PERIODIC INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN
PLANT BARRY GYPSUM POND
ALABAMA POWER COMPANY

EPA's "Disposal of Coal Combustion Residuals from Electric Utilities Final Rule (40 C.F.R. Part 257 and Part 261) and the State of Alabama's ADEM Admin. Code Chapter 335-13-15 establish certain hydrologic and hydraulic capacity requirements for CCR surface impoundments. Per §257.82 and ADEM Admin. Code r. 335-13-15-.05(3), the owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR surface impoundment is required to design, construct, operate and maintain an inflow design flood control system capable of safely managing flow during and following the peak discharge of the specified inflow design flood. The owner or operator also must prepare a written plan documenting how the inflow flood control system has been designed and constructed to meet the requirements of the referenced sections of the rules. In addition, §257.82(f)(4) and ADEM Admin. Code r. 335-13-15-.05(3)(c)4. require a revision to the inflow design flood control system plan be prepared every 5 years.

The existing CCR surface impoundment referred to as the Plant Barry Gypsum Pond is located at Alabama Power Company's Plant Barry. The facility consists of a CCR storage area and a sedimentation pond. The inflow design flood consists mainly of the rainfall that falls within the limits of the surface impoundment (process flows into the pond were determined to be negligible during the design storm). Stormwater is temporarily stored within the limits of the surface impoundment and discharged through a 6-foot square concrete riser connected to a 36" HDPE pipe that discharges into the sedimentation pond.

The inflow design flood has been calculated using the Natural Resources Conservation Service method (also known as the Soil Conservation Service (SCS) method) using the 1,000-yr storm event required for a Significant hazard potential facility. Runoff curve number data was determined using Table 2-2A from the Urban Hydrology for Small Watersheds (TR-55). Appendix A and B from the TR-55 were used to determine the rainfall distribution methodology. Precipitation values were determined from NOAA's Precipitation Frequency Data Server (Atlas-14).

The NRCS provided information on the soil characteristics and hydrologic groups present at the site. It was determined that the hydrological groups "C" should be used to best reflect the characteristics of the soils on site in order to determine curve number values. This information was placed into Hydraflow Hydrographs and used to generate appropriate precipitation curves, storm basin routing information, and resulting rating curves to evaluate surface impoundment capacity.

Calculations indicate the unit can safely store and pass the inflow design storm without overtopping the perimeter embankments.

The facility is operated subject to and in accordance with §257.3-3 and ADEM Admin. Code r. 335-13-4-.01(2)(a) and (b).

I hereby certify that the inflow design flood control system plan meets the requirements of 40 C.F.R. §257.82 and ADEM Admin. Code r. 335-13-15-.05(3).

10/13/2021

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Inflow Design Control System Plan:
Hydrologic and Hydraulic Calculation Summary

for

Plant Barry Gypsum Storage Area

Prepared by:

Southern Company Services
Environmental Solutions

Originator: ______________________ 9/30/21
Jim W. Minor Date

Reviewer: ______________________ 10/7/21
Jeff P. Harper Date

Approval: ______________________ 10/7/21
James C. Pegues Date

1.0 Purpose of Calculation

The purpose of this report is to demonstrate the hydraulic capacity of the subject CCR surface impoundment to prepare an inflow design flood control plan as required by the United States Environmental Protection Agency's (EPA) final rule for Disposal of CCR from Electric Utilities (EPA 40 CFR 257) and the State of Alabama's ADEM Admin. Code Chapter 335-13-15 to establish certain hydrologic and hydraulic capacity requirements for CCR surface impoundments.

2.0 Project Narrative

The CCR surface impoundment consists of one gypsum cell that is currently in operation (Cell 1). Cell 1 is constructed with a perimeter raised dike that prevents watershed run-on from entering the cell. Run-off within Cell 1 is managed by six 36" diameter pipe culverts and a riser structure with a 36" diameter horizontal discharge pipe. An interior perimeter ditch directs run-off within the cell into the Sedimentation Pond through the six 36" diameter pipe culverts and a leachate collection & removal system. The riser structure also directs run-off within the cell into the Sedimentation Pond through a single 36" diameter pipe culvert. Because the grades within the cell are constantly changing due to placement of the CCR by-product, a conservative approach was taken for determining the water level (normal pool) within the cell. For the purposes of this calculation, a normal pool water elevation of 25.00 was assumed for within the cell based on current gypsum levels.

The normal pool elevation for the sedimentation pond varies between elevation 14.00 and 16.00. For the purposes of this calculation, the maximum normal pool elevation of 18.00 was assumed for the inflow design control model. The normal pool elevation data was provided by the Plant Barry Steam Plant Engineering group.

This cell layout is shown on sketch SK-051821 on page 11 of this report.

3.0 Summary of Conclusions

A hydraulic and hydrologic model was developed for the Plant Barry Gypsum Storage Area to determine the hydraulic capacity of the impoundment. The design storm for the facility is a 1000-year, 24-hour rainfall event.

The results of routing this storm event are presented in Table 1 below:

Table 1 - Flood Routing Results for Plant Barry Gypsum Storage Area

Storage Pond Name	Normal Pool El.* (ft)	Top of Embank-ment El (ft)	Auxiliary Spillway Crest El (ft)	Peak Water Surface El. (ft)	Freeboard** (ft)	Peak Inflow (cfs)	Peak Outflow (cfs)
Gypsum Cell	25	31	N/A	25.28	5.72	242.06	269.23
Sedimentation Pond	18	31	N/A	25.28	5.72	272.09	0

*Normal pool is assumed at 18.00 as a conservative case within the Sedimentation Pond. Pumps will control the water level during normal operations and the pool elevation will fluctuate between 14.00 and 16.00. Elevation 18.00 was assumed as a worst-case scenario normal pool elevation.
**Freeboard is measured from the peak water surface to the top of embankment.

4.0 Methodology

The storm water flows have been calculated using the National Resources Conservation Service Method (also known as the Soil Conservation Service method-SCS Method) using the 24-hour 1000-year storm event.

4.1 Hydrologic Analyses

The design storm for all inflow design flood control plan analysis is a 24-hour, rainfall event. A summary of the design storm parameters and rainfall distribution methodology for these calculations is summarized below in Table 2.

Table 2 - Design Storm Distribution for Plant Barry Gypsum Storage Area

Return Frequency (years)	Storm Duration (hours)	Rainfall total (inches)	Rainfall Source	Storm Distribution
1000	24	21.5	NOAA Atlas 14	SCS Type III

Drainage basin delineation was made using topographic survey data for the project and construction drawings for the project (SCS drawings E5C11033, E5C11036, E5C11048, and E5C11050 and as shown on sketch CS-SK-051821 on page 11 of this report). The topographic data was provided by Southern Company Civil Field Services and is shown on a drawing titled “BAR_GYP_12-22-20_surface.dwg” dated December 22, 2020.

Pertinent basin characteristics of the gypsum storage area are provided below in Table 3.

Table 3 – Gypsum Storage Area Hydrologic Information

Drainage Basin Area	31.8
Hydrologic Curve Number, CN	91
Hydrologic Method	SCS Method
Time of Concentration (minutes)	6.00 minutes (sed pond) and 35.25 minutes (Cell)
Hydrologic Software	Autodesk Storm and Sanitary Analysis 2019

Run-off values were determined by importing the characteristics developed above into a hydrologic model with Autodesk Storm and Sanitary Analysis 2019 software.

4.2 Hydraulic Analyses

Storage values were determined by developing a stage-storage relationship utilizing contour data for the cell area and sedimentation pond area. The cell area is connected to the sedimentation pond through a concrete riser structure with a horizontal 36" diameter culvert and six 36" diameter culverts that discharge into the sedimentation pond.

5.0 Supporting Information

6.1 Curve Number

Table 4 - Curve Number Data

Location	Terrain Type	Area	Curve Number
Sedimentation Pond	Water & gravel	10.4	98
Gypsum Cell	Bare Gypsum	21.4	91

6.2 Stage Storage Tables

Sedimentation Pond Stage Storage			
Elevation	Total Area (s.f.)	Depth	Cumulative Volume (c.f.)
9	210,936	0	0
10	219,168	1	215,052
11	227,676	2	438,474
12	236,339	3	670,482
13	248,683	4	912,993
14	256,441	5	1,165,555
15	264,280	6	1,425,915
16	272,200	7	1,694,155
17	280,201	8	1,970,356
18	288,272	9	2,254,592
19	296,448	10	2,546,952
20	304,693	11	2,847,523
21	313,019	12	3,156,379
22	321,427	13	3,473,602
23	329,916	14	3,799,273
24	338,486	15	4,133,474
25	347,137	16	4,476,286
26	355,864	17	4,827,786
27	364,658	18	5,188,047
28	373,497	19	5,557,125
29	382,450	20	5,935,098
30	391,399	21	6,322,023
31	400,322	22	6,717,883

Gypsum Pond Stage Storage (Cell)			
Elevation	Area (s.f.)	Total Area (s.f.)	Cumulative Volume (c.f.)
22	11,019	19,358	0
24	60,639	128,248	147,606
26	8,307	291,335	573,590
28	875	684,015	1,555,341
30	808,734	808,734	3,048,090

6.0 Time of Concentration

Time of Concentration (Tc) for the sedimentation pond area is the minimum Tc of 6 minutes. The Time of Concentration for the gypsum storage area is shown below.

Subbasin : GypCellStorage

Input Data

Area (ac) 21.40
Weighted Curve Number 91.85
Rain Gage ID .... Storm

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Bare Gypsum	18.80	-	91.00
Paved parking & roofs	2.60	C	98.00
Composite Area & Weighted CN	21.40		91.85

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.10	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	3.58	0.00	0.00
2 yr, 24 hr Rainfall (in) :	5.47	0.00	0.00
Velocity (ft/sec) :	0.39	0.00	0.00
Computed Flow Time (min) :	4.29	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	1672	0.00	0.00
Slope (%) :	0.31	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	0.90	0.00	0.00
Computed Flow Time (min) :	30.96	0.00	0.00

Total TOC (min) 35.26

Subbasin : SedPond

Input Data

Area (ac) 10.40
Weighted Curve Number 98.00
Rain Gage ID .... Storm

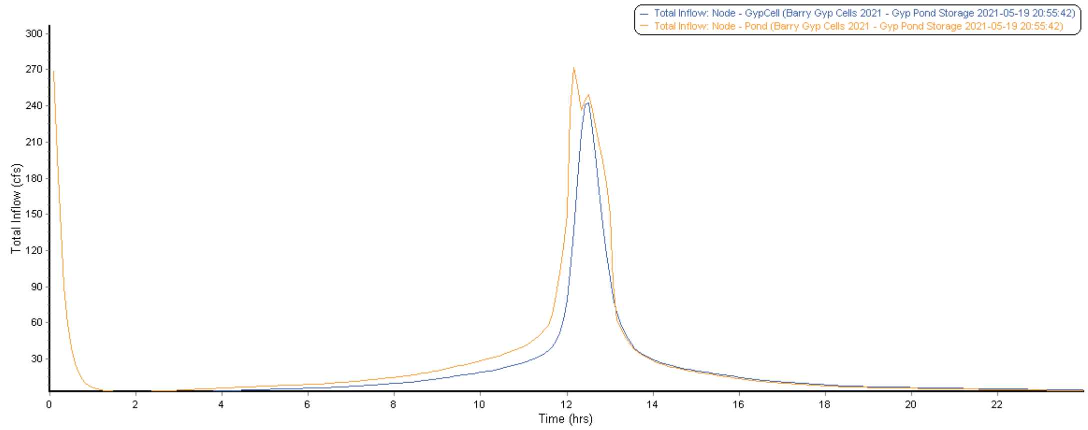
Composite Curve Number

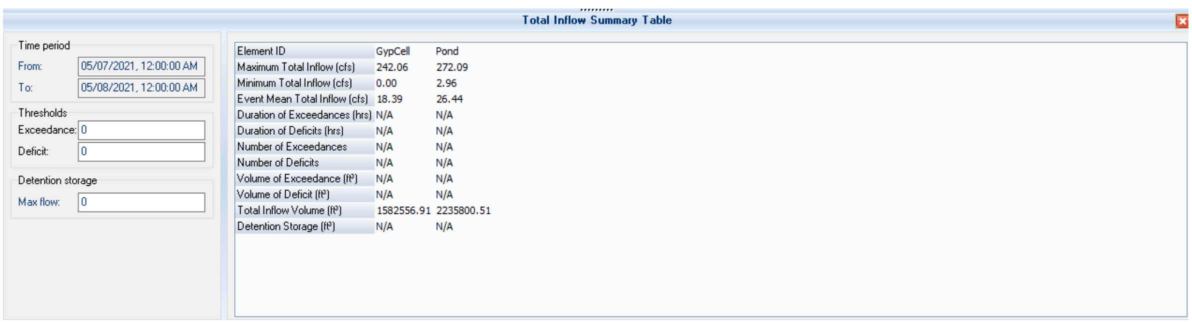
Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Ponded Area	6.61	-	98.00
Gravel perimeter road and exposed liner	3.78	-	98.00
Composite Area & Weighted CN	10.39		98.00

Time of Concentration

User-Defined TOC override (minutes): 6

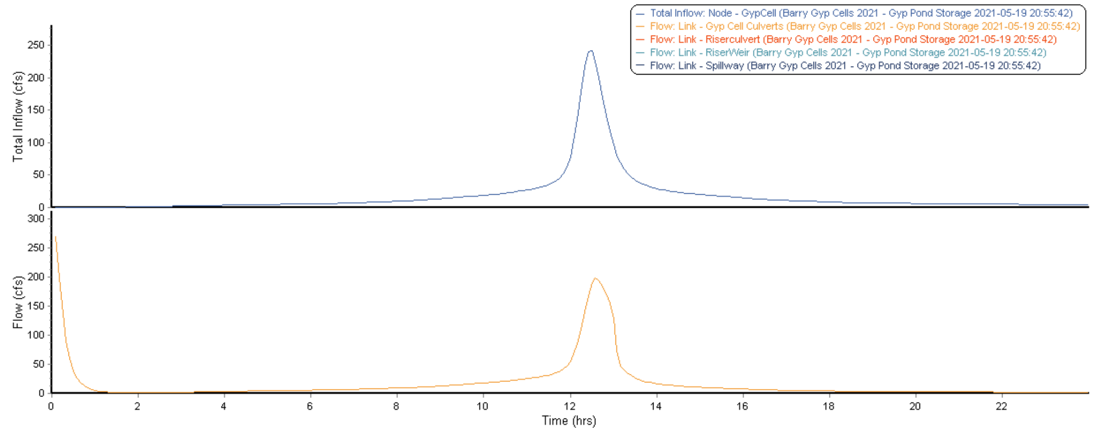
7.0 Results





Element ID	GypCell	Pond
Maximum Total Inflow (cfs)	242.06	272.09
Minimum Total Inflow (cfs)	0.00	2.96
Event Mean Total Inflow (cfs)	18.39	26.44
Duration of Exceedances (hrs)	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A
Number of Exceedances	N/A	N/A
Number of Deficits	N/A	N/A
Volume of Exceedance (ft³)	N/A	N/A
Volume of Deficit (ft³)	N/A	N/A
Total Inflow Volume (ft³)	1582556.91	2235800.51
Detention Storage (ft³)	N/A	N/A

Peak Inflow for the Gypsum Cell and Sedimentation Pond



Flow Summary Table

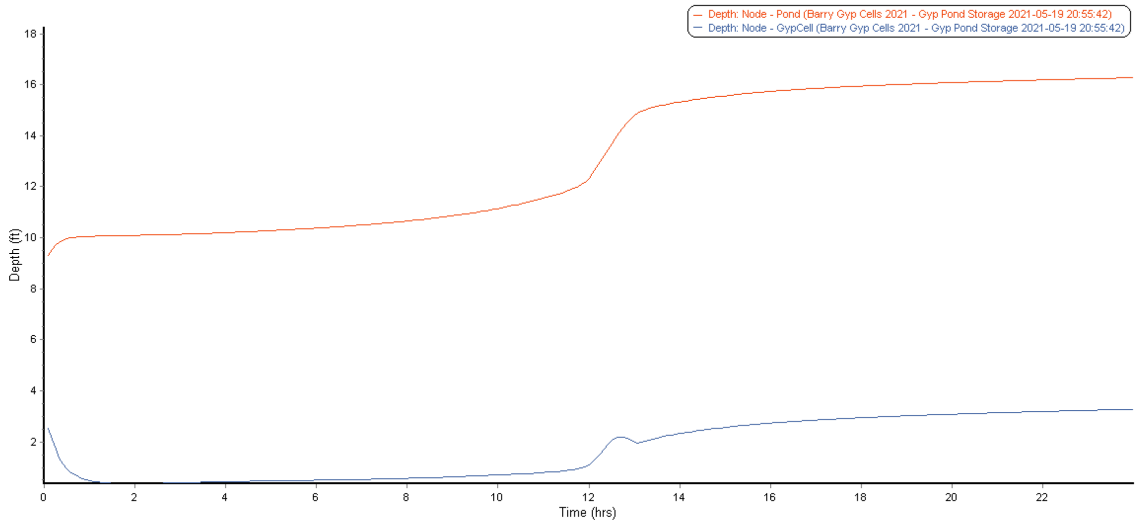
Time period
From: 05/07/2021, 12:00:00 AM
To: 05/08/2021, 12:00:00 AM

Thresholds
Exceedance: 0
Deficit: 0

Detention storage
Max flow: 0

Element ID	Gyp Cell Culverts	Riserculvert	RiserWeir	Spillway
Maximum Flow (cfs)	269.16	0.03	0.04	0.00
Minimum Flow (cfs)	1.03	-0.19	0.00	0.00
Event Mean Flow (cfs)	17.13	-0.02	0.00	0.00
Duration of Exceedances (hrs)	N/A	N/A	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A	N/A	N/A
Number of Exceedances	N/A	N/A	N/A	N/A
Number of Deficits	N/A	N/A	N/A	N/A
Volume of Exceedance (ft³)	N/A	N/A	N/A	N/A
Volume of Deficit (ft³)	N/A	N/A	N/A	N/A
Total Flow (ft³)	1434608.48	-1521.87	288.9	0
Detention Storage (ft³)	N/A	N/A	N/A	N/A

Peak Outflow for the Gypsum Cell



Depth Summary Table

Time period
From: 05/07/2021, 12:00:00 AM
To: 05/08/2021, 12:00:00 AM

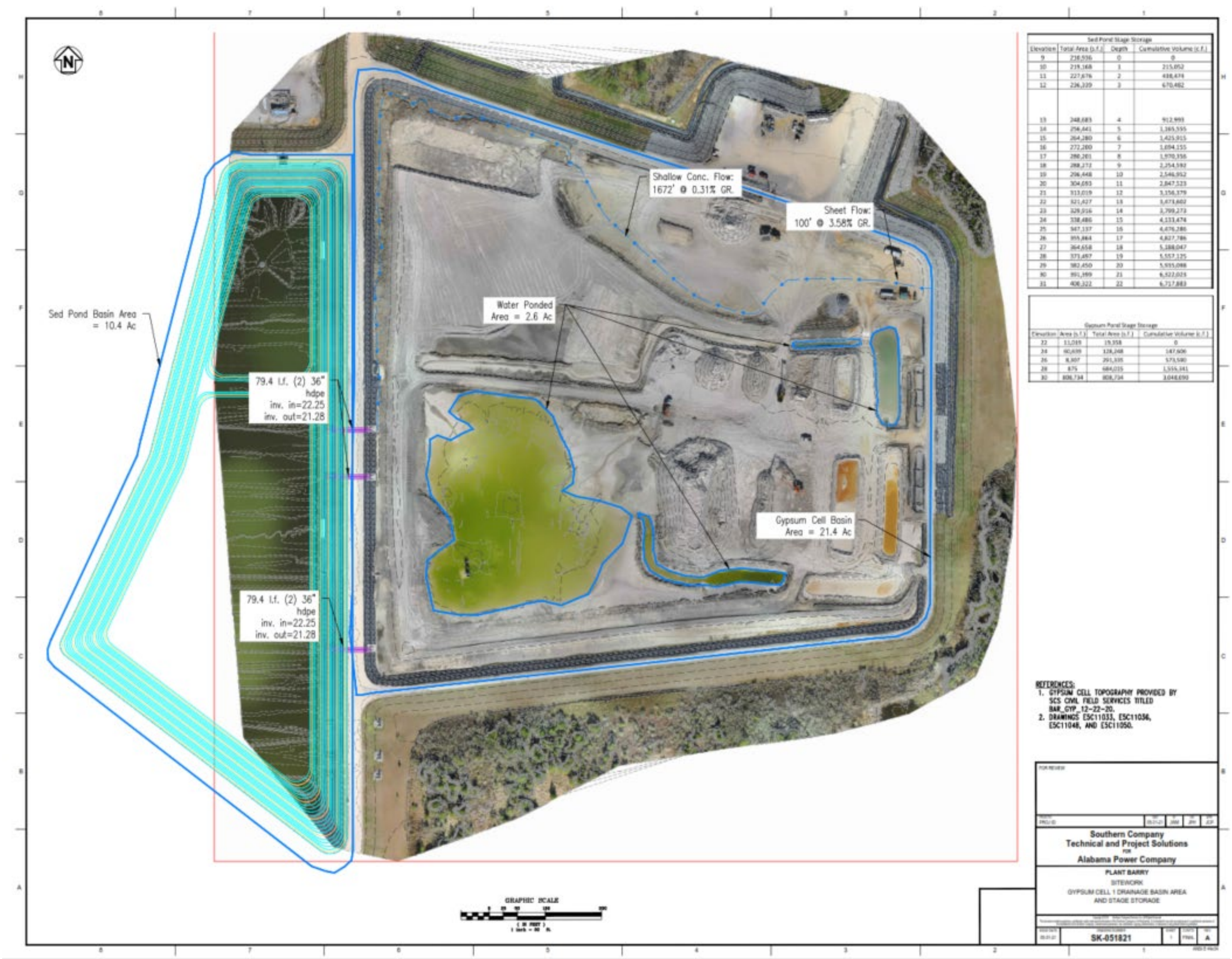
Thresholds
Exceedance: 0
Deficit: 0

Detention storage
Max flow: 0

Element ID	Pond	GypCell
Maximum Depth (ft)	16.28	3.28
Minimum Depth (ft)	9.30	0.36
Event Mean Depth (ft)	13.18	1.71
Duration of Exceedances (hrs)	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A
Number of Exceedances	N/A	N/A
Number of Deficits	N/A	N/A

Maximum water depths for the Gypsum Cell and Sedimentation Pond

8.0 Drainage Basin



<u>Sketch SK-051821</u>