Inflow Design Flood Control System Plan
Brame Fly Ash Pond

CLECO Corporation

Rodemacher Unit 2
Project No. 90965

Revision 0
10/17/2016

Inflow Design Flood Control System Plan
Brame Fly Ash Pond

prepared for

CLECO Corporation
Rodemacher Unit 2
Rapides Parish, Louisiana

Project No. 90965

Revision 0
10/17/2016

prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

INDEX AND CERTIFICATION

CLECO Corporation
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Certification

I hereby certify, as a Professional Engineer in the state of Louisiana, that the information in this document was assembled under my direct supervisory control. This report is not intended or represented to be suitable for reuse by the CLECO Corporation or others without specific verification or adaptation by the Engineer.

This document has been digitally sealed and signed. October 17, 2016.

Randell L Sedlacek, P.E.
Louisiana License #38408

Date: 10/17/16

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LIST OF ABBREVIATIONS

Abbreviation	**Term/Phrase/Name**
ac	acre
BMcD	Burns & McDonnell
Brame	Brame Energy Center
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
cfs	cubic feet per second
CLECO	CLECO Corporation
CY	cubic yard
ELG	Effluent Limitations Guidelines
EPA	Environmental Protection Agency
ft	feet
GPM	Gallons per Minute
hr	hour
in	inch
LDOTD	Louisiana Department of Transportation and Development
LPDES	Louisiana Pollutant Discharge Elimination System
LSU	Louisiana State University
MGD	Million Gallons per Day
min	minute
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988

Abbreviation	Term/Phrase/Name
NGVD 29	National Geodetic Vertical Datum of 1929
NRCS	Natural Resources Conservation Service
PFDS	Precipitation Frequency Data Server
RCRA	Resource Conservations and Recovery Act
SCS	Soil Conservation Service
U.S.C.	United States Code
USDA	US Department of Agriculture

1.0 INTRODUCTION

On April 17, 2015, the Environmental Protection Agency (EPA) issued the final version of the federal Coal Combustion Residual (CCR) Rule to regulate the disposal of CCR materials generated at coal-fired units. The rule will be administered as part of the Resource Conservation and Recovery Act [RCRA, 42 United States Code (U.S.C.) §6901 et seq.], using the Subtitle D approach.

The existing CCR impoundments at CLECO Corporation's (CLECO's) Brame Energy Center (Brame) are subject to the CCR Rule and as such must meet the hydrologic and hydraulic capacity requirements outlined in 40 Code of Federal Regulations (CFR) §257.82. This report serves as the inflow design flood control system plan for the Fly Ash Pond at Brame.

This inflow design flood control system plan is in addition to, not in place of, any other applicable site permits, environmental standards, or work safety practices.

2.0 PLAN OBJECTIVES

Per 40 CFR §257.82, the inflow design flood control system plan must contain documentation (including supporting engineering calculations) that the inflow design flood control system has been designed and constructed to:

- Adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood,
- Adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood, and
- Handle discharge from the CCR surface impoundment in accordance with the surface water requirements described in 40 CFR §257.3-3.

Per 40 CFR §257.82(c)(5), CLECO must obtain certification from a qualified professional engineer that the inflow design flood control system plan, and subsequent updates to the plan, meet the requirements of 40 CFR §257.82. This sealed document serves as that certification.

3.0 EXISTING CONDITIONS

Brame is located northwest of Alexandria in Rapides Parish, Louisiana. The Fly Ash Pond is a 36.3-acre diked pond with approximately 750,000 CY of ash capacity. A site plan is included in Appendix A. The impoundment is surrounded by a 20-foot wide perimeter dike with a crest elevation of approximately 105. The dike on the northwest side is shared with the Bottom Ash Pond.

The pond receives ESP fly ash from the dry fly ash silo that is loaded onto trucks, hauled, and deposited in the pond. Normal pool elevation is maintained at approximately 86 feet. Flow from the pond is discharged by manually pumping to the Bottom Ash Pond via a 6-inch HDPE pipe. The Bottom Ash Pond discharges to a channel on the northwest embankment via a 24-inch corrugated metal pipe. From the channel, excess flow can be discharged into Lake Rodemacher through permitted LPDES Outfall 401.

4.0 DESIGN BASIS / FLOOD CONTROL SYSTEM

4.1 Hazard Potential Classification

Per 40 CFR §257.73, CLECO has determined the Brame Fly Ash Pond to be a significant hazard potential CCR surface impoundment.

4.2 Inflow Design Flood System Criteria

4.2.1 Capacity Criteria

The CCR Rule requires CCR surface impoundments to have adequate hydrologic and hydraulic capacity to manage flows for the inflow design flood. For this analysis, the criteria was interpreted as being the top of the surface impoundment dike should not be overtopped during the inflow design flood event.

4.2.2 Freeboard Criteria

The CCR documentation further discusses that operating freeboard must be adequate to meet performance standards, but a specific freeboard is not defined.

4.2.3 Flood Routing Design Criteria

The inflow design flood for this analysis is a 1,000-year flood event per 40 CFR §257.82(a)(3)(ii).

4.3 Project Mapping

Project mapping for this analysis consisted of an inventory of stormwater assets that contribute to the surface impoundment. Three primary sources of information were utilized: construction record drawings, plant operational information, and survey data.

4.3.1 Mapping Sources

Survey data utilized included LIDAR topography from the Louisiana State University (LSU) Atlas Lidar Downloader, retrieved in January of 2016. Construction record drawings of the surface impoundment were also utilized in the analysis.

4.3.2 Vertical Datum

Elevations shown on the existing drawings are in the National Geodetic Vertical Datum of 1929 (NGVD 29). Mapping sources referenced were in the North American Vertical Datum of 1988 (NAVD 88) and have been converted to NGVD 29

4.3.3 Horizontal Coordinate System

Data from the LSU Atlas Lidar which was utilized as the basis for mapping and modeling efforts is in the Louisiana State Plane North, North American Datum 1983 (NAD 83) coordinate system.

5.0 HYDROLOGIC AND HYDRAULIC CAPACITY

HEC-HMS 4.0 was used to model reservoir characteristics under the design storm event. Inputs to the HEC-HMS model were assumed to be as follows.

5.1 Pond Inflows

5.1.1 Runoff

5.1.1.1 Recurrence Interval and Rainfall Duration

The inflow flood design event for this study, as dictated by the hazard potential classification, was a 1,000-year flood event. Because a storm duration is not specified under 40 CFR §257.82 or other pertinent inflow flood design sections within the CCR Rule, a 24-hour storm duration was utilized.

5.1.1.2 Rainfall Distribution and Depth

The Soil Conservation Service (SCS) Type III rainfall distribution was used for computations associated with this evaluation. Precipitation data was acquired from the NOAA Precipitation Frequency Data Server (PFDS). Precipitation depth for the inflow design flood event is 22.6 inches.

5.1.1.3 Subbasin Characteristics

Calculations were determined based on the watershed parameters shown in Table 5-1. Refer to Appendix B for more detailed calculations.

Table 5-1: Watershed Runoff Calculated Data for Brame Fly Ash Pond

Component	Value	Unit
Watershed Area	38.8	ac
SCS Storm Depth: 1,000-yr, 24-hr	22.6	in
Weighted Curve Number	87	-
Initial Abstraction	0.299	in
Time of Concentration	19.85	min
Basin Lag Time	11.91	min

5.1.2 Process Flows

When conducting the hydraulic analysis, it was assumed the pond is maintained at the normal operating level (86.0 feet) prior to the storm event. All runoff into the pond is considered additional flow above the normal operating level. No process flows are currently routed to the Fly Ash Pond, so it was assumed precipitation would be the only pond inflow over the duration of the storm event control period.

5.2 Pond Outflows

Stage discharge information was not included in this model. To be conservative, it was assumed the Fly Ash Pond manual pump would not be operated for the duration of the storm event control period.

6.0 RESULTS

The pond was modeled for a 1,000-year, 24-hour storm event with the initial elevation set at the normal operating level, no discharge, and the pond being 50% full of fly ash up to the top of the dike.

Under the design conditions, the pond was able to contain runoff from the 1,000-year, 24-hour storm without overtopping. The results of the modeled storm event are as follows:

Table 6-1: Modeled Pond Design and Proposed Conditions

Component	Property	Value	Unit
Subbasin Watershed	Peak Discharge	555.4	cfs
	Runoff Volume	20.9	in
Reservoir Fly Ash Pond – 50% full of ash	Initial EL	86.0	ft
	Peak Inflow	555.4	cfs
	Peak Discharge	0.0	cfs
	Peak Elevation	90.6	ft
	Peak Storage	68.0	ac-ft

After a significant storm event, excess water collected in the Fly Ash Pond can be discharged via pumping to the Bottom Ash Pond similar to current operations. From there, excess water can be pumped to the overflow channel for discharge via permitted LPDES Outfall 401.

7.0 PERIODIC ASSESSMENT AND AMENDMENT

CLECO must place the initial plan in the CCR Operating Record by October 17, 2016. After the initial plan is published in the Operating Record, periodic inflow design flood control system plans will be required every five years. CLECO may publish revised plans at shorter intervals, noting, however, the deadline for publishing the next revision will be maintained as five years after publish of the previous revision. CLECO may amend the plan at any time, and is required to do so whenever there is a change in conditions which would affect the current plan. All amendments and revisions must be placed on the CCR public website. A record of revisions made to this document is included in Section 8.0.

8.0 RECORD OF REVISIONS AND UPDATES

Revision Number	Date	Revisions Made	By Whom
0	10/17/2016	Initial Issue	Burns & McDonnell

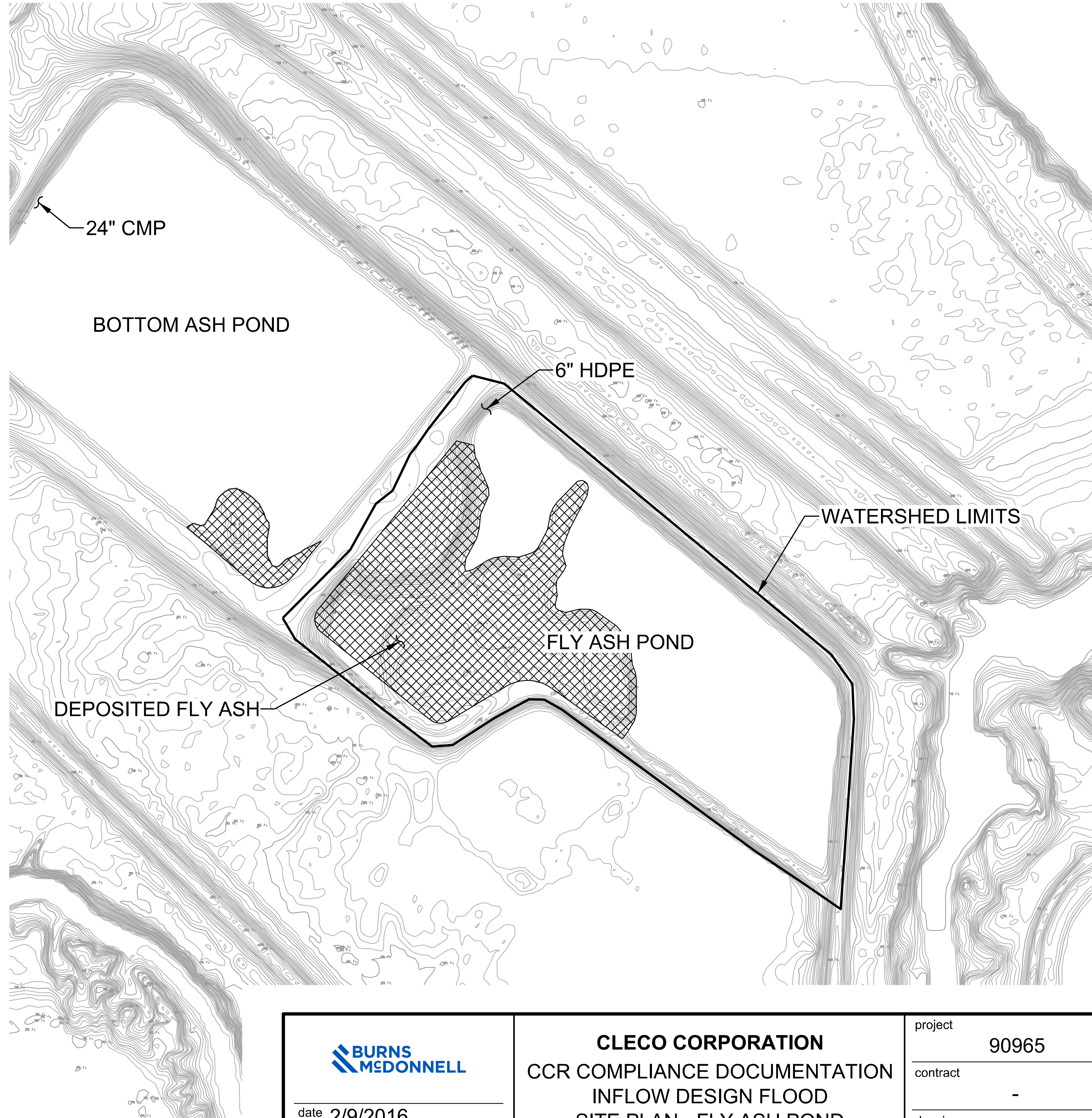
APPENDIX A – SITE PLAN

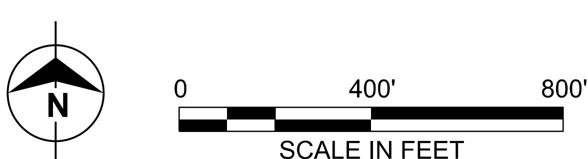
NOTES:

1. EXISTING CONTOURS PER LOUISIANA STATE UNIVERSITY ATLAS LIDAR DOWNLOADER, RETRIEVED JANUARY 2016

2. ASH POND OPERATING CHARACTERISTICS ARE AS FOLLOWS:

	WATERSHED AREA (AC)	OPERATING LEVEL (FT)
FLY ASH POND	38.8	86





BURNS McDONNELL

date 2/9/2016

designed A. MYERS

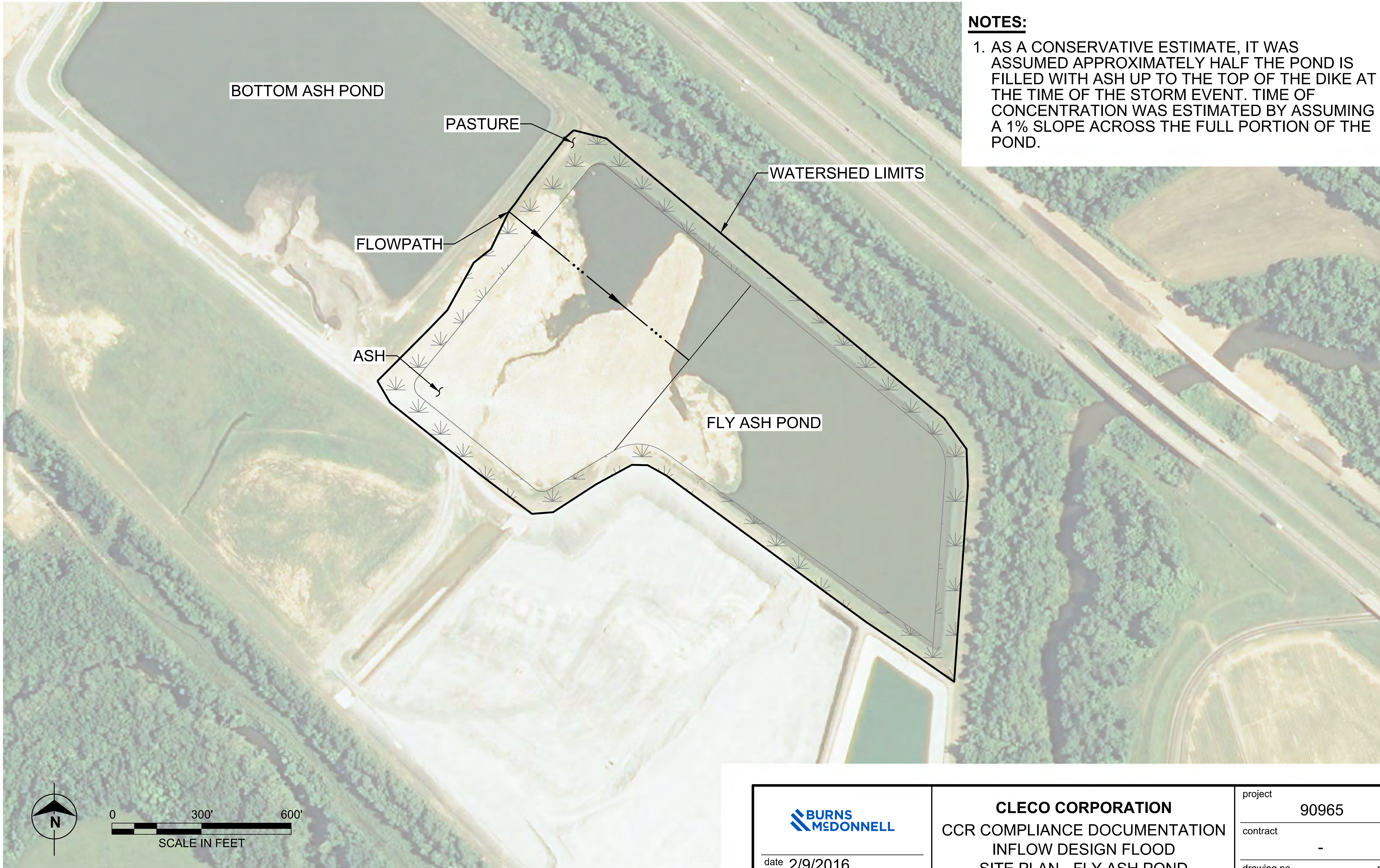
CLECO CORPORATION

CCR COMPLIANCE DOCUMENTATION

INFLOW DESIGN FLOOD

SITE PLAN - FLY ASH POND

project	90965
contract	-
drawing no.	**SK - CIVIL - 001**
rev.	**0**



NOTES:

1. AS A CONSERVATIVE ESTIMATE, IT WAS ASSUMED APPROXIMATELY HALF THE POND IS FILLED WITH ASH UP TO THE TOP OF THE DIKE AT THE TIME OF THE STORM EVENT. TIME OF CONCENTRATION WAS ESTIMATED BY ASSUMING A 1% SLOPE ACROSS THE FULL PORTION OF THE POND.

BURNS McDONNELL

date 2/9/2016

designed A. MYERS

CLECO CORPORATION

CCR COMPLIANCE DOCUMENTATION

INFLOW DESIGN FLOOD

SITE PLAN - FLY ASH POND

project 90965

contract -

drawing no. **SK - CIVIL - 002** rev. **0**

APPENDIX B – ENGINEERING CALCULATIONS

WORKSHEET TITLE:	Inflow Design Flood - Brame Fly Ash Pond	**CALCULATION NO.:**	90965 - C - 001
CREATED:	2/5/2016	**REVISION:**	0
PERFORMED BY:	A. MYERS	**REVIEWED BY:**	J. Eichenberger
OBJECTIVE:	Determine capacity of pond to maintain a 1,000-year, 24-hour storm event using SCS Curve Number Method		

REFERENCES:

1 Lindeburg, M. (2008). Civil engineering reference manual for the PE exam. 11th ed. Belmont, CA: Professional Publications, Inc.

2 US Department of Agriculture. (no date). Custom soils resouces report for Rapides Parish, LA. Retrieved from http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

3 National Oceanic and Atmospheric Administration. (2015). NOAA Atlas 14, Volume 9, Version 2. [Point precipitation frequency estimates for Alexandria, LA, US]. Retrieved from http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=la

4 United States. Department of Agriculture. Natural Resources Conservation Service. National Engineering Handbook: Part 630 Hydrology, Chapter 15 Time of Concentration. N.p., n.d. Web. 9 Feb. 2016. Retrieved from http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=27002.wba

SOFTWARE:

1 Bentley® FlowMaster® V8i (SELECTseries 1)

Bentley Systems, Inc
27 Siemon Company Drive Ste 200W
Watertown, CT 06795 USA

Phone: +1-203-755-1666
Fax: +1-203-597-1488
Web: http://www.bentley.com
Contact Technical Support

Registered To:
User Name:
Company:
Serial Number:
License: Commercial
Is Checked Out: False
Expiration Date:

SELECT Server Name: selectserver.bentley.com
Activation Key: VS-E254C09D30C24FFB881E3218676F8
Site ID:

2 **Hydrologic Modeling System (HEC-HMS)**
Version: 4.0 Build: 1542 Date: 31Dec2013 Java: 1.6.0_65

This software is developed primarily to meet the needs of the U.S. Army Corps of Engineers, though we provide a copy free on our website. Funding comes from the Corps' Civil Works Research and Development program and from special projects. To provide feature suggestions, report errors, or request additional information, write to the development team at:

U.S. Army Corps of Engineers
Institute For Water Resources
Hydrologic Engineering Center
609 Second Street
Davis, CA 95616-4620

You can also contact the development team through our website at:
www.hec.usace.army.mil

ASSUMPTIONS:

1 Design storm is 1,000 years (significant hazard classification per 2016 hazard potential classification)
2 Max intensity duration is 5 minutes
3 Soils are generally sandy loam or loamy fine sand, Hydrologic Soil Group B — Reference 2
4 Fly Ash Pond is 50% full of sediment up to the top of dike at the time of the storm event
5 Ash modeled as Hydrologic Soil Group C
6 Discharge pump is inoperable over duration of storm event

EQUATIONS:

1 Rational Method
$Q = CIA_d$ — Reference 1, p. 20-13, eq. 20.36

2 Sheet Flow Travel Time
$t_{sheet} = 0.007*(nL)^{0.8}/\sqrt{(P_2)}*S_{decimal}{}^{0.4}$ — Reference 1, p. 20-3, eq. 20.6

3 Shallow Flow Travel Time
$t_{shallow} = L/v_{shallow}$ — Reference 1, p. 20-3, section 5

4 Velocity of Shallow Flow
$v_{shallow} = 16.1345\sqrt{(S_{decimal})}$ — Reference 1, p. 20-3, eq. 20.7, [unpaved]

5 Channel Flow Travel Time
$t_{channel} = L/v_{channel}$ — Reference 1, p. 20-3, section 5

6 Time of Concentration
$t_c = t_{sheet} + t_{shallow} + t_{channel}$ — Reference 1, p. 20-3, eq. 20.5

7 Lag Time
$t_{lag} = 0.6*t_c$ — Reference 1, p.20-11, eq. 20.27

8 Soil Water Storage Capacity
$S = (1000/CN) - 10$ — Reference 1, p. 20-19, eq. 20.43

9 Initial Abstraction
$I_a = 0.2*S$ — Reference 1, p. 20-15, eq. 20.38

10 Weighted Curve Number

$CN_W = (CN_i*A_i)/A_T$

11 Weighted Rational Runoff Coefficient

$C_W = (C_i*A_i)/A_T$

VARIABLES:

1	Q	peak runoff rate, cfs
2	C	rational runoff coefficient, unitless
3	I	rainfall intensity, in/hr
4	A_d	total drainage area, ac or mi^2
5	t_{sheet}	sheet flow travel time, min
6	n	Manning's roughness coefficient, unitless
7	L	hydraulic length of the watershed, ft
8	P_2	2yr 24hr rainfall, in
9	$S_{decimal}$	slope, ft/ft
10	$t_{shallow}$	shallow concentrated flow travel time, min
11	$v_{shallow}$	shallow velocity, ft/s
12	$t_{channel}$	channel flow travel time, min
13	$v_{channel}$	channel velocity, ft/s
14	t_c	time of concentration, min
15	t_{lag}	lag time, hrs
16	S	soil water storage capacity, in
17	CN	curve number, unitless
18	I_a	initial abstraction, in
19	CN_W	weighted curve number, unitless
20	A_T	total area, ac
21	C_W	weighted rational runoff coefficient, unitless
22	CN_{WT}	total weighted curve number, unitless
23	C_{WT}	weighted rational runoff coefficient, unitless

CALCULATIONS:

1 Establish drainage area

	Fly Ash Pond	
A_d (ac)	38.8	Measured in Microstation, see SK-CIVIL-001 in Appendix A. Area delineated using contours generated from the LSU Atlas Lidar.
A_d (mi^2)	0.061	Conversion from ac to mi^2

2 Establish rainfall data (assume SCS Type III distribution)

SCS Storm	Depth (in)	
1000yr, 24hr	22.6	Reference 3

3 Establish CN, percent impervious cover, and initial abstraction. Assume antecedent moisture condition (AMC) II - average conditions.

	Fly Ash Pond			
Land Description	CN_i*	A_i** (ac)	CN_W	
Open space, fair condition	69	9.8	17	Equation 10
Open space, poor condition (ash)	86	14.5	32	Equation 10
Pond	100	14.5	37	Equation 10
A_T (ac)		38.8		Sum
CN_{WT}			87	Sum
S (in)			1.49	Equation 8
I_a (in)			0.299	Equation 9

*Reference 1, Table 20.4, p. 20-17 and Assumptions 4 & 5

**Measured in Microstation, see SK-CIVIL-002 in Appendix A. Adjusted ash area based on Assumption 4.

4 Establish Time of Concentration and Basin Lag time for SCS Unit Hydrograph Transform

Subbasin	Fly Ash Pond	
Sheet Flow		
n	0.06	Reference 1, p. 20-3, Table 20.1 - cultivated soils (cover <20%)
L* (ft)	300	Measured in Microstation, see SK-CIVIL-002 in Appendix A
P_2 (in)	5.13	Reference 3, 2yr 24hr rainfall
$S^*_{decimal}$ (ft/ft)	0.01	Assumed 1% slope across ash
t_{sheet} (hrs)	0.20	Equation 2
t_{sheet} (min)	11.81	Conversion from hrs to min
Shallow Flow		
$S^*_{decimal}$ (ft/ft)	0.01	Assumed 1% slope across ash
$V_{shallow}$ (ft/s)	1.00	Reference 4, Figure 15-4
L* (ft)	482	Measured in Microstation, see SK-CIVIL-002 in Appendix A
$t_{shallow}$ (s)	482.00	Equation 3
$t_{shallow}$ (min)	8.03	Conversion from s to min
Time of Concentration		
t_c (min)	19.85	Equation 6
Lag Time		
t_{lag} (min)	11.91	Equation 7

*Measured in Microstation

5 Run HEC-HMS with input parameters: all discharge into ponds (rainfall) is additional flow above normal operating level (EL 86).
Elevation-area data for the pond is as noted below.

EL	area* (ac)
86	14.5
87	14.6
88	14.8
89	15.0
90	15.2
91	15.4
92	15.6
93	15.8
94	15.9
95	16.1
96	16.3
97	16.5
98	16.7
99	16.9
100	16.9
101	17.3
102	17.5
103	17.7
104	17.9
105	18.0

*Measured in Microstation and adjusted based on pond being 50% full of ash

RESULTS:

Component	Subbasin		Reservoir				
Property	Peak Discharge (cfs)	Runoff Volume (in)	Initial EL*	Peak Inflow (cfs)	Peak Discharge (cfs)	Peak Elevation (ft)	Peak Storage** (ac-ft)
Fly Ash Pond	555.4	20.90	86.0	555.4	0.0	90.6	68.0

*Assumed based on pump operation info provided by Owner
**Peak storage reflects storage above initial EL

CONCLUSION:

Under the modeled conditions, the Fly Ash Pond can accept inflows from the design flood event without overtopping.
Excess water may be discharged to the Bottom Ash Pond by activating the existing, manually operated pump.

BURNS & McDONNELL

CREATE AMAZING.

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