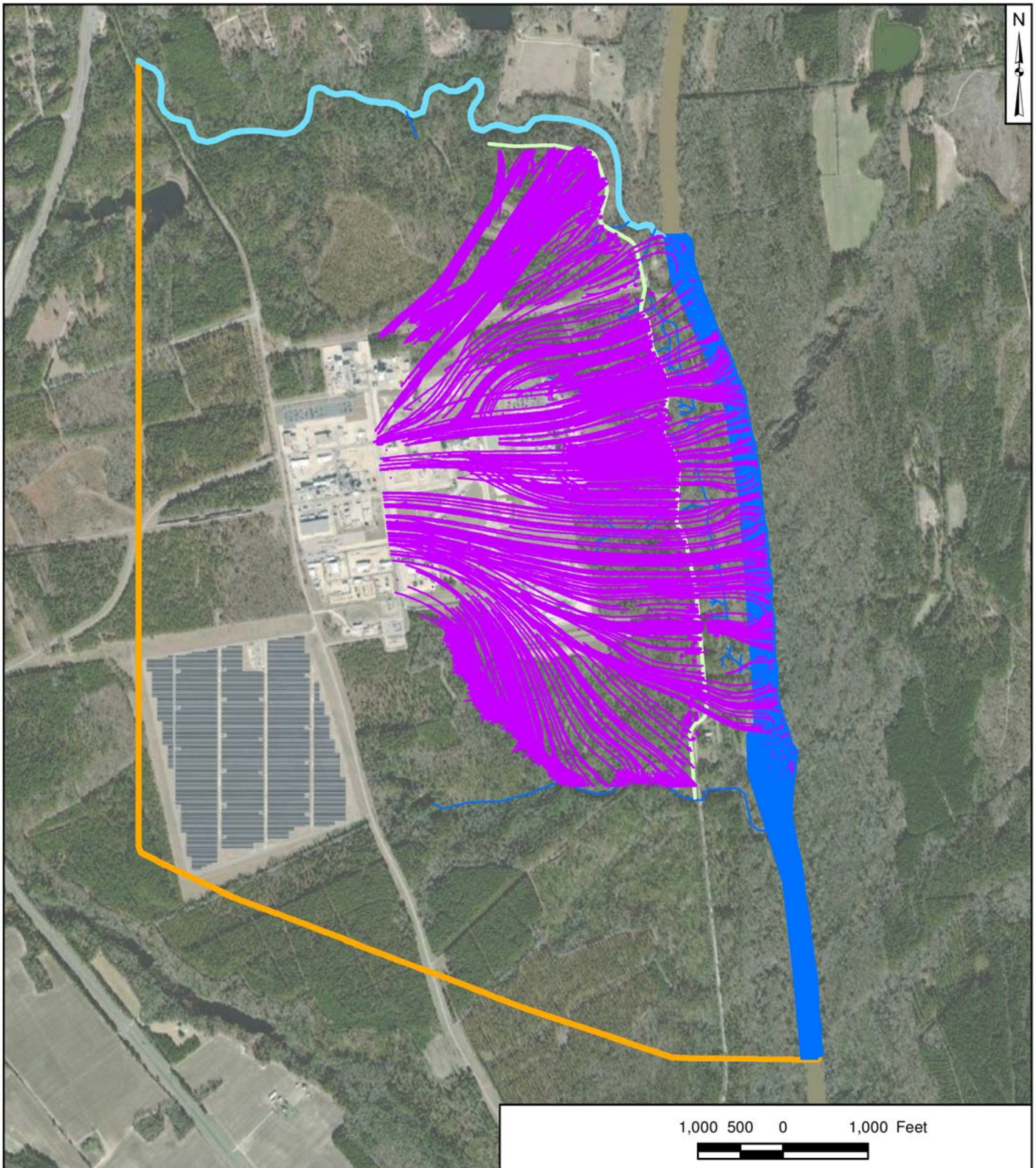
Figure **B.07**



Legend

- 5 year Particle Tracks
- Barrier Wall
- River Boundary (Willis Creek)
- River Boundary (Cape Fear)
- Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 2 - Particle Tracking from Plant Area - Vertical Barrier

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Figure **B.08**

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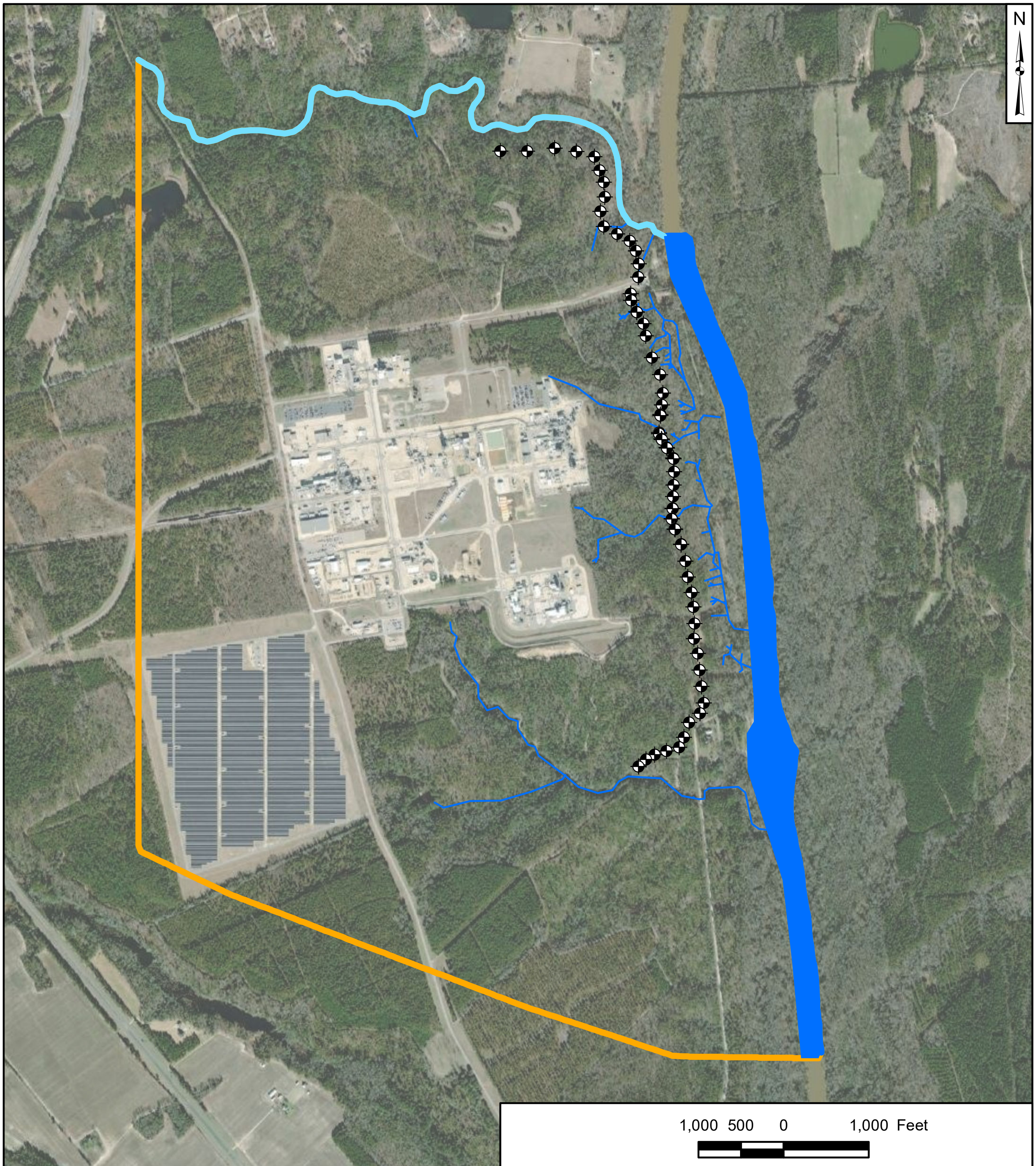


Legend

- Extraction Well Location
- River Boundary (Willis Creek)
- River Boundary (Cape Fear)
- Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 3 – Hydraulic Barrier Remedial Design

Chemours Fayetteville Works, North Carolina

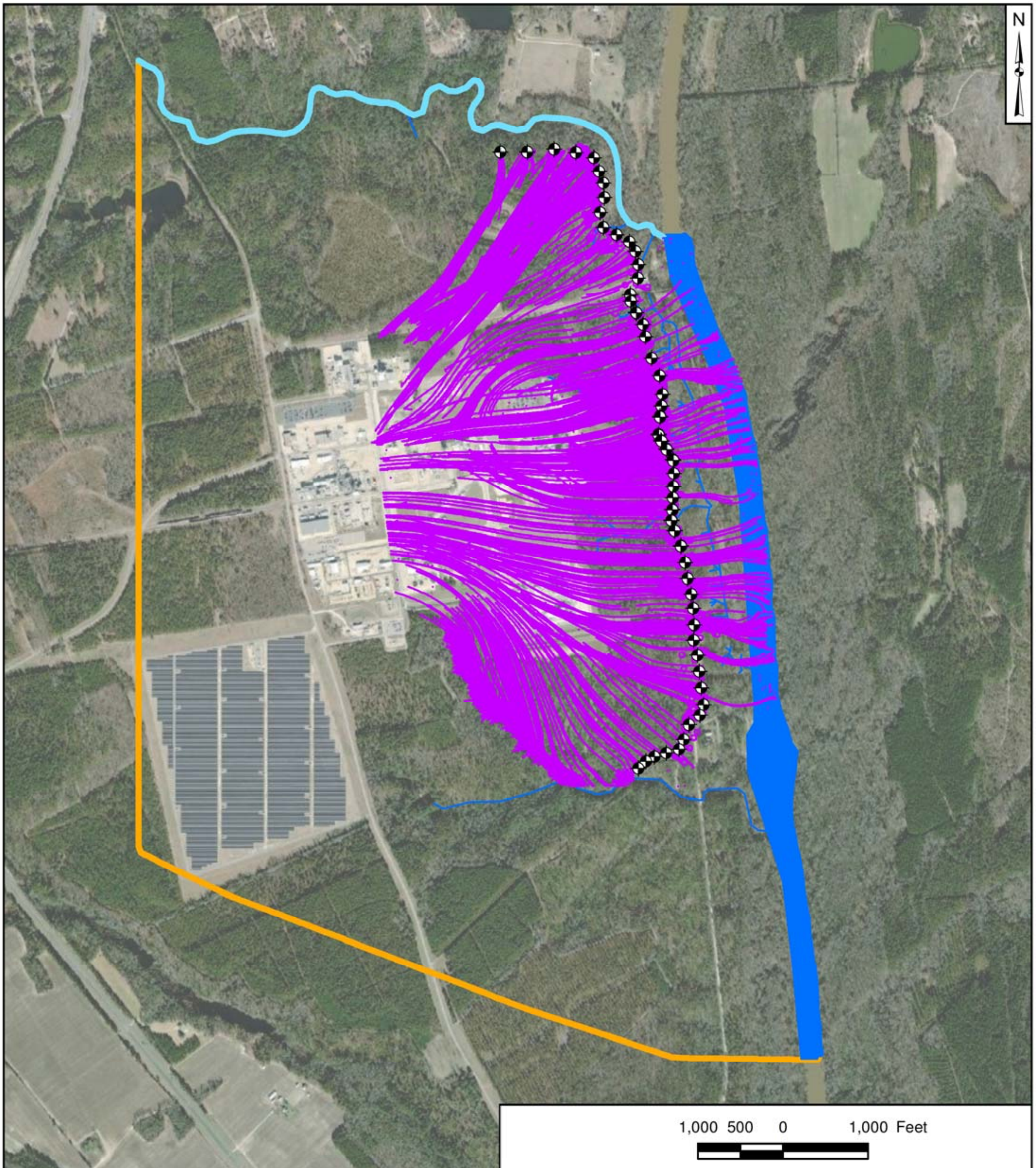
Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Raleigh | August 2021

Figure

B.09



Legend

River Boundary (Willis Creek)

River Boundary (Cape Fear)

Model Boundary

Notes

1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 3 - Particle Tracking from Plant Area – Hydraulic Barrier

Chemours Fayetteville Works, North Carolina

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Figure **B.10**

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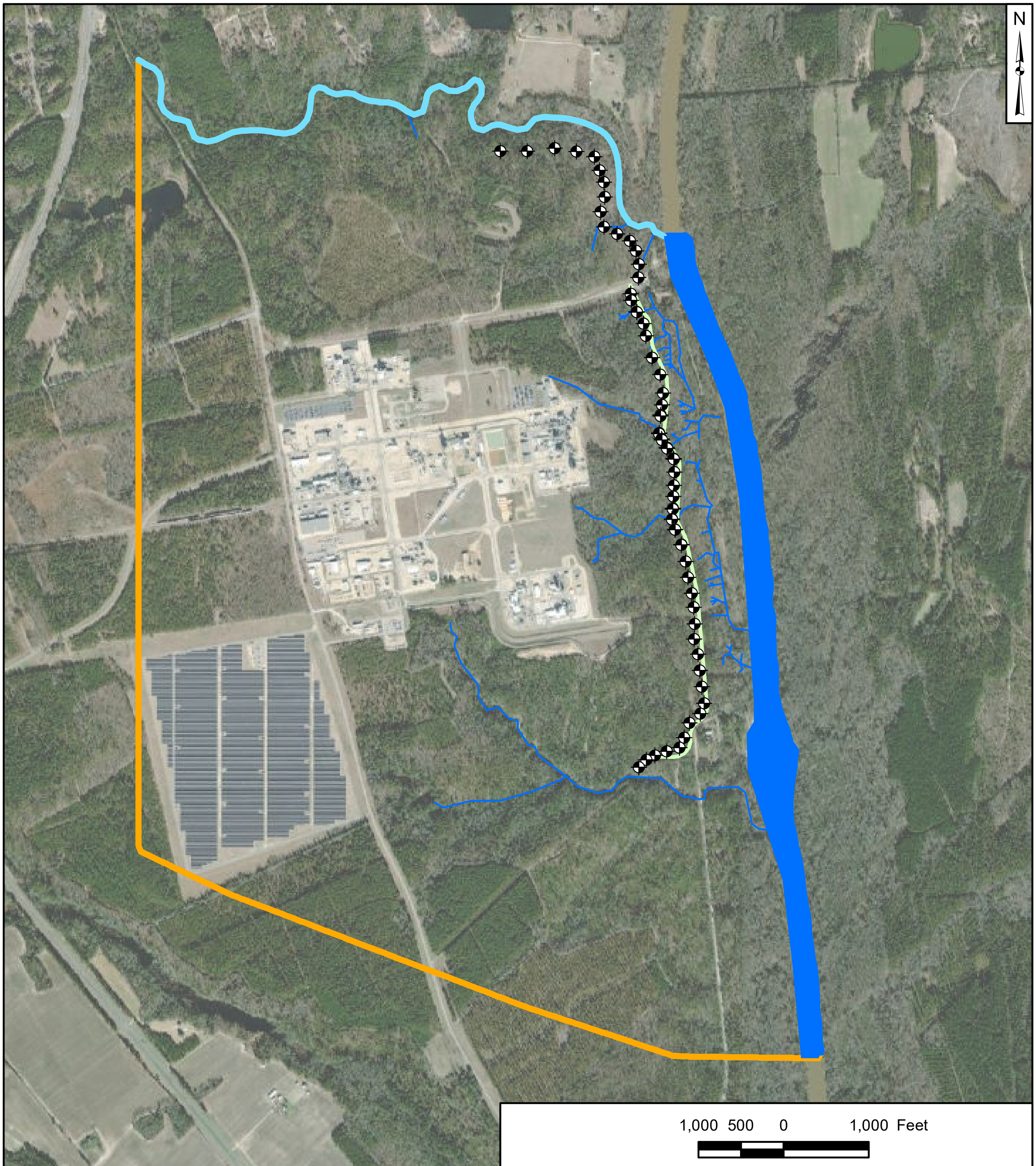

Legend

- Extraction Well Location
- Barrier Wall
- River Boundary (Willis Creek)
- River Boundary (Cape Fear)
- Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 4 – Vertical and Hydraulic Remedial Design

Chemours Fayetteville Works, North Carolina

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
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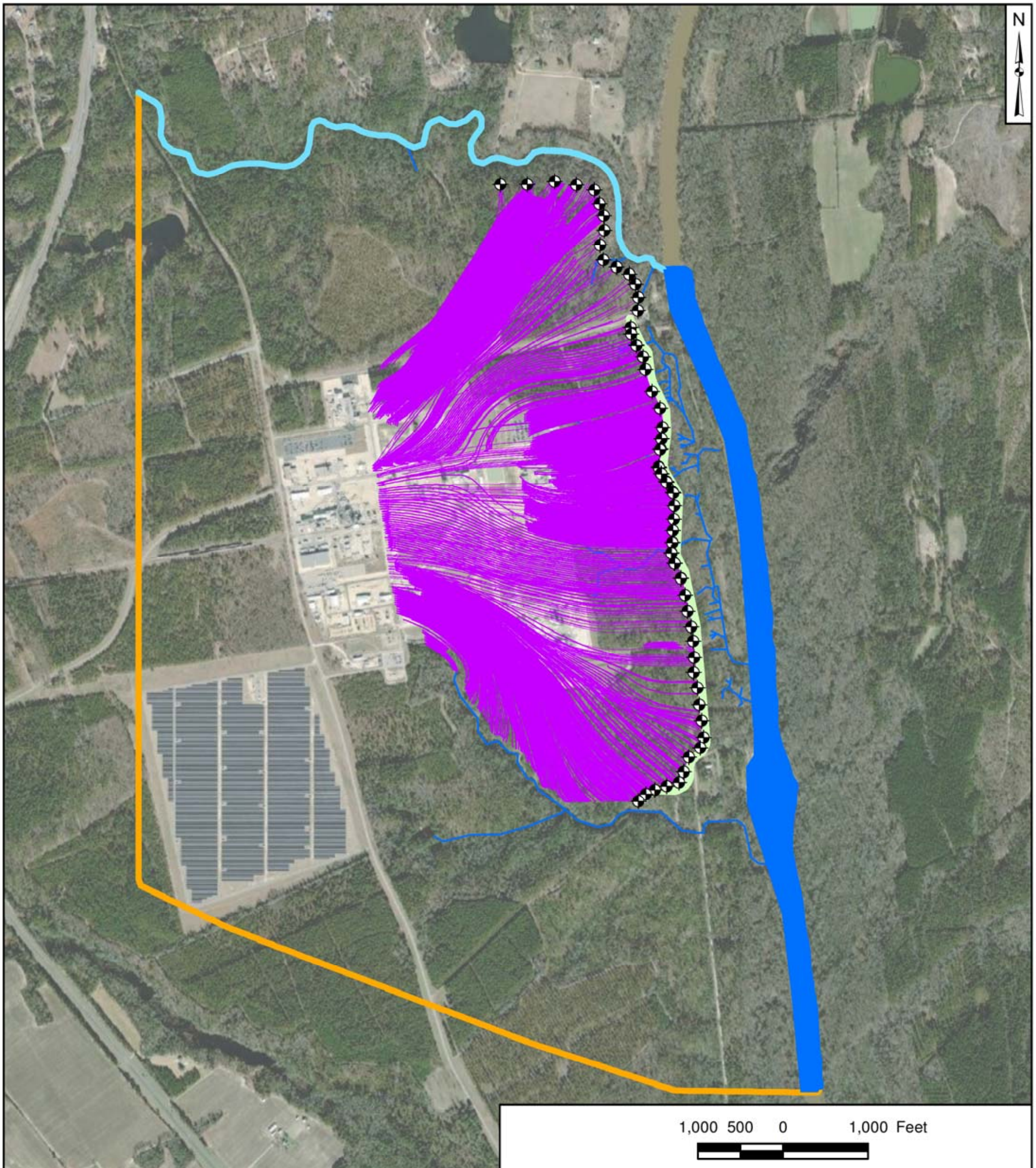
Figure **B.11**



Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 4 - Particle Tracking from Plant Area – Vertical and Hydraulic Barrier

Chemours Fayetteville Works, North Carolina

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Figure **B.12**

Raleigh | August 2021

BARRIER WALL AND GROUNDWATER EXTRACTION AND TREATMENT SYSTEM:

EX-SITU CAPTURE REMEDY REVISED CONCEPTUAL DESIGN

Chemours Fayetteville Works

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December 2021

TABLE OF CONTENTS

LIST OF TABLES

ATTACHMENTS

1 INTRODUCTION AND OBJECTIVES

The site for the proposed Barrier Wall and Groundwater Extraction System project is located at the existing Chemours Fayetteville Works facility located at 22828 NC Highway 87 in Fayetteville, North Carolina.

At the Chemours Fayetteville Works facility there are four on-site Seeps (A through D) with identified discharges into the nearby Cape Fear River. The seeps are currently being collected in in-situ flow-through cells to reduce loadings from the seeps to the Cape Fear River pursuant to Consent Order Paragraph 12 Addendum (COA) paragraph 2(a). Under the COA, the Long-Term Seep Remediation Objective is to reduce the total annual mass loading of PFAS (as measured by indicator parameters) to the Cape Fear River from Seeps A through D by: (i) during dry weather flow, reducing total mass by at least 99%; (ii) during dry weather flow and following rain events of 0.5 inches or less, reduce total mass loading by at least 95%; and (iii) for any seep that daylights upgradient of the Barrier Wall, capture total dry weather flow plus rain events up to 0.5 inches in a 24-hour period upgradient of the Barrier Wall and treat PFAS (as measured by indicator parameters) with a removal efficiency of at least 99%.

The purpose of this document is to outline the conceptual design methods for the collection of dry weather and 0.5-inch or less rain event flows from four seeps that daylight upgradient of the Barrier Wall: Seep A, a Seep A tributary, Seep B, and a Willis Creek tributary. The document also describes transportation of the collected water to the on-site water treatment plant. The following sections of this document and the supporting figures outline the design basis, capture basis, implementation, and verification methods utilized for this portion of the design.

2 SEEPS CAPTURE REMEDY DESIGN

Per the COA, the seep remedy at the sites of seeps designated Seep A and Seep B will consist of the ex-situ capture of dry weather baseflow and rain events up to one-half inch in a 24-hour period. Based on topography and the observed seeps on site, the Seep A flow and capture system is separated into two seeps designated as Seep A and Seep A tributary. Dry weather baseflow will also be collected from the Willis Creek tributary seep and from seven “weeps” that daylight upgradient of the Barrier Wall.

The seep remedy was developed based on flume data and catchment modeling prepared by Geosyntec Consultants of NC, P.C. (Geosyntec). The tables outlining the flows used for the design are included below.

Table 1: Hydraulic Loading from Dry Weather Flow

Channel	Dry Weather Flow Rate (gpm)
Willis Creek Tributary	39
Seep A Tributary	19
Seep A	31
Seep B	130
Weeps (7 total)	12 (each)

Table 2: Hydraulic Loading from Stormflow (0.5" event in 24 hours)

Channel	Stormflow Volume (gallons)
Willis Creek Tributary	--
Seep A Tributary	26,000
Seep A	110,000
Seep B	46,000
Weeps (6 total)	--

The remaining sections of this document discuss the basis for the design, the collection, storage, conveyance, and solid control and maintenance requirements for the Ex-Situ Capture design.

2.1 Seep Capture Basis of Design

Conceptual ex-situ capture systems for both Seep A and B were described in the 60 percent design submittal pursuant to the COA. In the 60 percent design systems, the seeps were captured and diverted to a series of storage ponds located near the seep collection system. The ponds were designed to smooth the peak flows to the water treatment plant while also settling solids from the seep waters very near their collection points.

Subsequent to the 60 percent design submittal, the flow rates have been refined using new information and the design has been modified to reduce the size of the ponds at the seep locations while maintaining the simultaneous benefits of the equalization of flows and solids management before the water reaches the treatment plant. Additional dry weather flows from the Willis Creek Tributary and seven "weeps" daylighting above the Barrier Wall have also been included in the revised design.

Based on experience at the existing treatment plant at Outfall OO3, the ½" rainfall flow is expected to be the most sediment laden component of the proposed network. To allow for TSS control, the dry weather baseflow and stormflow will be pumped to a single surge pond prior to entering the water treatment plant. The single surge pond functions similar to the original design but combines all captured flow into one surge basin instead of individual basins at each capture location.

2.1.1 Seep Capture

In the revised design, the seeps will still be collected in existing topographic channels or adjacent low-lying areas, but the method of collection has changed to account for the topography of each location.

Based on the topography and the relatively small flows, dry weather flow from the Willis Creek Tributary and the seven surficial weeps will be collected in structures and pumped directly to the lined surge pond.

At the Seep A Tributary and Seep B locations, the lined basin has been located and graded such that the dry weather flow and stormflow will flow directly into the small basin located at each location before being conveyed to the surge pond.

The flows from Seep A manifest from two drainage areas that currently (before the barrier wall) convene into one collectable seep near the location of the temporary collection system. Once the barrier wall is installed, the flows from the two areas will manifest separately but close together so the revised design collects the north side of the Seep A area and conveys it via actuated sluice gate into the lined Seep A basin located further to the south (Sheet SC-0.3). Once both flows are collected into the Seep A basin near the Barrier Wall, the water is conveyed to the surge pond and ultimately to the water treatment plant.

2.1.2 Collected Water Conveyance

A series of pumps will be utilized to transport the dry weather flow and storm flow from the individual collection locations to the large surge pond. The pump stations will provide a steady/known flow to the surge pond via a force main system. Each seep (A and B, A tributary) will include a pump station. The pump station will be sized to function with the surge pond of each seep. A pump station will also be present at the Willis Creek feature.

The purpose of the single large surge pond is to replace the functionality (solids reduction and consistent flow rates to the treatment plant) of the original design settling basins. The combination of peak storm flow attenuation at the site of collection and the large surge pond provides multiple layers of surge protection for the water treatment system that is also handling flows from other sources. The Schematic Flow Diagram is shown on Figure SC-0.2.

2.2 Maintenance

As with all systems, general maintenance will be required. A summary of expected weekly inspections and maintenance is listed below:

- Inspect trash rack system at Seep A
- Remove all material from pipe guard grates (debris, leaves, limbs, sticks, etc.)
- Inspect base flow collection structures at Willis Creek Tributary and weeps including inlet grates. Remove any debris blocking the inlet grate.
- Measure sediment in each pond and record depths. Remove sediment, as necessary.
- Inspect pump stations and test each pump. Remove any collected solids.

In addition to the general maintenance listed above, the system shall be monitored during rainfall events to ensure proper operation.

3 SUMMARY AND CLOSING

The conceptual design of ex-situ seep capture is part of the overall Barrier Wall and Groundwater Extraction System planned to accomplish the requirements of the Consent Order Addendum with the State of North Carolina. Hydraulic modeling results and subsequent hydraulic loading information prepared by Geosyntec Consultants of NC, P.C. have been utilized to prepare the conceptual design documents which are attached to this document.

The conceptual design plan is based on the collection system for each seep functioning as part of an equalization chain between the seep capture and the treatment plant. This storage chain function allows the flow to the treatment plant to be controlled. The design of the seep capture system will capture and store both the dry weather flow and the peak flow/volume from the ½" rainfall event.