Prepared for

Santee Cooper
One Riverwood Drive
Moncks Corner, SC 29461

INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN ASH POND B, REV. 1

WINYAH GENERATING STATION

Prepared by

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Project Number: GC8100

November 2021

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 39112 CHRISTOPHER JORDAN

Chris Jordan Digitally signed by Chris Jordan Date: 2021.11.10 08:00:13 -05'00'

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 to prepare documentation for existing surface impoundments (SIs) at WGS. Pursuant to Section 257.82(c) of the CCR Rule, Geosyntec Consultants (Geosyntec) prepared this Inflow Design Flood Control System Plan for Ash Pond B 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 Ash Pond B currently meets these requirements.

The inflow design flood control system for Ash Pond B 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

Ash Pond B, encompassing approximately 66 acres (ac), is located east of the power block. Ash Pond B is bounded by Ash Pond A to the north, the Cooling Pond to the east and south, and the Discharge Canal to the west. Ash Pond B is bounded by perimeter dikes ranging from 12.0 feet (ft) to 15.0 ft in the west and 20.0 ft to 24.5 ft in the east (Thomas and Hutton, 2012). The minimum crest elevation of the Ash Pond B perimeter dikes is 39.68 ft National Geodetic Vertical Datum of 1929 (NGVD 29) (38.68 ft NAVD 88) (Thomas and Hutton, 2016). 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 including the surface impoundments and hydraulic features associated with Ash Pond B is provided in **Figure 1**.

Ash Pond B historically decanted ash sluice water, low volume wastewater, and Unit 2 Slurry Pond stormwater from Ash Pond A. Ash Pond B now only receives stormwater inflows from the pond area, and process water inflow has been halted to the pond. Ash Pond A does not have an outfall structure but routes water southward through rim ditches and culverts to Ash Pond B. Ash Ponds A and B are hydraulically connected through a 30 inch (in.) diameter corrugated metal pipe (CMP), a 48 in. diameter smooth steel pipe, and a 42 in. diameter smooth steel pipe (Thomas and Hutton, 2016; Thomas and Hutton, 2012). Since the initial assessment, an emergency spillway was constructed between Ash Ponds A and B to provide capacity for larger storm events between the two ponds.

The operating level in Ash Pond B is maintained by a concrete riser structure with a top stop log elevation of 34.9 ft NGVD 29 (33.9 ft NAVD 88) (Thomas and Hutton, 2016). A 24 in. diameter smooth interior, corrugated exterior high density polyethylene pipe culvert with a downstream invert elevation of 17.99 ft NGVD 29 (16.99 ft NAVD 88) conveys water from the riser structure to the Discharge Canal of the Cooling Pond (Santee Cooper, 2012b; Thomas and Hutton, 2016). The average operating elevation provided by the plant from February 2011 through September 2021 is 34.1 ft NGVD 29 (33.1 ft NAVD 88). Receipt of wastewater was halted in April of 2021, the operating elevation is regularly decreasing as dewatering occurs to facilitate closure of Ash Pond B.

CATCHMENT AREAS AND DESIGN STORM EVENT

During the design flood event Ash Ponds A and B will effectively operate as a single pond as the culverts and spillway provide a hydraulic connection between the ponds. The contributing watershed areas for Ash Ponds A and B are 90.6 ac and 65.7 ac, respectively. The impoundment is surrounded on all sides by a raised perimeter dike, which limits stormwater run-on to that generated within the footprint of the pond itself. There are no longer any inflows to the pond other than rainfall that lands directly on the pond. 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 Ash Pond B is classified as a low hazard potential surface impoundment, the inflow design flood is the 100-year flood event.

STORAGE CAPACITIES

The available stormwater storage volume of Ash Pond A was calculated by developing an area-volume curve based on topographic data (McKim & Creed, 2021). The lowest contour surveyed within Ash Pond A is 18.0 ft NGVD 29 (17.0 ft NAVD 88). The minimum crest elevation of the Ash Pond A perimeter dikes is 38.8 ft NGVD 29 (37.8 ft NAVD 88). The surface area of each contour was measured and tabulated at each elevation. The available surface water volume in each 1 ft 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 area-volume data are presented in Appendix A.

Similarly, the available stormwater storage volume of Ash Pond B between elevations was calculated by developing an area-volume curve based on topographic and bathymetric data (McKim & Creed, 2021). The lowest contour surveyed within Ash Pond B is 22.0 ft NGVD 29 (21.0 ft NAVD 88). The minimum crest elevation of the Ash Pond B perimeter dikes is 39.7 ft NGVD 29 (38.7 ft NAVD 88). The surface area of each contour was measured and tabulated at each elevation. Next, the available surface water volume at each 1 ft 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 area-volume data are presented in Appendix A.

HYDROLOGIC AND HYDRAULIC ANALYSIS

A hydrologic and hydraulic analysis of Ash Ponds A and B were performed using *HydroCAD Version 10.0* software (HydroCAD, 2019). Stormwater inflows into Ash Ponds A and B, and outflows from Ash Pond B to the Cooling Pond via the Discharge Canal were used to compute maximum water elevation during the design storm event. Tailwater effects associated with discharge from Ash Pond B to the Discharge Channel were modeled using a fixed water surface elevation within the Discharge Channel and Cooling Pond. Appendix A presents the Hydrologic and Hydraulic analysis report and documents assumptions, rainfall abstractions, drainage areas, and model results.

ROUTING RESULTS

During the design storm event. Ash Ponds A and B will effectively operate as a single pond as the culverts and spillway provide a hydraulic connection between the ponds. As currently operated, Ash Pond B will contain the 100-yr flood event. The resulting peak water surface elevation in Ash Pond B during the 100-yr flood event based on the hydraulic and hydrologic analysis (Appendix A) is shown in **Table 2**. Ash Pond B will effectively contain the 100-yr flood event and maintain a freeboard of 3.5 feet. The modeling results for Ash Pond A are discussed in a separate report.

Under peak design flood inflows, the outflow from the Ash Pond B 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 257.82. All discharges from the Ash Pond B ultimately are discharged through NPDES Outfall 002, thus complying with CCR Rule Section 257.82(b).

Table 2 – Ash Pond B - Peak Elevations and Freeboard

Event	***Elevation (NAVD 88) (ft)***	***Free Board (ft)***
Normal Operating Condition	33.14	5.54
100-Yr Flood	35.14	3.5

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:

Date Chris Jordan Digitally signed by Chris Jordan Date: 2021.11.10 07:59:58 -05'00'

Chris Jordan, P.E. South Carolina License Number 39112
Project Engineer

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

FIGURES

LEGEND

POND BOUNDARY

NOTE 1: AERIAL IMAGERY TAKEN FROM ESRI, DATED 2021. ASH POND A CURRENTLY IS BEING EXCAVATED AND A CCR LANDFILL IS BEING CONSTRUCTED WITHIN THE ASH POND A AREA.

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\AP A&B H&H\F1 - SITE MAP

APPENDIX A

Hydrologic and Hydraulic Analysis – Ash Pond B

Written by:	**C. Jordan**	Date:	**10/7/21**	Reviewed by:	**A. Soroka**	Date:	**10/7/21**
Client:	**Santee Cooper**	Project:	**Winyah Generating Station**	Project/ Proposal No.:	**GC8100**	Task No.:	**04**

WINYAH GENERATING STATION
ASH POND B HYDROLOGIC AND HYDRAULIC CAPACITY

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 calculation package is to: (i) compute the hydraulic capacity of Ash Ponds A and B; (ii) demonstrate the combined spillway capacity requirement is met; and (iii) estimate the maximum surcharge pool elevation for static slope stability analyses. Since Ash Ponds A and B are hydraulically connected to each other through an emergency spillway and culvert system, both ponds were analyzed together herein. Both ponds are regulated by the CCR Rule as existing CCR surface impoundments. According to the CCR Rule, the combined capacity of the spillways for low hazard CCR surface impoundments is required to manage flow during and following the peak discharge from a 100-year (yr) precipitation event. Since Ash Pond A and B are low hazard surface impoundments, the 100-yr storm event was considered herein.

Ash Pond A, encompassing approximately 90 acres (ac), is located east of the power block. Ash Pond A is bounded by the intake canal to the north, the Cooling Pond to the east, Ash Pond B to the south, and the Discharge Canal to the west. Ash Pond A is separated from Ash Pond B by a divider dike, which traverses from west to east from the Discharge Canal to the Cooling Pond. Ash Pond A is bounded by perimeter dikes ranging from 20.0 feet (ft) to 24.5 ft high on the east from 12.0 ft to 15.0 ft high on the north (McKim & Creed, 2021; Thomas and Hutton, 2016). The minimum crest elevation of the Ash Pond A perimeter dikes is 38.8 ft National Geodetic Vertical Datum of 1929 (NGVD 29) (37.8 ft NAVD 88) (Thomas and Hutton, 2012).

Ash Pond B, encompassing approximately 66 acres (ac), is located east of the power block. (Note that 66 ac is the area contained within the dike crest boundary. The area of the limits of CCR is slightly less at approximately 65 ac.) Ash Pond B is bounded by Ash Pond A to the north, the Cooling Pond to the east and south, and the Discharge Canal to the west. Ash Pond B is bounded by perimeter dikes ranging from 12.0 feet (ft) to 15.0 ft high on the west to 20.0 ft to 24.5 ft high on the east (Thomas and Hutton, 2012). The minimum crest elevation of the Ash Pond B perimeter dikes is 39.68 ft NGVD 29 (38.69 NAVD 88) (Thomas and Hutton, 2016).

Ash Pond B is discharged through a riser structure with a horizontal outlet pipe approximately 100 linear ft in length to the Discharge Canal (Santee Cooper, 2012b; Thomas and Hutton, 2016). A Site Map including the surface impoundments and hydraulic features associated with Ash Pond B is provided in **Figure 1**.

METHODOLOGY AND INPUT PARAMETERS

Stormwater runoff volumes and associated discharges to Ash Ponds A and B 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 System (SCS) Technical Release 20 (TR-20) method was applied in *HydroCAD* to calculate stormwater runoff volumes (SCS, 1982).

The following parameters and assumptions were used for calculating stormwater runoff volumes for Ash Ponds A and B.

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 100 yr frequency return period for the site is 12.8 in. (NOAA, 2021). The design storm hyetograph was developed using SCS Type III rainfall distribution and was directly input into the *HydroCAD* model.

Drainage Areas and Curve Numbers

The contributing watershed areas for Ash Ponds A and B are approximately 90 ac and 66 ac, respectively. These areas were delineated using the dike crests to correspond to the ponds' direct drainage areas. Each 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. Ash Pond A was assumed to be 100% CCR (Weighted CN = 86) while Ash Pond B was a mix of CCR and water (Weighted CN = 87). The contributing watershed areas and CNs are summarized in **Table 1** and were directly input to the *HydroCAD* model.

Time 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 within Ash Ponds A and B can be characterized by sheet flow, shallow concentrated flow and channel flow or a combination thereof (shown in **Figures 2 and 3**).

HydroCAD applied the Overton and Meadows formulation to calculate travel time for sheet flow for distances less than 300 ft (NRCS, 2010):

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

where:

T_t = travel time for over land sheet flow (hr);

n = Manning's roughness coefficient (dimensionless);

L = flow length (ft);

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

S = slope of hydraulic grade line (or land slope) (feet per feet [ft/ft]).

A Manning's roughness coefficient of 0.020 was used to represent sheet flow in Ash Pond A. 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 Ash Ponds A and B are shown in **Table 2**.

Open channel flow travel time was calculated as:

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

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

L = flow length (ft); and

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

The open channel flow velocity was calculated using Manning's equation. The average velocity was 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 (dimensionless);

R = hydraulic radius (ft); and

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

A Manning's roughness coefficient of 0.020 was used to represent open channel flow in Ash Ponds A and B. Channel dimensions with Ash Ponds A and B were estimated using topographic data, and these dimensions are summarized in **Table 3** (Thomas and Hutton, 2012). The hydraulic radius was 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 area was 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 perimeter was 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 Ash Ponds A and B are presented in **Table 2**. The computed times of concentration for Ash Ponds A and B are summarized in **Table 2**.

Inflows

In the *HydroCAD* model, stormwater inflows associated with Ash Ponds A and B are represented by Sub-Catchments 1S and 2S, respectively. Ponds 3P and 4P represent Ash Ponds A and B, respectively. The *HydroCAD* model routing diagram is provided in **Appendix A**.

Storage Capacities

The available stormwater storage volume of Ash Pond A between elevations 17.0 ft and 38.0 ft NAVD 88 was calculated by developing an area-volume curve based on topographic data (McKim & Creed, 2021). The minimum crest elevation of the Ash Pond A perimeter dikes is 37.8 ft NAVD 88. The surface area of each contour was measured and tabulated at each elevation. The available surface water volume in each 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 area-volume data are presented in **Table 4**.

Similarly, the available stormwater storage volume of Ash Pond B was calculated by developing an area-volume curve based on topographic and bathymetric data (McKim & Creed, 2021). The average operating elevation provided by the plant is 34.1 ft NGVD 29 (33.1 NAVD 88) (Santee Cooper, WGS, 2016). Elevation 33.1 is used as the starting water surface elevation for Pond B in the model. The minimum crest elevation of the Ash Pond B perimeter dikes is 38.7 ft NAVD 88. The surface area of each contour was measured and tabulated at each elevation. Next, the available surface water volume at each 1-ft 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 area-volume data are presented in **Table 5**.

<u>Outlet Structures</u>

The outlets from Ash Pond A to Ash Pond B are a 30 in. diameter CMP culvert with an upstream invert at 37.5 ft NGVD 29 (36.50 ft NAVD 88) and a downstream invert at 36.52 ft (35.52 ft NAVD 88), a 48 in. diameter smooth steel pipe with an upstream invert at 35.49 ft NGVD 29 (34.49 ft NAVD 88) and a downstream invert at 35.28 ft NGVD 29 (34.28 ft NAVD 88), and a 42 in. diameter smooth steel pipe with an upstream invert at 36.20 ft NGVD 29 (35.20 ft NAVD 88) and a downstream invert at 35.70 ft NGVD 29 (34.70 ft NAVD 88) (Thomas and Hutton, 2016; Thomas and Hutton, 2012). These outlet pipes allow water to drain from Ash Pond A to Ash Pond B. An emergency spillway between Ash Ponds A and B was permitted for construction in 2016 and placed into operation in 2018 to allow for excess stormwater to bypass the primary discharge pipes between the two ponds.

The operating level in Ash Pond B is maintained by a concrete riser structure with an internal length of 4 ft and an internal width of 4 ft (Santee Cooper, 2012b). The concrete riser structure has 4 ft long stop logs on a single face, and the top stop log elevation is 34.90 ft NGVD 29 (33.90 ft NAVD 88) (Santee Cooper, 2012b; Thomas and Hutton, 2016). A 24 in. diameter smooth interior corrugated exterior high density polyethylene pipe culvert with a downstream invert elevation of 17.99 ft NGVD 29 (16.99 ft NAVD 88) conveys water from the riser structure to the Discharge Canal of the Cooling Pond (Santee Cooper, 2012b; Thomas and Hutton, 2016).

The tailwater effects associated with discharge from Ash Pond B to the Discharge Canal were modeled using a fixed water surface elevation within the Discharge Canal and Cooling Pond. This tailwater surface elevation was estimated by conservatively assuming 2.5 ft depth of water over the Cooling Pond emergency spillway during the 100 yr storm event. The water surface of the Discharge Canal and Cooling Pond was assumed to be at 23.15 ft NAVD 88 (20.65 ft NAVD 88 plus an additional 2.5 ft of water). The tailwater effects associated with the Discharge Canal and Cooling Pond were represented by Node 7L in the *HydroCAD* model.

RESULTS

As currently operated, Ash Pond B will contain the 100-yr storm event. The resulting peak water surface elevation and storage volume for the 100-yr storm event is shown in **Table 6**. During this storm event, Ash Ponds A and B will effectively operate as a single pond as the culverts and spillway provide a hydraulic connection between the storage areas in both ponds. The results from this analysis show that all spillways manage and convey the stormwater flow from the design storm event.

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TABLES

Table 1 – Watershed Areas and Curve Numbers

Drainage Area ID	Land Use Description	CN	Area (Acres)	Total Area (Acres)	Weighted CN
Ash Pond A	CCR	86	88.9	88.9	86
Ash Pond B	CCR	86	61.1	65.69	87
	Water	100	4.62		

Table 2 – Input Parameters Describing Sheet Flow and Open Channel Flow

Time of Concentration - Sheet Flow Contribution							Time of Concentration - Channel Flow Contribution						Total Time of Concentration $\{T_t\}$ (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 $\{T_{t,\,sheet}\}$ (minutes)	Cross Sectional Area (ft^2)	Wetted Perimeter (ft)	Mannings n	Flow Length (ft)	Channel Slope (ft/ft)	Time of Concentration from Channel Flow $\{T_{t,cf}\}$ (minutes)	
Ash Pond A	Smooth	0.020	100	4.38	0.0663	1.0	147	59	0.02	2300	0.001	8.9	9.9
Ash Pond B	N/A	N/A	N/A	N/A	N/A	N/A	107	37	0.02	3100	0.001	10.8	10.8

Table 3 – Open Channel Dimensions

Flow Path	Channel Shape	Side Slope Ratio (H:V)	Bottom Width (ft)	Depth (ft)
Ash Pond A	Trapezoidal	3:1	40	3
Ash Pond B	Trapezoidal	3:1	12.5	4.5

Table 4 – Ash Pond A Stage - Storage

Elevation (ft-NAVD 88)	Area (acre)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
17	1.5	0.0	0
18	2.7	2.1	2.1
19	6.0	4.3	6.4
20	8.0	7.0	13.3
21	12.2	10.1	23.5
22	17.7	15.0	38.4
23	23.0	20.4	58.8
24	26.3	24.7	83.4
25	32.9	29.6	113.0
26	34.8	33.8	146.9
27	37.5	36.1	183.0
28	41.4	39.4	222.4
29	49.0	45.2	267.6
30	53.1	51.0	318.6
31	56.8	54.9	373.6
32	61.8	52.3	425.9
33	69.1	59.3	485.2
34	68.9	65.4	550.6
35	69.3	69.0	619.5
36	72.2	70.8	690.3
37	72.6	75.4	765.7
38	44.3	58.5	824.2

Table 5 – Ash Pond B Stage - Storage

Elevation (ft-NAVD 88)	Area (acre)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
21	0.1	0.0	0.0
22	0.2	0.1	0.1
23	0.5	0.3	0.5
24	1.0	0.7	1.2
25	1.2	1.1	2.3
26	1.5	1.4	3.7
27	1.8	1.6	5.3
28	2.5	2.1	7.4
29	3.9	3.2	10.6
30	5.3	4.6	15.2
31	6.3	5.8	21.0
32	9.3	7.8	28.8
33	11.9	10.6	39.4
34	17.7	14.8	54.2
35	26.8	22.2	76.5
36	34.7	30.8	107.2
37	41.4	38.0	145.2
38	45.1	43.2	188.5
39	49.3	47.2	235.7

Table 6 – Peak Elevation and Volume

Pond ID	Storm Event	Peak Water Surface Elevation (ft-NAVD 88)	Water Volume (ac-ft)
Ash Pond A	100-yr, 72-hr	24.06	85.1
Ash Pond B	100-Yr, 72-hr	35.14	80.3

FIGURES

LEGEND

POND BOUNDARY

NOTE 1: AERIAL IMAGERY TAKEN FROM ESRI, DATED 2021. ASH POND A CURRENTLY IS BEING EXCAVATED AND A CCR LANDFILL IS BEING CONSTRUCTED WITHIN THE ASH POND A AREA.

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\AP A&B H&H\F1 - SITE MAP

LEGEND

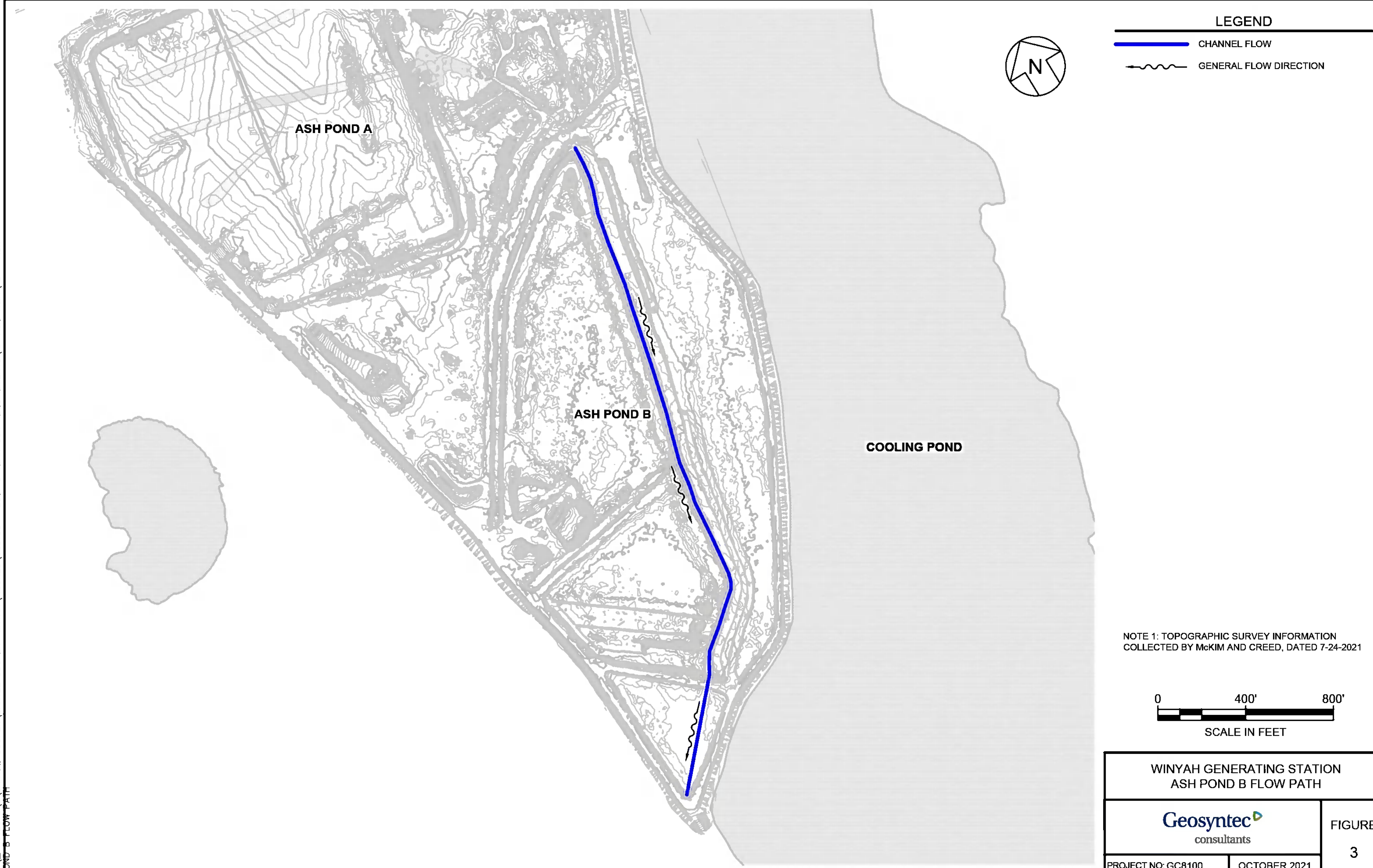
- SHEET FLOW
- CHANNEL FLOW
- GENERAL FLOW DIRECTION

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

0 400' 800'
SCALE IN FEET

WINYAH GENERATING STATION ASH POND A 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\AP A&B H&H\F2 – ASH POND A FLOW PATH



WINYAH GENERATING STATION
ASH POND B FLOW PATH

Geosyntec consultants

FIGURE 3

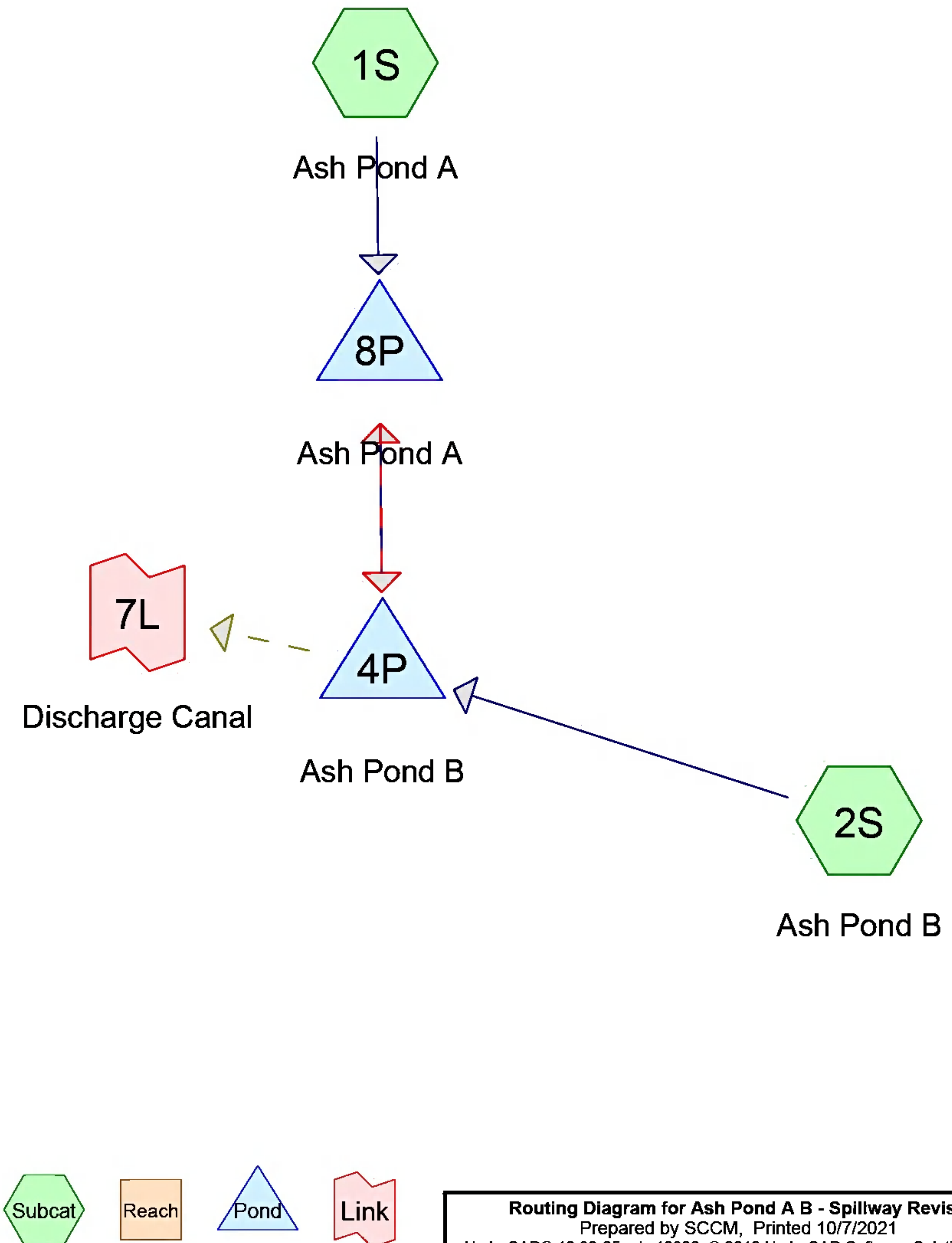
PROJECT NO: GC8100

OCTOBER 2021

K:_PROJECTS\S\SANTEE COOPER\SANTEE COOPER-WINYAH\FIGURES\GC8100 - 2021 5 YEAR CCR REQUIREMENTS\AP A&B H&H\F3 - ASH POND B FLOW PATH

APPENDICES

APPENDIX A



Routing Diagram for Ash Pond A B - Spillway Revision
Prepared by SCCM, Printed 10/7/2021
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Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
65.693	87	90% Ash and 10% Water Surface (2S)
88.900	86	CCR (1S)
154.593	**86**	**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	
154.593	Other	1S, 2S
154.593		**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	65.693	65.693	90% Ash and 10% Water Surface	2S
0.000	0.000	0.000	0.000	88.900	88.900	CCR	1S
0.000	**0.000**	**0.000**	**0.000**	**154.593**	**154.593**	**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	4P	30.21	16.99	113.3	0.1167	0.013	21.6	0.0	0.0
2	4P	35.52	36.50	40.8	-0.0240	0.025	30.0	0.0	0.0
3	4P	34.28	34.49	30.9	-0.0068	0.012	48.0	0.0	0.0
4	4P	34.70	35.20	24.6	-0.0203	0.012	42.0	0.0	0.0
5	8P	36.50	35.52	40.8	0.0240	0.025	30.0	0.0	0.0
6	8P	34.49	34.28	30.9	0.0068	0.012	48.0	0.0	0.0
7	8P	35.20	34.70	24.6	0.0203	0.012	42.0	0.0	0.0

Time span=0.00-900.00 hrs, dt=0.01 hrs, 90001 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: Ash Pond A Runoff Area=88.900 ac 0.00% Impervious Runoff Depth=11.03"
Flow Length=2,400' Tc=9.9 min CN=86 Runoff=392.93 cfs 81.747 af

Subcatchment 2S: Ash Pond B Runoff Area=65.693 ac 0.00% Impervious Runoff Depth=11.17"
Flow Length=3,100' Slope=0.0010 '/' Tc=10.8 min CN=87 Runoff=289.00 cfs 61.130 af

Pond 4P: Ash Pond B Peak Elev=35.14' Storage=80.298 af Inflow=289.00 cfs 61.130 af
Primary=2.88 cfs 3.339 af Secondary=0.00 cfs 0.000 af Tertiary=16.95 cfs 46.431 af Outflow=19.84 cfs 49.770 af

Pond 8P: Ash Pond A Peak Elev=24.06' Storage=85.072 af Inflow=393.04 cfs 85.086 af
Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.000 af

Link 7L: Discharge Canal Inflow=16.95 cfs 46.431 af
Primary=16.95 cfs 46.431 af

Total Runoff Area = 154.593 ac Runoff Volume = 142.876 af Average Runoff Depth = 11.09"
100.00% Pervious = 154.593 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Ash Pond A

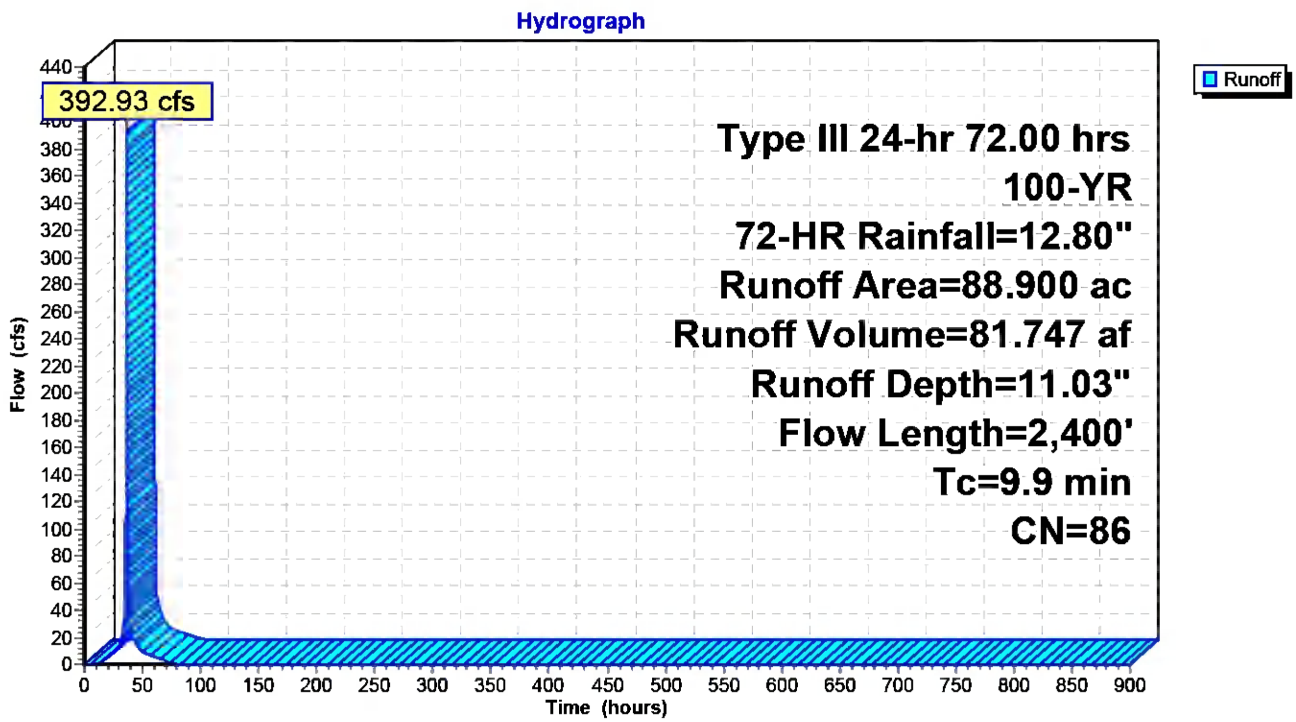
Runoff = 392.93 cfs @ 36.14 hrs, Volume= 81.747 af, Depth=11.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-900.00 hrs, dt= 0.01 hrs
Type III 24-hr 72.00 hrs 100-YR, 72-HR Rainfall=12.80"

	Area (ac)	CN	Description
*	88.900	86	CCR
	88.900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0663	1.61		**Sheet Flow, Sheet Flow** n= 0.020 P2= 4.38"
8.9	2,300	0.0010	4.32	634.77	**Channel Flow, Channel Flow** Area= 147.0 sf Perim= 59.0' r= 2.49' n= 0.020
9.9	2,400	Total			

Subcatchment 1S: Ash Pond A



Summary for Subcatchment 2S: Ash Pond B

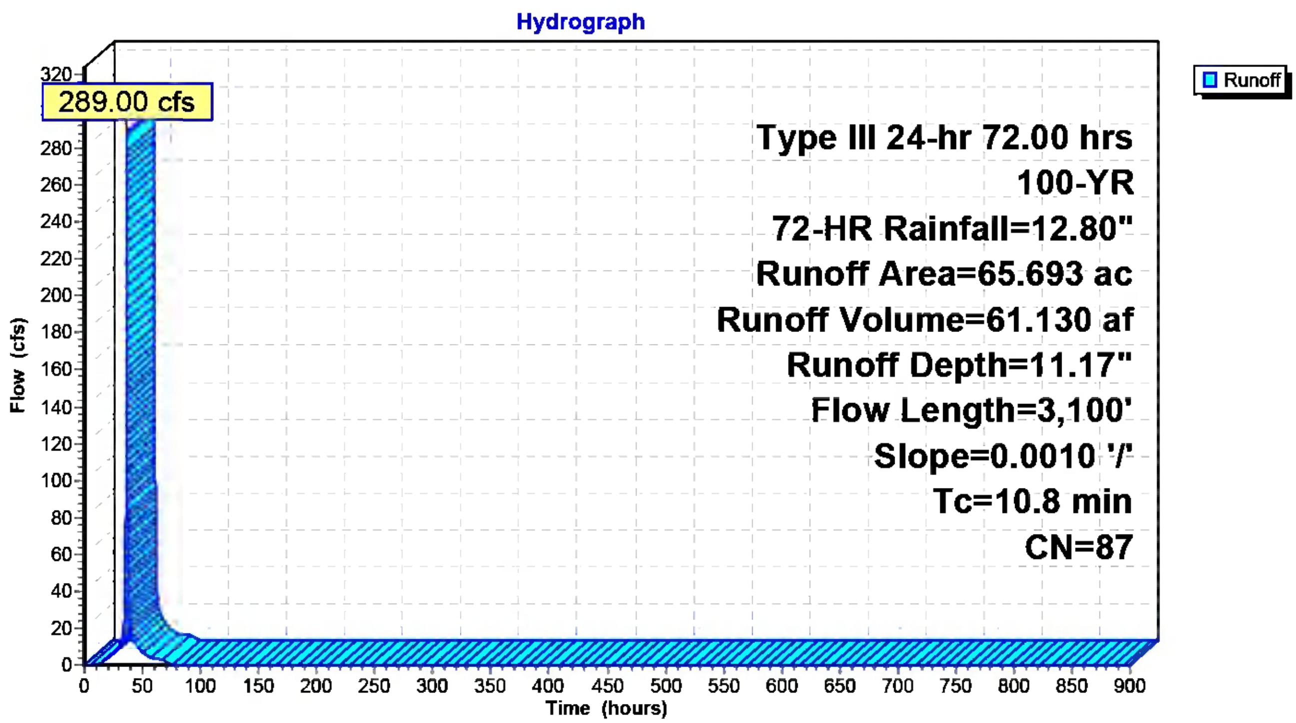
Runoff = 289.00 cfs @ 36.15 hrs, Volume= 61.130 af, Depth=11.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-900.00 hrs, dt= 0.01 hrs
Type III 24-hr 72.00 hrs 100-YR, 72-HR Rainfall=12.80"

	Area (ac)	CN	Description
*	65.693	87	90% Ash and 10% Water Surface
	65.693		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	3,100	0.0010	4.77	510.30	**Channel Flow, Channel Flow** Area= 107.0 sf Perim= 37.0' r= 2.89' n= 0.020

Subcatchment 2S: Ash Pond B



Summary for Pond 4P: Ash Pond B

Inflow	=	289.00 cfs @	36.15 hrs, Volume=	61.130 af	
Outflow	=	19.84 cfs @	39.36 hrs, Volume=	49.770 af,	Atten= 93%, Lag= 192.3 min
Primary	=	2.88 cfs @	39.36 hrs, Volume=	3.339 af	
Secondary	=	0.00 cfs @	0.00 hrs, Volume=	0.000 af	
Tertiary	=	16.95 cfs @	39.36 hrs, Volume=	46.431 af	

Routing by Sim-Route method, Time Span= 0.00-900.00 hrs, dt= 0.01 hrs
Starting Elev= 33.14' Surf.Area= 12.744 ac Storage= 41.153 af
Peak Elev= 35.14' @ 39.36 hrs Surf.Area= 27.906 ac Storage= 80.298 af (39.145 af above start)

Plug-Flow detention time= 5,856.7 min calculated for 8.617 af (14% of inflow)
Center-of-Mass det. time= 1,574.5 min (3,880.9 - 2,306.3)

Volume	Invert	Avail.Storage	Storage Description
#1	21.00'	235.686 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
21.00	0.110	0.000	0.000
22.00	0.174	0.142	0.142
23.00	0.482	0.328	0.470
24.00	0.975	0.728	1.198
25.00	1.245	1.110	2.308
26.00	1.474	1.359	3.668
27.00	1.800	1.637	5.305
28.00	2.451	2.125	7.430
29.00	3.866	3.159	10.589
30.00	5.289	4.577	15.166
31.00	6.338	5.813	20.980
32.00	9.304	7.821	28.801
33.00	11.944	10.624	39.425
34.00	17.658	14.801	54.226
35.00	26.792	22.225	76.451
36.00	34.713	30.752	107.203
37.00	41.359	38.036	145.239
38.00	45.093	43.226	188.465
39.00	49.349	47.221	235.686

Device	Routin	Invert	Outlet Devices
#1	Tertiary	30.21'	**21.6" Round Culvert** L= 113.3' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 30.21' / 16.99' S= 0.1167 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 2.54 sf
#2	Device 1	33.90'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	36.50'	**30.0" Round Culvert 1** L= 40.8' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 35.52' / 36.50' S= -0.0240 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 4.91 sf
#4	Primary	34.49'	**48.0" Round Culvert 2** L= 30.9' CMP, projecting, no headwall, Ke= 0.900

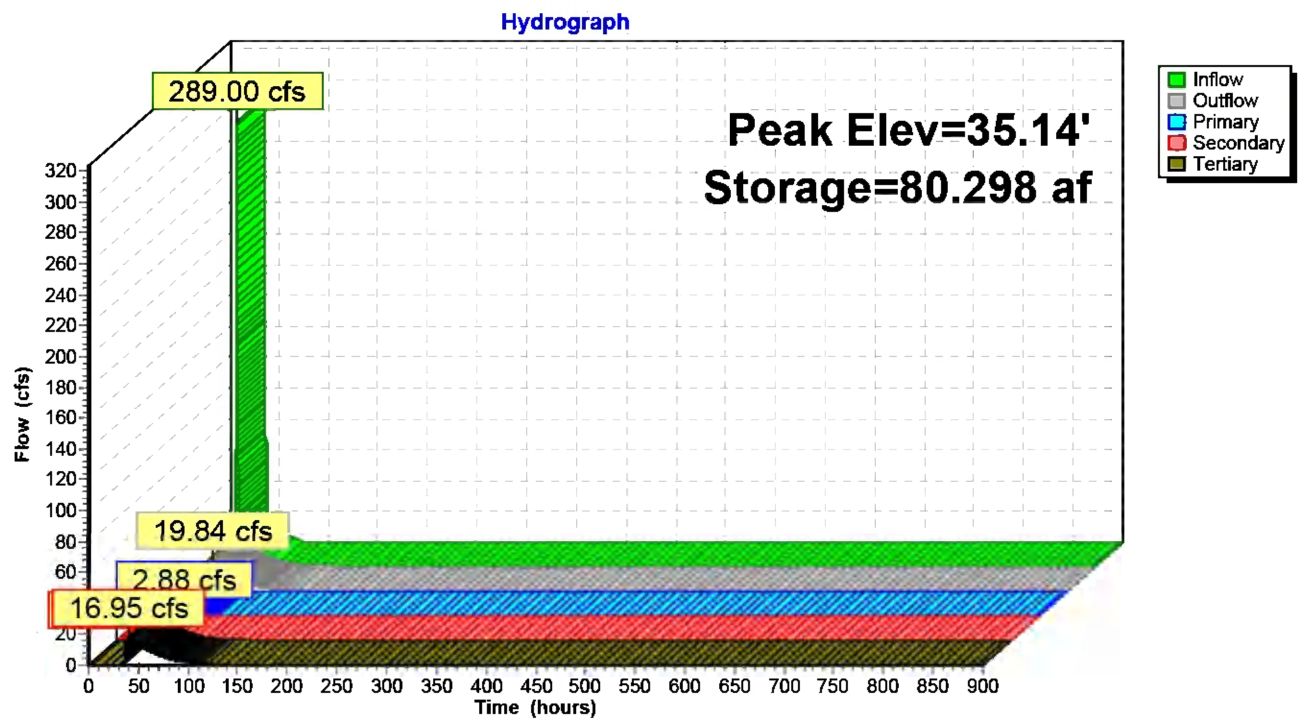
			Inlet / Outlet Invert= 34.28' / 34.49' S= -0.0068 '/' Cc= 0.900
			n= 0.012 Steel, smooth, Flow Area= 12.57 sf
#5	Primary	35.20'	**42.0" Round Culvert 3**
			L= 24.6' CMP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 34.70' / 35.20' S= -0.0203 '/' Cc= 0.900
			n= 0.012 Steel, smooth, Flow Area= 9.62 sf
#6	Secondary	36.00'	**85.0' long x 11.5' 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) 2.55 2.60 2.70 2.67 2.67 2.67 2.66 2.64

Primary OutFlow Max=2.88 cfs @ 39.36 hrs HW=35.14' TW=23.03' (Dynamic Tailwater)
3=Culvert 1 (Controls 0.00 cfs)
4=Culvert 2 (Inlet Controls 2.88 cfs @ 2.17 fps)
5=Culvert 3 (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=33.14' TW=17.00' (Dynamic Tailwater)
6=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Tertiary OutFlow Max=16.95 cfs @ 39.36 hrs HW=35.14' TW=23.15' (Dynamic Tailwater)
1=Culvert (Passes 16.95 cfs of 19.42 cfs potential flow)
2=Sharp-Crested Rectangular Weir (Weir Controls 16.95 cfs @ 3.64 fps)

Pond 4P: Ash Pond B



Summary for Pond 8P: Ash Pond A

Inflow =	393.04 cfs @	36.14 hrs,	Volume=	85.086 af
Outflow =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af, Atten= 100%, Lag= 0.0 min
Primary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af

Routing by Sim-Route method, Time Span= 0.00-900.00 hrs, dt= 0.01 hrs
Peak Elev= 24.06' @ 73.10 hrs Surf.Area= 26.727 ac Storage= 85.072 af

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	17.00'	837.990 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
17.00	1.463	0.000	0.000
18.00	2.653	2.058	2.058
19.00	5.950	4.301	6.359
20.00	8.019	6.984	13.344
21.00	12.211	10.115	23.459
22.00	17.713	14.962	38.421
23.00	23.002	20.357	58.778
24.00	26.325	24.664	83.442
25.00	32.861	29.593	113.035
26.00	34.797	33.829	146.864
27.00	37.477	36.137	183.001
28.00	41.370	39.424	222.425
29.00	48.989	45.179	267.604
30.00	53.062	51.026	318.629
31.00	56.826	54.944	373.573
32.00	61.765	59.295	432.869
33.00	69.069	65.417	498.286
34.00	68.844	68.957	567.242
35.00	69.304	69.074	636.317
36.00	72.249	70.776	707.093
37.00	72.617	72.433	779.526
38.00	44.312	58.465	837.990

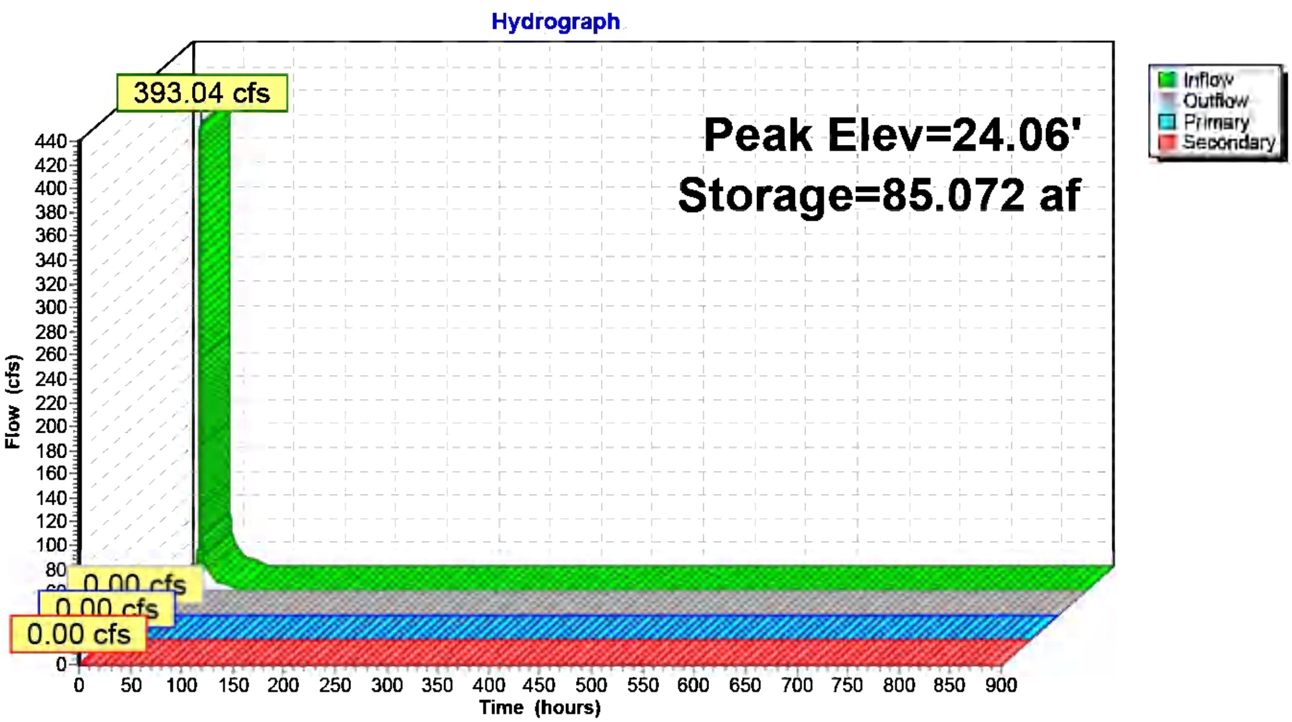
Device	Routing	Invert	Outlet Devices
#1	Primary	36.50'	**30.0" Round Culvert 1** L= 40.8' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 36.50' / 35.52' S= 0.0240 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 4.91 sf
#2	Primary	34.49'	**48.0" Round Culvert 2** L= 30.9' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 34.49' / 34.28' S= 0.0068 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 12.57 sf
#3	Primary	35.20'	**42.0" Round Culvert 3** L= 24.6' CMP, projecting, no headwall, Ke= 0.900

			Inlet / Outlet Invert= 35.20' / 34.70' S= 0.0203 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 9.62 sf
#4	Secondary	36.00'	**86.5' long x 11.0' 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) 2.53 2.59 2.70 2.68 2.67 2.68 2.66 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=17.00' TW=33.14' (Dynamic Tailwater)
1=Culvert 1 (Controls 0.00 cfs)
2=Culvert 2 (Controls 0.00 cfs)
3=Culvert 3 (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=17.00' TW=33.14' (Dynamic Tailwater)
4=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 8P: Ash Pond A



Summary for Link 7L: Discharge Canal

Inflow	=	16.95 cfs @	39.36 hrs,	Volume=	46.431 af
Primary	=	16.95 cfs @	39.37 hrs,	Volume=	46.431 af, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-900.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 23.15'

Link 7L: Discharge Canal