Prepared for

Santee Cooper
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INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN – SLURRY POND 3 AND 4, REV. 1

WINYAH GENERATING STATION

Prepared by

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Project Number: GC8100

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INTRODUCTION

Winyah Generating Station (WGS or the Site) is a 1,260 megawatt coal-fired steam electric generating facility owned and operated by South Carolina Public Service Authority (Santee Cooper). The Site is situated between Pennyroyal and Turkey Creeks and is located in Georgetown, South Carolina. Coal combustion residuals (CCR) generated at WGS have been historically managed in existing CCR surface impoundments.

In response to the CCR Rule (40 Code of Federal Regulations (CFR) Part 257), South Carolina Public Service Authority (Santee Cooper) retained Geosyntec Consultants, Inc. (Geosyntec) to prepare documentation for existing surface impoundments (SIs) at WGS. Pursuant to Section 257.82(c) of the CCR Rule, Geosyntec prepared this Inflow Design Flood Control System Plan for the Slurry Pond 3 & 4 (Slurry Pond) at WGS.

Section § 257.82(a) of the Rule states that "*The owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR surface impoundment must design, construct, operate, and maintain an inflow design flood control system as specified in paragraphs (a)(1) and (2) of this section.*" The Preamble to the CCR Rule provides guidance on the documentation that should be provided for the Inflow Design Flood Control System Plan.

Section § 257.82(b) of the Rule states that the *"discharge from the CCR unit must be handled in accordance with the surface water requirements under §257.3-3"*. The discharge from the Slurry Pond 3 & 4 currently meets these requirements.

The inflow design flood control system for the Slurry Pond at the Site consists of maintaining minimum operating freeboards for the SI. Justification and documentation of the adequacy of the inflow design flood control systems are presented in the sections below.

The work presented in this report was performed under the direction of Mr. Chris Jordan, P.E., of Geosyntec in accordance with §257.82(c).

SURFACE IMPOUNDMENT DESCRIPTION

The Slurry Pond, encompassing approximately 107.2 acres (ac), is situated near the northwest corner of the Site, directly adjacent to Pennyroyal Creek. The Slurry Pond is bounded by perimeter dikes which are approximately 30 feet (ft) in height to the north, 26 ft in height to the west, and 18 ft in height to the east (Thomas and Hutton, 2012). The Slurry Pond is separated from the West Ash Pond by a divider dike which forms the southern boundary of the Slurry Pond. Under the CCR Rule, the West Ash Pond is an inactive landfill. The original report published in 2016 was created using NGVD 29. This report was calculated using NAVD88. A conversion from NGVD 29 to NAVD88 is calculated by subtracting a foot from the NGVD29 elevations. A Site Map depicting the Slurry Pond boundary and hydraulic features associated with the Slurry Pond is provided in **Figure 1**.

Stormwater is collected in Detention Ponds No. 1 and No. 2 located along the outside perimeter of the Slurry Pond. These Detention Ponds were designed to manage the 25-year (yr), 24-hour (hr) storm event (Santee Cooper, 2004). Pump Station No. 2 receives water from Detention Pond No. 2 and discharges to the Slurry Pond. Detention Pond No. 2 is equipped with a spillway to Pennyroyal Creek which may only be activated during storm events greater than the 25 yr, 24 hr storm. Non-contact stormwater collected on top of the geosynthetic cover of the West Ash Pond gravity drains to the Slurry Pond through two (2) 36-inch (in.) diameter culverts. There is also an emergency spillway that hydraulically connects the Slurry Pond and West Ash Pond.

A Floating Pump Station equipped with two (2) Tsurumi GSZ-4-45-4 submersible pumps, installed in the Slurry Pond in 2015, normally conveys water from the Slurry Pond directly to the West Low Volume Waste Pond. The capacity of these pumps operating in parallel is 3,100 gallons per minute (gpm) at the maximum head, normal pool operating elevation of 19.6 NGVD 29 (18.6 ft NAVD 88) when pumping directly to the West Low Volume Waste Pond constructed as part of the CCR project updates. Piping is valved such that the Floating Pump Station may convey water to the Pump Station No. 1 sump located immediately east of the Slurry Pond. Pump Station No. 1 conveys water to the West Low Volume Waste Pond to be further treated prior to discharging in the Cooling Pond.

CATCHMENT AREAS AND DESIGN STORM EVENT

The contributing watershed areas for the West Ash Pond and Slurry Pond are 64.4 ac and 107.2 ac, respectively. The impoundment is surrounded on all sides by a raised perimeter dike, which limits the stormwater run-on to that generated within the footprint of the pond itself. As discussed previously, the only other inflows to the Slurry Pond is the non-contact stormwater from the adjacent West Ash Pond and pumped flow from Detention Pond No 2. These areas were delineated using the dike crests to correspond to the ponds' footprints. A description of drainage areas is included in the Hydrologic and Hydraulic Analysis report, provided in Appendix A. Since the Slurry Pond is classified as a high hazard potential surface impoundment (Geosyntec, 2016), the inflow design flood is the Probable Maximum Flood (PMF).

STORAGE CAPACITIES

The available stormwater storage volume in the Slurry Pond between elevations 11 ft (pond bottom per bathymetric survey) and 34.67 ft NAVD 88 was calculated by developing an area-volume curve based on topographic and bathymetric data (McKim & Creed, 2021). The lowest available contour within the Slurry Pond is 12 ft NGVD 29 (11 ft NAVD 88). The minimum crest elevation of the Slurry Pond perimeter dikes is 35.67 ft NGVD 29 (34.67 ft NAVD 88) (Thomas and Hutton, 2016). The surface area of each contour was measured and tabulated at each elevation. Next, the available surface water volume in each depth increment was calculated by averaging the surface area of the upper and lower contour and multiplying by the change in elevation between each contour. The cumulative storage volume of Slurry Pond between these elevations is 629.7 ac-ft. The area-volume data are presented in **Appendix A**.

Similarly, the available stormwater storage volume of the West Ash Pond between elevations 26 ft and 37 ft National Geodetic Vertical Datum of 1929 (NGVD 29) (approximate crest) was calculated by developing an area-volume curve based on the closure design grading plan (Geosyntec, 2015). The lowest available contour within the West Ash Pond is 26 ft NGVD 29 (25 ft NAVD 88). The minimum crest elevation of the West Ash Pond perimeter dikes is 37 ft NGVD 29 (36 ft NAVD 88). The surface area of each contour was measured and tabulated at each elevation. The available surface water volume in each depth increment was calculated by averaging the surface area of the upper and lower contour and multiplying by the change in elevation between each contour. The cumulative storage volume of the West Ash Pond between these elevations is 98.9 acre-feet (ac-ft). The area-volume data are presented in Appendix A.

HYDROLOGIC AND HYDRAULIC ANALYSIS

Geosyntec performed a hydrologic and hydraulic analysis of the Slurry Pond. Stormwater runoff volumes and associated discharges to the Slurry Pond were modeled using *HydroCAD Version 10.0* software (HydroCAD, 2019). The model also assumed that the Floating Pump Station is non-operational due to temporary loss of power during the PMF storm event. Appendix A presents the Hydrologic and Hydraulic analysis report and documents assumptions, rainfall abstractions, and drainage areas.

ROUTING RESULTS

The *HydroCAD* model results are presented in Appendix A. During the PMF storm event, the Slurry Pond and the West Ash Pond will effectively operate as a single pond as the intermediary culverts and spillway allow flow between both areas. The resulting peak water surface elevation at the Slurry Pond and West Ash Pond during the PMF storm event based on the hydraulic and hydrologic analysis are shown in **Table 2**. The Slurry Pond will effectively contain the PMF storm event and maintain a freeboard of 1.6 feet. Detailed results are presented in Appendix A.

Under peak design flood inflows, the outflow from the Slurry Pond 3&4 is controlled through the existing riser structure that ultimately discharges through an NPDES outlet. The inflow design flood elevations do not overtop the dike crest and all water is routed through engineered discharge devices located within the pond.

The results from this analysis show that the inflow design flood control system adequately manages flow into the CCR unit during and following the peak discharge of the inflow design flood as specified in the CCR Rule Section 257.83. All discharges from the Slurry Pond 3 & 4 ultimately are discharged through NPDES Outfall 002, thus complying with CCR Rule Section 257.82(b).

Table 2 – Peak Elevations and Freeboard

Event	***Slurry Pond***	
	Elevation (NAVD 88) (ft)	***Freeboard (ft)***
Normal Operating Condition	18.6	16.1
PMF	33.06	1.61

CERTIFICATION

This inflow design flood control system plan meets the requirements of this section (§257.82 Hydrologic and hydraulic capacity requirements for CCR impoundments.) of the Code of Federal Regulations Title 40, Part 257, Subpart D, and was prepared in accordance with current practices and the standard of care exercised by scientists and engineers performing similar tasks in the field of civil engineering, and no other warranty is provided in connection therewith. The contents of this report are based solely on the observations of the conditions observed by Geosyntec personnel and information provided to Geosyntec by Santee Cooper. Consistent with applicable professional standards of care, our opinions and recommendations were based in part on data furnished by others. Although we were not able to independently verify such data, we did evaluate it to determine whether it was consistent with other information that we developed in the course of our performance of the scope of services.

Certified by: Chris Jordan Digitally signed by Chris Jordan Date: 2021.11.10 08:02:27 -05'00'

Date

Chris Jordan, P.E. South Carolina License Number
Project Engineer

Geosyntec consultants

REFERENCES

Geosyntec. (2014). *Mitigation Drawdown Design for Increased Seismic Stability, Slurry Pond 3 & 4 and West Ash Pond.*

Geosyntec. (2015). *Wastewater Construction Permit Request - Phase I West Ash Pond Closure.*

Geosyntec. (2016). *Hazard Potential Classification Assessment - Slurry Pond 3 and 4.*

HydroCAD. (2019). *HydroCAD Stormwater Modeling.* HydroCAD Software Solutions, LLC.

McKim & Creed. (2021). *Topographic Survey for Winyah Generating Station - Slurry Pond.*

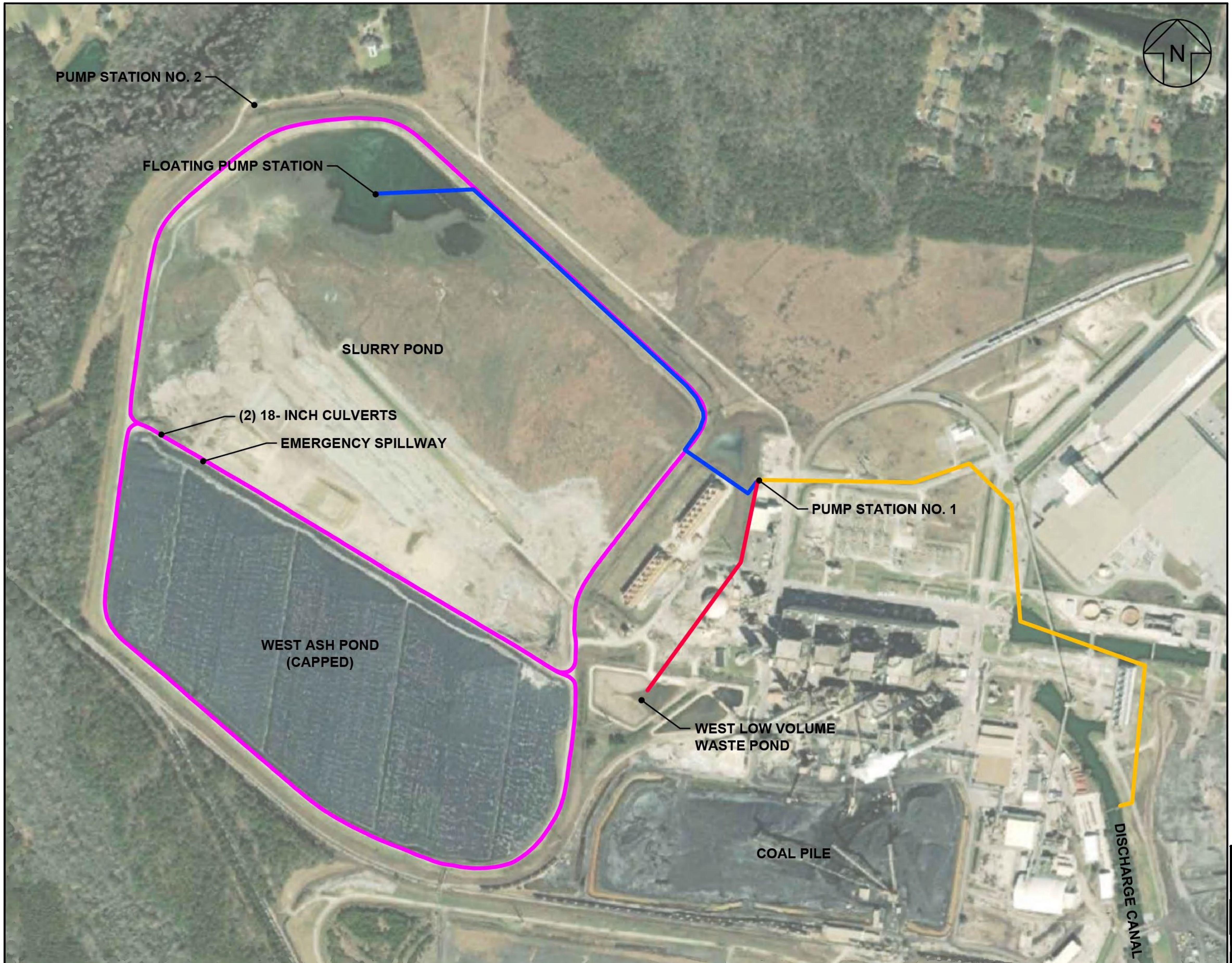
Santee Cooper. (2004). *Pump Station Design Report - Winyah Generating Station Redirect Drainage Project.*

Santee Cooper. (2013). *Inter-Office Communication - Winyah Generating Station Construction Report, Hydrologic Remediation of West Ash Pond and Unit 3 & 4 Slurry Pond.*

Thomas and Hutton. (2012). *Topographic Survey of a Portion of Santee Cooper Winyah Generating Station.*

Thomas and Hutton. (2016). *Topographic Survey of the Dike Crests at Santee Cooper Winyah Generating Station.*

FIGURES



LEGEND

- POND BOUNDARY
- PIPE ALIGNMENT FROM FLOATING PUMP STATION TO PUMP STATION NO. 1
- PIPE ALIGNMENT FROM PUMP STATION NO. 1 TO WEST LOW VOLUME WASTE POND
- HISTORIC PIPE ALIGNMENT FROM PUMP STATION NO. 1 TO DISCHARGE CANAL

NOTE 1: AERIAL IMAGERY TAKEN FROM ESRI, DATED 2019.

0 500' 1000'
SCALE IN FEET

WINYAH GENERATING STATION
SITE MAP

Geosyntec consultants

FIGURE 1

PROJECT NO: GC8100 | OCTOBER 2021

K:_PROJECTS\S\SANTEE COOPER\SANTEE COOPER-WINYAH\FIGURES\GC8100 - 2021 5 YEAR CCR REQUIREMENTS\SP34 H&H\F1 - SITE MAP

APPENDIX A

Hydrologic and Hydraulic Analysis – Slurry Pond

Written by:	Chris Jordan	Date:	10/7/21	Reviewed by:	A. Soroka	Date:	10/7/21
Client:	Santee Cooper	Project:	WGS SP 3&4 H&H	Project No.:	GC8100	Phase No.:	04

HYDROLOGIC AND HYDRAULIC ANALYSIS WINYAH GENERATING STATION, SLURRY POND 3+4, GEORGETOWN, SOUTH CAROLINA

1 PURPOSE AND BACKGROUND

Winyah Generating Station (WGS or the Site) is a coal-fired, electric generating facility located in Georgetown County, South Carolina. The Site is located between Pennyroyal and Turkey Creeks, tributaries to the Sampit River, and is approximately four miles southwest of Georgetown.

The purpose of this computation package is to evaluate the hydraulic capacity of Slurry Pond 3 and 4 (Slurry Pond) to support spillway capacity assessment requirements, static factor of safety analyses, and hazard rankings required by the United States Environmental Protection Agency's (USEPA's) Coal Combustion Residuals (CCR) Rule. The Slurry Pond is regulated by the CCR Rule as an existing CCR surface impoundment. Under the CCR Rule, a high hazard ranking classification is associated with the Probable Maximum Flood (PMF) precipitation event. Since the Slurry Pond is a high hazard surface impoundment, the PMF storm frequency is analyzed herein.

The Slurry Pond, encompassing approximately 107 acres (ac), is situated near the northwest corner of the Site, directly adjacent to Pennyroyal Creek. (Note that 107 ac is the area contained within the dike crest boundary. The area of the limits of CCR is slightly less at approximately 106 ac.) The Slurry Pond is bounded by perimeter dikes which are approximately 30 feet (ft) in height to the north, 26 ft in height to the west, and 18 ft in height to the east (Thomas and Hutton, 2012). The Slurry Pond is separated from the West Ash Pond by a divider dike which forms the southern boundary of the Slurry Pond. A Site Map depicting the Slurry Pond boundary and hydraulic features associated with the Slurry Pond is provided in **Figure 1**.

A Floating Pump Station, installed in the Slurry Pond in 2015, normally conveys water from the Slurry Pond directly to the West Low Volume Waste Pond. Piping is valved such that the Floating Pump Station may convey water to the Pump Station No. 1 sump located immediately east of the Slurry Pond. Pump Station No. 1 conveys to the West Low Volume Waste Pond for further treatment prior to discharge to the Cooling Pond.

Stormwater is collected in Detention Ponds No. 1 and No. 2 located along the outside perimeter of the Slurry Pond. These Detention Ponds were designed to manage the 25-yr, 24-hour (hr) storm event (Santee Cooper, 2004). Pump Station No. 1 (labeled in **Figure 1**) receives water from

Detention Pond No. 1, as well as Cooling Tower blowdown, and discharges to the West Low Volume Waste Pond. Detention Pond No. 2 is equipped with a spillway to Pennyroyal Creek which may only be activated during storm events greater than the 25 yr, 24 hr storm. Pump station No. 2 recives water from Detention Pond No. 2 and discharges to the Slurry Pond.

The West Ash Pond gravity drains to the Slurry Pond through two (2) 36-inch (in.) diameter culverts. There is also an emergency spillway that hydraulically connects the Slurry Pond and West Ash Pond. The West Ash Pond is not subject to the CCR Rule, because it was capped before the effective date of the CCR Rule. This package also evaluates the capacity of the West Ash Pond due to the hydraulic connectivity of the Slurry Pond 3&4.

2 METHODOLOGY AND INPUT PARAMETERS

Stormwater runoff volumes and associated discharges to the Slurry Pond were modeled using *HydroCAD Version 10.0* software (HydroCAD, 2019). *HydroCAD* utilizes frequency-based precipitation events, in conjunction with watershed properties, to calculate peak runoff by several accepted methods. The Soil Conservation Service (SCS) Technical Release 20 (TR-20) method was applied in *HydroCAD* to calculate stormwater runoff volumes (SCS, 1982).

The following parameters and assumptions were selected for calculating stormwater runoff volumes to the Slurry Pond.

Rainfall

The 72-hour (hr) duration precipitation event was used in this analysis. The rainfall depth corresponding to the 72-hr duration precipitation event for the PMF for the Site is 51 inches (in.) (NOAA, 1980). The design storm hydrograph was developed using SCS Type III rainfall distribution and was directly input to the *HydroCAD* model.

Drainage Areas and Curve Numbers

The contributing watershed area for the Slurry Pond is 107.2 ac (McKim and Creed, 2021). The area was delineated using the dike crests to correspond to the pond's direct drainage area. The pond was assigned a curve number (CN) based on guidance provided in Technical Release 55 (TR-55) (SCS, 1986) representing the type of ground cover in that area. The Slurry Pond was assumed to be approximately 86% ash (CN = 86) and 14% water (CN = 100) (Weighted CN = 88). The contributing watershed area and CN is summarized in **Table 1** and was directly input into the *HydroCAD* model.

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Times of Concentration Calculations

The time of concentration represents the time required for runoff to flow from the most hydraulically remote point of the drainage area to the point under investigation. The flow path from the most remote point is characterized entirely as open channel flow (shown in **Figure 2**). Open channel flow travel times were calculated as:

$$T_t = \frac{L}{V}$$

where: T_t = travel time (seconds [s]);

L = flow length (ft); and

V = average velocity (feet per second [ft/s]).

Open channel flow velocities were calculated using Manning's equation. The average velocities were computed assuming bank-full elevation as:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

where: V = average velocity (ft/s);

n = Manning's roughness coefficient;

R = hydraulic radius (ft); and

S = slope of hydraulic grade line (or longitudinal channel slope for normal flow conditions) (feet per feet [ft/ft]).

A Manning's roughness coefficient of 0.013 was used to represent open channel flow across the geomembrane cover for the West Ash Pond. The open channels were designed with trapezoidal configurations per Phase I of the West Ash Pond closure plan (Geosyntec, 2015). The hydraulic radii were computed as:

$$R = \frac{A}{P_w}$$

where: R = hydraulic radius (ft);

A = cross sectional flow area (square feet [sq ft]); and

P_w = wetted perimeter (ft).

The cross sectional flow areas were calculated by:

$$A = (B + DZ)D$$

where: A = cross sectional flow area (sq ft);

B = bottom width of the channel (ft);

D = depth of the channel (ft); and

Z = side slope of the channel (horizontal run divided by vertical rise) (ft/ft).

The wetted perimeters were calculated by:

$$P_w = B + 2D\sqrt{1 + Z^2}$$

where: P_w = wetted perimeter (ft);

B = bottom width of the channel (ft);

D = depth of the channel (ft); and

Z = side slope of the channel (horizontal run divided by vertical rise (ft/ft).

The parameters used to describe open channel flow in the West Ash Pond are presented in **Table 2**. The computed times of concentration for the West Ash Pond channels are summarized in **Table 2**.

The flow path from the most remote point within the Slurry Pond is characterized by sheet flow, shallow concentrated flow, and channel flow (shown in **Figure 3**). *HydroCAD* applied the Overton and Meadows formulation to calculate travel time for sheet flow for distances less than 300 ft (NRCS, 2010):

$$T_t = \frac{0.007(n\mathrm{L})^{0.8}}{P_{2-24}^{0.5} S^{0.4}}$$

where: T_t = travel time for overland sheet flow (hr);

n = Manning's roughness coefficient for sheet flow (--);

L = flow length (ft);

$P_{2\text{-}24}$ = 2 yr, 24 hr rainfall (in.); and

S = slope of hydraulic grade line (or land slope) (ft/ft).

A Manning's roughness coefficient of 0.020 was used to represent sheet flow in the Slurry Pond. The sheet flow length was limited to 100 ft, because sheet flow beyond 100 ft typically transitions to shallow concentrated flow. The rainfall depth for the 2 yr, 24 hr frequency storm event is 4.38 in. (NOAA, 2021). The parameters used to model sheet flow within the Slurry Pond are shown in **Table 3**.

Shallow concentrated flow travel time was computed using the Upland Method (NRCS, 2010).

$$T_t = \frac{L}{V}$$

where: T_t = travel time (s);

L = flow length (ft); and

V = average velocity (ft/s).

The average velocity was computed using the following equation (NRCS, 2010).

$$V = K_v S^{0.5}$$

where: V = average velocity (ft/s);

K_v = velocity factor (ft/s); and

S = slope of hydraulic grade line (or land slope) (ft/ft).

A velocity factor of 16.1 ft/s, representing flow across an unpaved surface, was used to calculate shallow concentrated flow travel time within the Slurry Pond. The parameters used to describe shallow concentrated flow within the Slurry Pond are presented in **Table 2**.

Open channel flow within the Slurry Pond is characterized using the method previously described for open channel flow within the West Ash Pond. The open channel flow velocities were calculated using Manning's equation. A Manning's roughness coefficient of 0.020 was selected to represent open channel flow across the FGD residuals present within the Slurry Pond. The open channels were designed with trapezoidal configurations per Phase I of the West Ash Pond closure plan (Geosyntec, 2015). The parameters used to describe open channel flow within the Slurry Pond are presented in **Table 2**. The resulting times of concentration for sheet flow, shallow concentrated flow, and open channel flow are presented in **Table 2**.

Inflows

In the *HydroCAD* model, stormwater inflow generated from the West Ash Pond and Slurry Pond is modeled as Sub-Catchments 1S and 2S, respectively. Stormwater inflow generated from Sub-Catchment 1S is routed into Pond 3P (the West Ash Pond), while stormwater inflow generated from Sub-Catchment 2S flows into Pond 4P (the Slurry Pond). The *HydroCAD* model routing diagram is provided in **Appendix B**. While Pump Station No. 2 flows, this model simulates that Pump Station No. 2 will be shut off from operation during storm events larger than the 25-year flood event.

Storage Capacities

In *HydroCAD*, Ponds 3P and 4P model the available storage volumes within the West Ash Pond and Slurry Pond, respectively.

The available stormwater storage volume of the West Ash Pond between elevations 26 ft and 37 ft National Geodetic Vertical Datum of 1929 (NGVD 29) (approximate crest) was calculated by developing an area-volume curve based on the closure design grading plan (Geosyntec, 2015). The lowest available contour within the West Ash Pond is 26 ft NGVD 29. The minimum crest elevation of the West Ash Pond perimeter dikes is 37 ft NGVD 29. The surface area of each contour was measured and tabulated at each elevation. The available surface water volume in each depth increment was calculated by averaging the surface area of the upper and lower contour and multiplying by the change in elevation between each contour. The cumulative storage volume of the West Ash Pond between these elevations is 98.9 acre-feet (ac-ft). The area-volume data are presented in **Table 4**.

Similarly, the available stormwater storage volume in the Slurry Pond between elevations 12 ft (pond bottom per bathymetric survey) and 35.67 ft NGVD 29 was calculated by developing an area-volume curve based on topographic and bathymetric data (McKim & Creed, 2021; Thomas and Hutton, 2016; Thomas and Hutton, 2012). The lowest available contour within the Slurry Pond is 12 ft NGVD 29 (11 ft NAVD 88). The minimum crest elevation of the Slurry Pond perimeter dikes is 35.67 ft NGVD 29 (34.67ft NAVD 88) (Thomas and Hutton, 2016). The surface area of each contour was measured and tabulated at each elevation. Next, the available surface water volume in each depth increment was calculated by averaging the surface area of the upper and lower contour and multiplying by the change in elevation between each contour. The cumulative storage volume of Slurry Pond between these elevations is 629.7 ac-ft. Per the weekly inspection reports, the Slurry Pond is maintained at a normal operational pool elevation of 19.6 ft NGVD 29 (18.6 ft NGVD 88) by the Floating Pump Station. As a result, the starting elevation of Pond 4P is set to 19.6 ft NGVD 29 (18.6 ft NAVD 88). The area-volume data are presented in **Table 3**.

Outlet Structures

The outlet structures between the West Ash Pond to the Slurry Pond include two (2) 36 in. diameter smooth interior, corrugated exterior, high density polyethylene (HDPE) pipe culverts with upstream inverts at 25.96 and 25.90 ft NGVD 29 (24.96 and 24.90 NAVD 88) (Thomas and Hutton, 2016). An existing 200 ft wide spillway with an invert elevation of 36.25 ft NGVD 29 (35.25 NAVD 88) is provided in the divider dike (Santee Cooper, 2013). These outlet structures allow water to drain from the West Ash Pond to Slurry Pond.

The Slurry Pond is equipped with two (2) Tsurumi GSZ-4-45-4 submersible pumps, housed in the Floating Pump Station located over the deepest area of the Slurry Pond. The capacity of these pumps operating in parallel is 3,100 gallons per minute (gpm) at the maximum head, normal pool operating elevation of 19.6 ft NGVD 29 (18.6 NAVD88) when pumping directly to the West Low Volume Waste Pond (Geosyntec, 2014). Normally, the Floating Pump Station discharges directly to the West Low Volume Waste Pond. However, for this analysis, the Floating Pump Station is assumed to be nonoperational due to temporary loss of power during a large storm event.

3 RESULTS OF ANALYSES

The resulting peak water surface elevation and storage volume for the PMF storm event is shown in **Table 5**. The Slurry Pond will effectively contain the PMF storm event. This hydrologic and hydraulic analysis demonstrates that the Slurry Pond contains the 72-hr duration precipitation event for the PMF assuming the Slurry Pond is maintained at a normal operating elevation of 19.6 ft NGVD 29 (18.6 ft NAVD88).

4 REFERENCES

Geosyntec. (2014). *Mitigation Drawdown Design for Increased Seismic Stability, Slurry Pond 3 & 4 and West Ash Pond.*

Geosyntec. (2015). *Wastewater Construction Permit Request - Phase I West Ash Pond Closure.*

HydroCAD. (2019). *HydroCAD Stormwater Modeling.* HydroCAD Software Solutions, LLC.

McKim & Creed. (2021). *Topographic Survey for Slurry Ponds 3+4.*

NOAA. (2021). *Precipitation-Frequency Atlas of the United States.* Atlas 14, Volume 2, Version 3.0, National Oceanic and Atmospheric Administration.

NRCS. (2010). National Engineering Handbook, Part 630: Hydrology.

Santee Cooper. (2004). *Pump Station Design Report - Winyah Generating Station Redirect Drainage Project.*

Santee Cooper. (2013). *Inter-Office Communication - Winyah Generating Station Construction Report, Hydrologic Remediation of West Ash Pond and Unit 3 & 4 Slurry Pond.*

Santee Cooper. (2014). *Construction Permit Application - Winyah Station Runoff Pump Replacement.*

SCS. (1982). *Technical Release Number 20 (TR-20).* National Technical Information Service.

SCS. (1986). *Technical Release Number 55 (TR-55).* Soil Conservation Service. National Technical Information Service.

Thomas and Hutton. (2012). *Topographic Survey of a Portion of Santee Cooper Winyah Generating Station.*

Thomas and Hutton. (2016). *Topographic Survey of the Dike Crests at Santee Cooper Winyah Generating Station.*

TABLES

Table 1. Land Use Conditions

Drainage Area ID	Land Use Description	CN	Area (Acres)	Total Area (Acres)	Weighted CN
Slurry Pond	CCR	86	95.4	107.2	88
	Water	100	11.8		
West Ash Pond	Geomembrane	96	64	64	96

Table 2. Time of Concentration

Time of Concentration - Sheet Flow Contribution							Time of Concentration - Shallow Concentrated Flow Contribution					Time of Concentration - Channel Flow							Total Time of Concentration {Tc} (minutes)
Drainage Area	Surface Description	Manning's No. {n}	Flow Length {L} (ft)	2-Year, 24-Hour Rainfall {I} (in)	Land Slope {S} (ft/ft)	Time of Concentration from Sheet Flow {$T_{c, sheet}$} (minutes)	Surface Description	Velocity Factor (ft/s)	Flow Length {L} (ft)	Land Slope {S} (ft/ft)	Time of Concentration from Shallow Concentrated Flow {$T_{c, scf}$} (minutes)	Channel ID	Cross Sectional Area (sq. ft)	Wetted Perimeter (ft)	Mannings n	Flow Length	Channel Slope (ft/ft)	Time of Concentration from Channel Flow {Tc, cf} (minutes)	
Slurry Pond	Smooth	0.020	100	4.38	0.0005	7.3	Unpaved	10.0	1600	0.0009	55.2	Channel A	104	39.3	0.02	656	0.02	1.5	64.6
												Channel B	104	39.3	0.02	674	0.0169	0.6	
West Ash Pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Channel A	39	23	0.013	302	0.0025	0.6	8.5
												Channel B	39	23	0.013	1022	0.0025	2.1	
												Channel C	69	33	0.013	2222	0.0025	5.8	

Table 3. Slurry Pond Stage Storage

Elevation (ft)	Area (ac)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
11	0.2	0.0	0
12	0.5	0.4	0.4
14	1.9	2.4	2.7
16	4.8	6.7	9.4
18	5.8	10.5	20.0
20	17.2	23.0	43.0
22	25.0	42.2	85.2
24	29.4	54.4	139.6
26	31.9	61.3	200.8
28	35.8	67.7	268.5
30	39.2	75.0	343.6
32	43.8	83.0	426.6
34	51.7	95.5	522.1
35.67	77.2	107.6	629.7

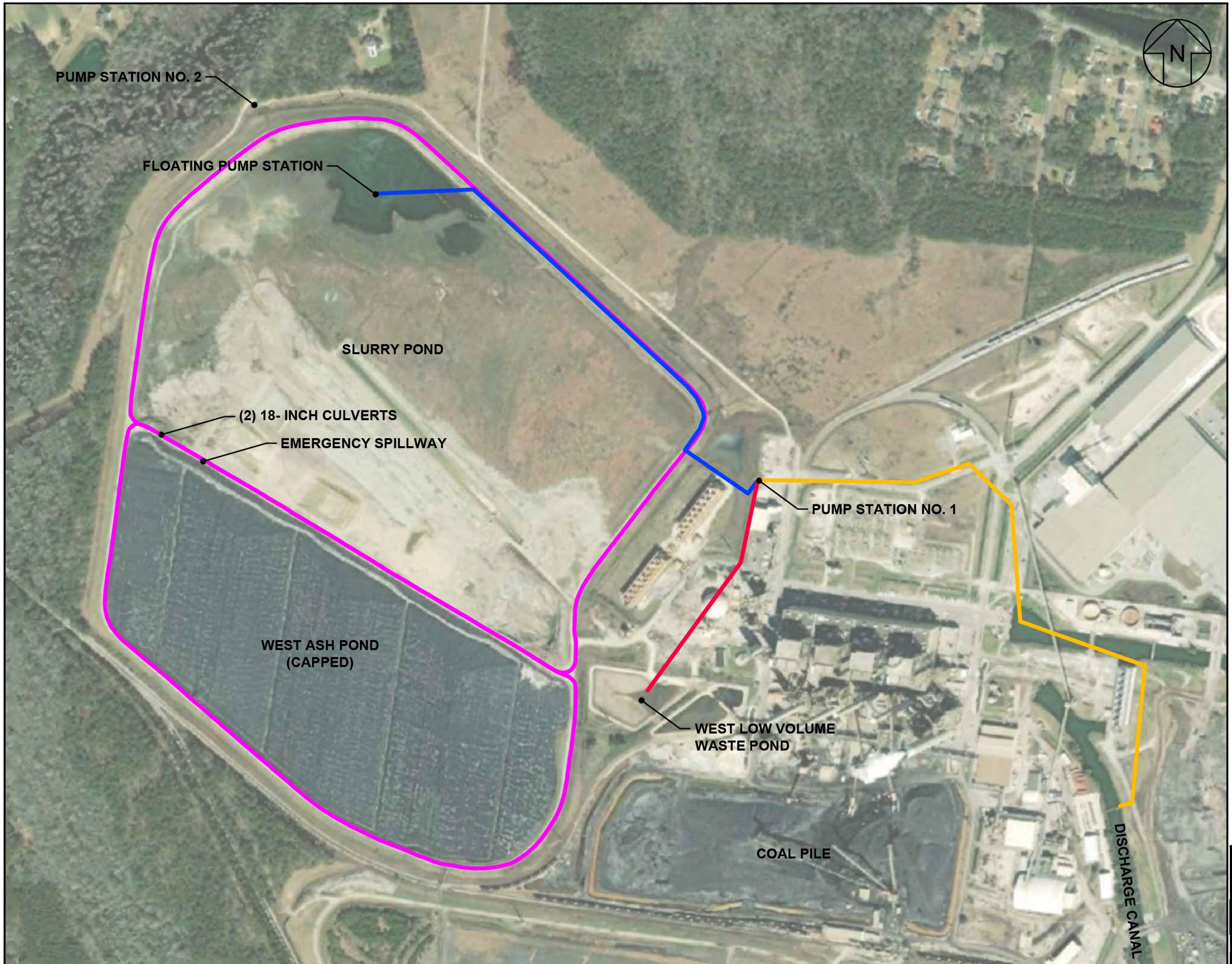
Table 4. West Ash Pond Stage Storage

Elevation (ft)	Area (ac)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
26	0.0	0.0	0
27	0.2	0.1	0.1
28	0.5	0.3	0.4
29	0.9	0.7	1.1
30	1.6	1.3	2.4
31	3.0	2.3	4.7
32	5.4	4.2	8.9
33	8.9	7.1	16.0
34	13.4	11.1	27.1
35	19.4	16.4	43.5
36	27.4	23.4	66.9
37	36.6	32.0	98.9

Table 5. H&H Calculation Results

Pond ID	Storm Event	Peak Water Surface Elevation (ft)	Water Volume (ac-ft)
Slurry Pond	PMF	33.06	479.4
WAP	PMF	35.80	61.6

FIGURES



LEGEND

- POND BOUNDARY
- PIPE ALIGNMENT FROM FLOATING PUMP STATION TO PUMP STATION NO. 1
- PIPE ALIGNMENT FROM PUMP STATION NO. 1 TO WEST LOW VOLUME WASTE POND
- HISTORIC PIPE ALIGNMENT FROM PUMP STATION NO. 1 TO DISCHARGE CANAL

NOTE 1: AERIAL IMAGERY TAKEN FROM ESRI, DATED 2019.

0 500' 1000'
SCALE IN FEET

WINYAH GENERATING STATION
SITE MAP

Geosyntec consultants

FIGURE 1

PROJECT NO: GC8100 | OCTOBER 2021

K:_PROJECTS\S\SANTEE COOPER\SANTEE COOPER-WINYAH\FIGURES\GC8100 - 2021 5 YEAR CCR REQUIREMENTS\SP34 H&H\F1 - SITE MAP

WINYAH GENERATING STATION
WEST ASH POND FLOW PATH

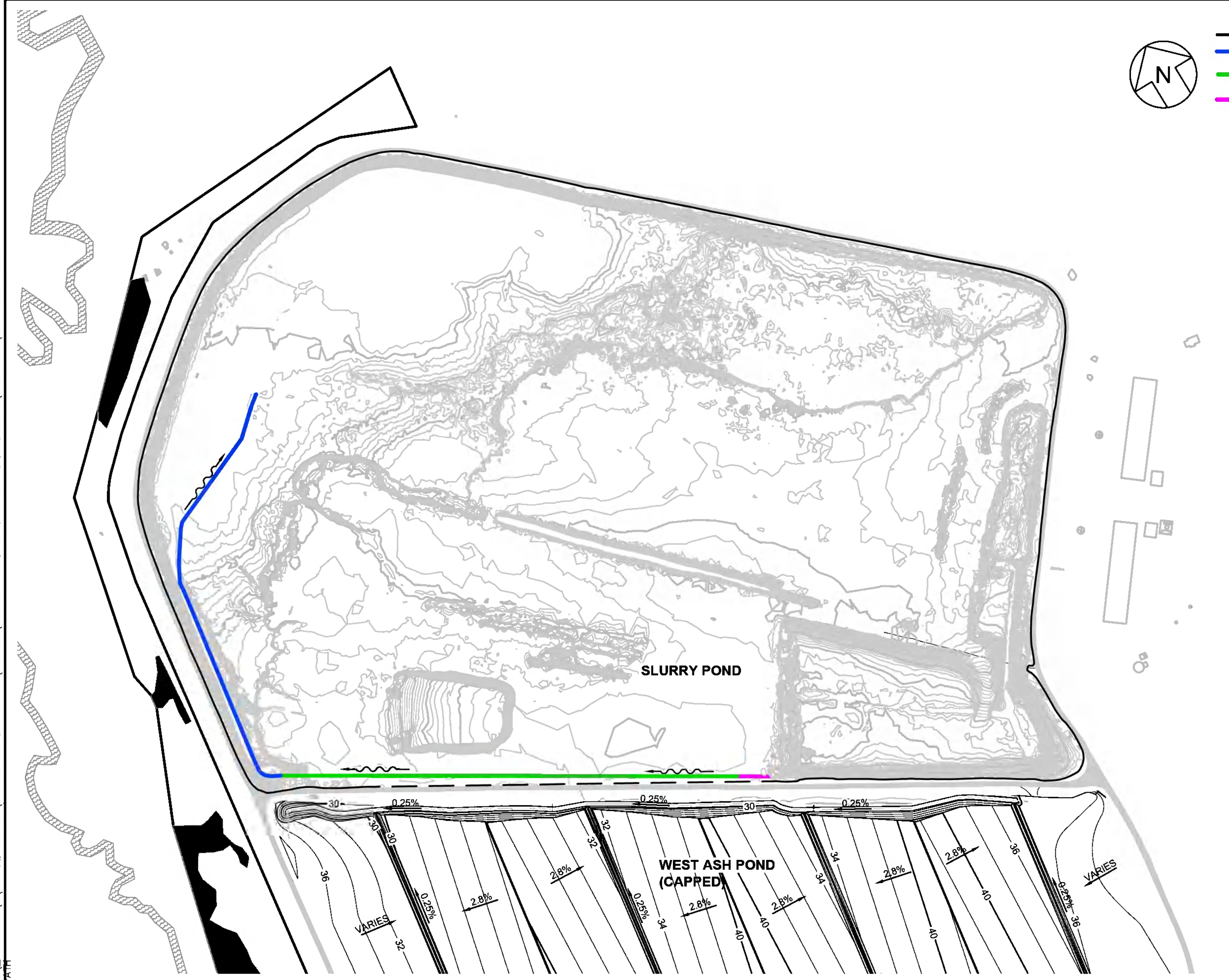
Geosyntec consultants

FIGURE 2

PROJECT NO: GC8100

OCTOBER 2021

K:_PROJECTS\S\SANTEE COOPER\SANTEE COOPER-WINYAH\FIGURES\GC8100 - 2021 5 YEAR CCR REQUIREMENTS\SP34 H&H\F2 - WAP FLOW PATH



LEGEND

- CHANNEL FLOW
- SHALLOW CONCENTRATED FLOW
- SHEET FLOW
- GENERAL FLOW DIRECTION

NOTE 1: TOPOGRAPHIC SURVEY INFORMATION COLLECTED BY McKIM AND CREED, DATED 7-24-2021

0 300' 600'
SCALE IN FEET

WINYAH GENERATING STATION
SLURRY POND FLOW PATH

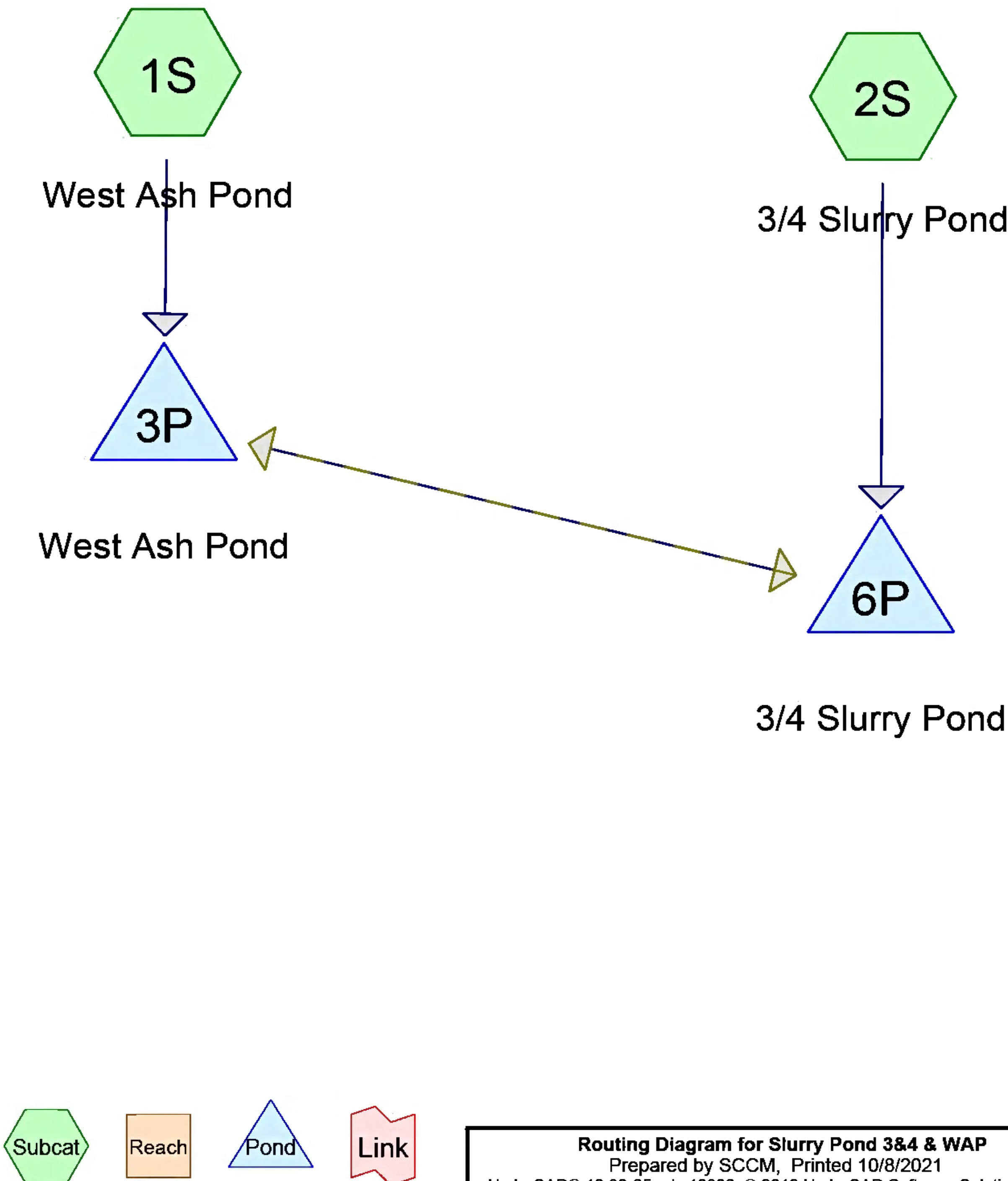
Geosyntec consultants

FIGURE 3

PROJECT NO: GC8100 | OCTOBER 2021

APPENDICES

APPENDIX A



Routing Diagram for Slurry Pond 3&4 & WAP
Prepared by SCCM, Printed 10/8/2021

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
107.205	88	(2S)
64.385	98	Exposed Geomembrane (1S)
171.590	**92**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
171.590	Other	1S, 2S
171.590		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	107.205	107.205		2S
0.000	0.000	0.000	0.000	64.385	64.385	Exposed Geomembrane	1S
0.000	**0.000**	**0.000**	**0.000**	**171.590**	**171.590**	**TOTAL AREA**	

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	3P	24.96	23.87	99.1	0.0110	0.013	36.0	0.0	0.0
2	3P	24.90	23.64	98.7	0.0128	0.013	36.0	0.0	0.0
3	6P	23.87	24.96	99.1	-0.0110	0.013	36.0	0.0	0.0
4	6P	23.64	23.90	98.7	-0.0026	0.013	36.0	0.0	0.0

Time span=0.00-600.00 hrs, dt=0.050 hrs, 12001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Sim-Route method - Pond routing by Sim-Route method

Subcatchment 1S: West Ash Pond Runoff Area=64.385 ac 100.00% Impervious Runoff Depth=50.76"
Flow Length=3,546' Slope=0.0025 '/' Tc=8.5 min CN=98 Runoff=1,203.47 cfs 272.327 af

Subcatchment 2S: 3/4 Slurry Pond Runoff Area=107.205 ac 0.00% Impervious Runoff Depth=49.40"
Flow Length=3,030' Tc=98.3 min CN=88 Runoff=987.21 cfs 441.321 af

Pond 3P: West Ash Pond Peak Elev=35.80' Storage=61.640 af Inflow=1,203.47 cfs 272.327 af
Primary=168.30 cfs 255.515 af Tertiary=220.33 cfs 25.039 af Outflow=380.58 cfs 280.554 af

Pond 6P: 3/4 Slurry Pond Peak Elev=33.06' Storage=479.354 af Inflow=1,327.53 cfs 721.876 af
Primary=160.23 cfs 608.983 af Tertiary=0.00 cfs 0.000 af Outflow=160.23 cfs 608.983 af

Total Runoff Area = 171.590 ac Runoff Volume = 713.648 af Average Runoff Depth = 49.91"
62.48% Pervious = 107.205 ac 37.52% Impervious = 64.385 ac

Summary for Subcatchment 1S: West Ash Pond

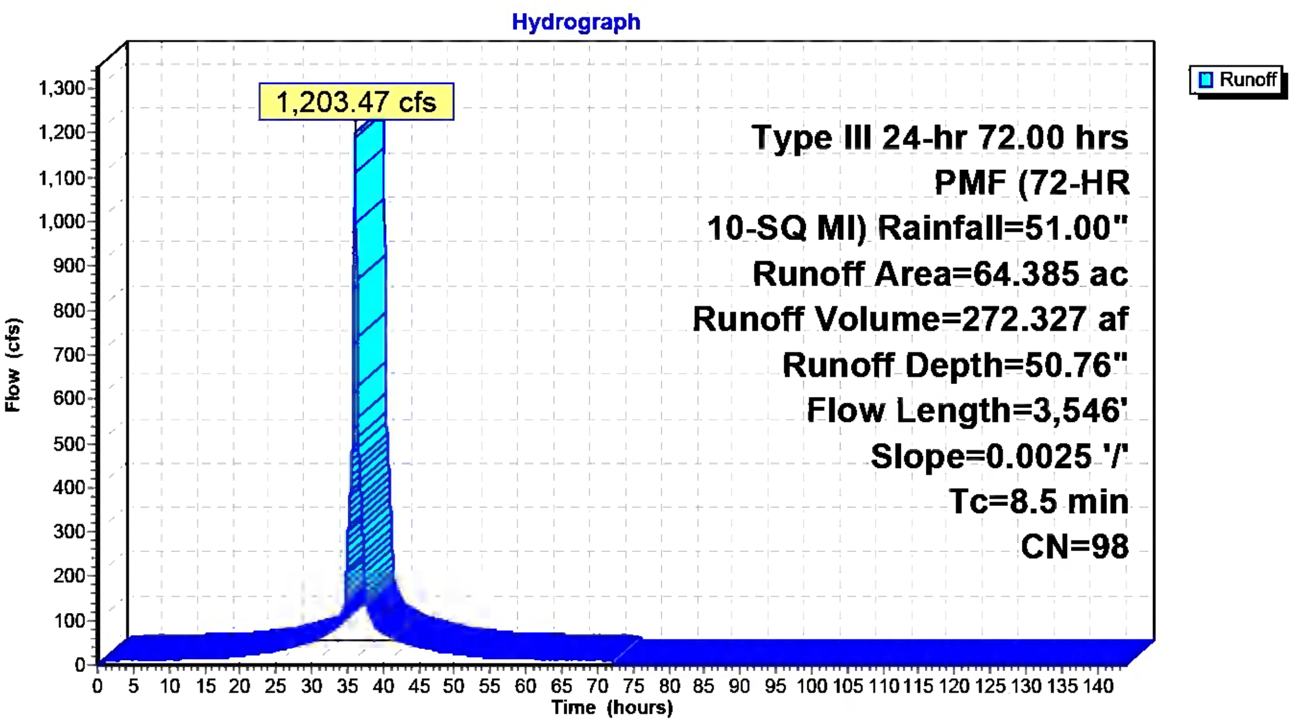
Runoff = 1,203.47 cfs @ 36.12 hrs, Volume= 272.327 af, Depth=50.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-600.00 hrs, dt= 0.050 hrs
Type III 24-hr 72.00 hrs PMF (72-HR, 10-SQ MI) Rainfall=51.00"

	Area (ac)	CN	Description
ỹ	64.385	98	Ex osed Geomembrane
	64.385		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	302	0.0025	8.13	316.96	**Channel Flow, Channel A Flow** Area= 39.0 sf Perim= 23.0' r= 1.70' n= 0.013
2.1	1,022	0.0025	8.13	316.96	**Channel Flow, Channel B Flow** Area= 39.0 sf Perim= 23.0' r= 1.70' n= 0.013
5.8	2,222	0.0025	6.39	249.16	**Channel Flow, Channel C Flow** Area= 39.0 sf Perim= 33.0' r= 1.18' n= 0.013
8.5	3,546	Total			

Subcatchment 1S: West Ash Pond



Summary for Subcatchment 2S: 3/4 Slurry Pond

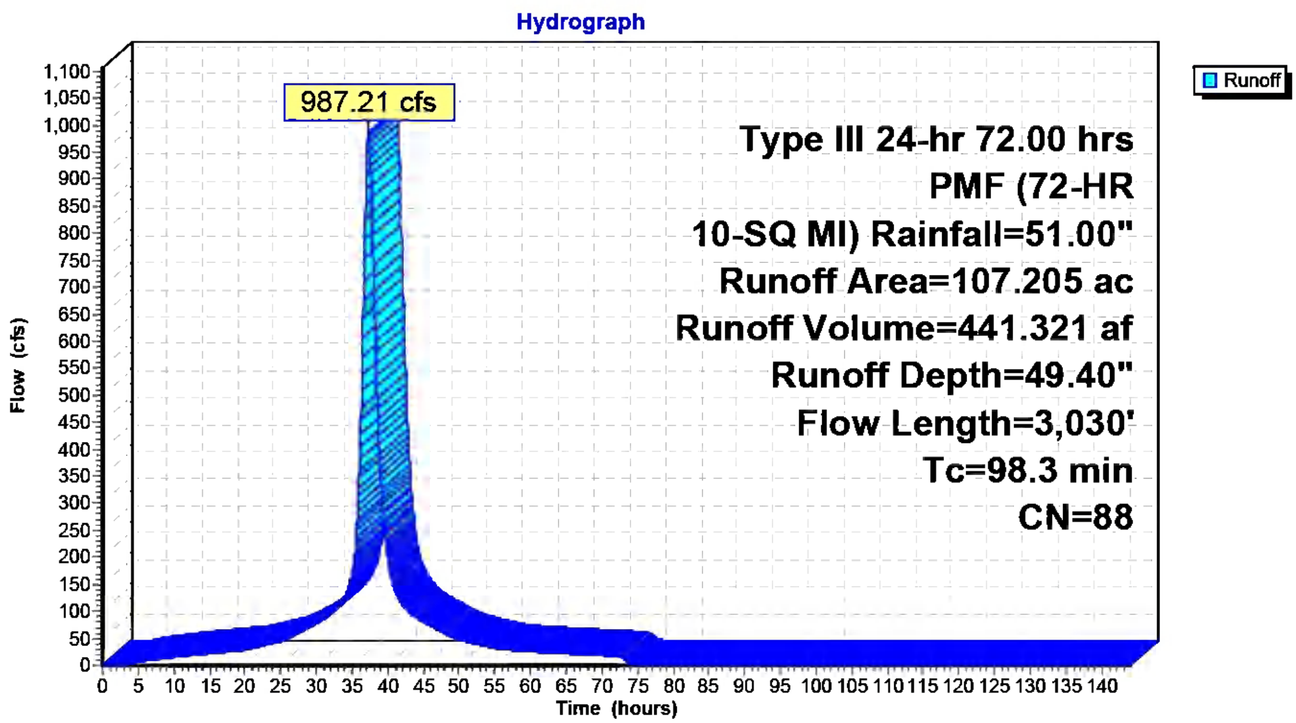
Runoff = 987.21 cfs @ 37.26 hrs, Volume= 441.321 af, Depth=49.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-600.00 hrs, dt= 0.050 hrs
Type III 24-hr 72.00 hrs PMF (72-HR, 10-SQ MI) Rainfall=51.00"

	Area (ac)	CN	Description
*	107.205	88	
	107.205		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0005	0.23		**Sheet Flow, Sheet Flow** n= 0.020 P2= 4.38"
88.9	1,600	0.0009	0.30		**Shallow Concentrated Flow, Shallow Concentrated Flow** Nearly Bare & Untilled Kv= 10.0 fps
1.5	656	0.0025	7.11	739.18	**Channel Flow, Channel A Flow** Area= 104.0 sf Perim= 39.3' r= 2.65' n= 0.020
0.6	674	0.0169	18.48	1,921.88	**Channel Flow, Channel B Flow** Area= 104.0 sf Perim= 39.3' r= 2.65' n= 0.020
98.3	3,030	Total			

Subcatchment 2S: 3/4 Slurry Pond



Summary for Pond 3P: West Ash Pond

[44] Hint: Outlet device #1 is below defined storage
[44] Hint: Outlet device #2 is below defined storage
[86] Warning: Oscillations may require smaller dt (severity=283)

Inflow	=	1,203.47 cfs @	36.12 hrs,	Volume=	272.327 af
Outflow	=	380.58 cfs @	36.85 hrs,	Volume=	280.554 af, Atten= 68%, Lag= 43.6 min
Primary	=	168.30 cfs @	36.40 hrs,	Volume=	255.515 af
Tertiary	=	220.33 cfs @	36.89 hrs,	Volume=	25.039 af

Routing by Sim-Route method, Time Span= 0.00-600.00 hrs, dt= 0.050 hrs
Peak Elev= 35.80' @ 36.89 hrs Surf.Area= 25.815 ac Storage= 61.640 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 115.5 min (2,292.5 - 2,177.0)

Volume	Invert	Avail.Storage	Storage Description
#1	26.00'	98.929 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

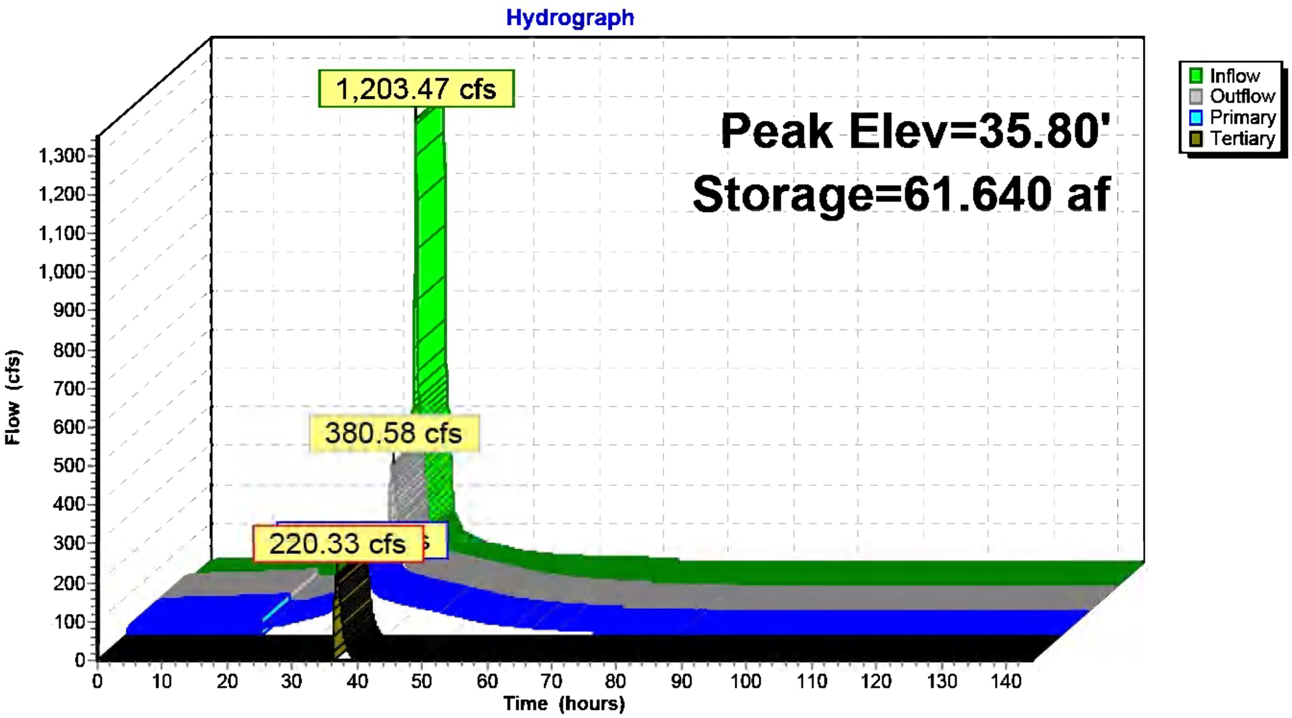
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
26.00	0.004	0.000	0.000
27.00	0.182	0.093	0.093
28.00	0.481	0.331	0.425
29.00	0.932	0.706	1.131
30.00	1.599	1.265	2.397
31.00	2.978	2.288	4.685
32.00	5.395	4.186	8.872
33.00	8.851	7.123	15.995
34.00	13.446	11.149	27.143
35.00	19.354	16.400	43.543
36.00	27.418	23.386	66.929
37.00	36.582	32.000	98.929

Device	Routing	Invert	Outlet Devices
#1	Primary	24.96'	**36.0" Round Culvert 1** L= 99.1' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 24.96' / 23.87' S= 0.0110 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf
#2	Primary	24.90'	**36.0" Round Culvert 2** L= 98.7' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 24.90' / 23.64' S= 0.0128 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf
#3	Tertiary	35.25'	**200.0' long x 12.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64
#4	Tertiary	35.75'	**30.0' long x 12.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64

Primary OutFlow Max=167.42 cfs @ 36.40 hrs HW=35.58' TW=27.81' (Dynamic Tailwater)
—**1=Culvert 1** (Inlet Controls 83.71 cfs @ 11.84 fps)
—**2=Culvert 2** (Inlet Controls 83.71 cfs @ 11.84 fps)

Tertiary OutFlow Max=220.18 cfs @ 36.89 hrs HW=35.80' TW=28.86' (Dynamic Tailwater)
—**3=Broad-Crested Rectangular Weir** (Weir Controls 219.29 cfs @ 1.99 fps)
—**4=Broad-Crested Rectangular Weir** (Weir Controls 0.89 cfs @ 0.58 fps)

Pond 3P: West Ash Pond



Summary for Pond 6P: 3/4 Slurry Pond

[92] Warning: Device #4 is above defined storage

Inflow	=	1,327.53 cfs @ 37.17 hrs,	Volume=	721.876 af
Outflow	=	160.23 cfs @ 44.49 hrs,	Volume=	608.983 af, Atten= 88%, Lag= 439.6 min
Primary	=	160.23 cfs @ 44.49 hrs,	Volume=	608.983 af
Tertiary	=	0.00 cfs @ 0.00 hrs,	Volume=	0.000 af

Routing by Sim-Route method, Time Span= 0.00-600.00 hrs, dt= 0.050 hrs
Starting Elev= 18.60' Surf.Area= 9.203 ac Storage= 26.855 af
Peak Elev= 33.06' @ 44.49 hrs Surf.Area= 48.761 ac Storage= 479.354 af (452.499 af above start)

Plug-Flow detention time= 2,196.1 min calculated for 582.128 af (81% of inflow)
Center-of-Mass det. time= 1,849.6 min (4,146.6 - 2,297.0)

Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	692.546 af	**Custom Stage Data (Prismatic)**Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
11.00	0.216	0.000	0.000
12.00	0.486	0.351	0.351
14.00	1.904	2.390	2.741
16.00	4.777	6.681	9.422
18.00	5.756	10.533	19.955
20.00	17.245	23.001	42.956
22.00	24.986	42.231	85.187
24.00	29.380	54.366	139.553
26.00	31.772	61.152	200.705
28.00	35.815	67.587	268.292
30.00	39.208	75.023	343.315
32.00	45.474	84.682	427.997
34.00	51.692	97.166	525.163
35.67	148.767	167.383	692.546

Device	Routin	Invert	Outlet Devices
#1	Primary	24.96'	**36.0" Round Culvert 1** L= 99.1' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 23.87' / 24.96' S= -0.0110 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Primary	23.90'	**36.0" Round Culvert 2** L= 98.7' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 23.64' / 23.90' S= -0.0026 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#3	Tertiary	35.25'	**200.0' long x 12.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64
#4	Tertiary	35.67'	**30.0' long x 12.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64

Primary OutFlow Max=160.23 cfs @ 44.49 hrs HW=33.06' (Free Discharge)
↑**1=Culvert 1** (Inlet Controls 77.13 cfs @ 10.91 fps)
└**2=Culvert 2** (Inlet Controls 83.10 cfs @ 11.76 fps)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=18.60' TW=26.00' (Dynamic Tailwater)
↑**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 6P: 3/4 Slurry Pond