REPORT

Inflow Design Flood Control System Plan 5 Year Update

Oak Grove Steam Electric Station
FGD Ponds
Robertson County, Texas

Submitted to:

Oak Grove Management Company LLC
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Irving, TX 75039

Submitted by:

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October 2021

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Golder Associates Inc. under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the Inflow Design Flood Control System Plan has been prepared in accordance with the requirements of 40 C.F.R. § 257.82 and 30 T.A.C. § 352.821.

STATE OF TEXAS
PATRICK J. BEHLING
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1.0 INTRODUCTION

Oak Grove Management Company LLC (Oak Grove) owns and operates the Oak Grove Steam Electric Station (OGSES) located approximately ten miles north of Franklin in Robertson County, Texas. The power plant and related support areas are located along the south side of Twin Oak Reservoir (Figure 1). The OGSES consists of two lignite-fired units with a combined operating capacity of approximately 1,796 megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash, and gypsum are generated as part of OGSES unit operation. The CCRs are transported off-site for beneficial use by third-parties or are disposed at the OGSES Ash Landfill 1.

The U.S. Environmental Protection Agency promulgated 40 C.F.R. Part 257, Subpart D (the CCR Rule) and the Texas Commission on Environmental Quality (TCEQ) promulgated 30 T.A.C. Chapter 352 (which largely adopts the federal CCR Rule by reference) to establish technical requirements for new and existing CCR landfills and surface impoundments. On June 28, 2021, USEPA approved the majority of TCEQ's CCR program, which will now operate in lieu of the federal regulations. FGD-A, FGD-B, and FGD-C (collectively the "FGD Ponds") at the OGSES have been identified as Existing CCR Surface Impoundments regulated under the CCR Rule.

Section 257.82 specifies that an Inflow Design Flood Control System Plan (IDFCSP) be designed, constructed, operated, and maintained for each existing CCR surface impoundment and 30 T.A.C. 352.821 adopts this requirement by reference. In accordance with § 257.82(c)(3), the initial IDFCSP for the FGD Ponds was completed and placed in the OGSES operating record in October 2016 (Golder, 2016a). As specified in §257.82(c)(4), the IDFCSP must be updated every five years from the completion date of the initial plan. Golder Associates Inc., a member of WSP (Golder), was retained by Oak Grove to prepare this updated IDFCSP for the FGD Ponds.

1.1 CCR Surface Impoundment Inflow Design Flood Control System Plan Requirements

Section 257.82(a) specifies that an IDFCSP be designed, constructed, operated, and maintained for each existing CCR surface impoundment. The flood control system must adequately:

- Manage flow into the CCR impoundment during and following the peak discharge of the specified inflow design flood.
- Manage flow from the CCR impoundment to collect and control the peak discharge resulting from the specified inflow design flood.

The inflow design flood (IDF) for each CCR impoundment varies based on the hazard potential classification of the impoundment:

- High hazard potential impoundment: Probable Maximum Flood
- Significant hazard potential impoundment: 1,000-year flood
- Low hazard potential impoundment: 100-year flood

The IDFCSP must document how the inflow design flood control system has been designed and constructed to comply with the requirements of § 257.82 and must be certified by a qualified professional engineer.

1.2 OGSES Surface Impoundments Subject to Inflow Design Flood Control System Plan Requirements

Section 257.53 defines CCR's such as fly ash, bottom ash, boiler slag, flue gas desulfurization (FGD) materials (gypsum), and related solids generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers. The IDFCSP requirements of the CCR Rule apply to surface impoundments that dispose or otherwise engage in solid waste management of CCRs.

The FGD Ponds have been identified as CCR Units subject to the IDFCSP requirements at the OGSES.

1.3 Description of FGD Ponds

The FGD Ponds are located approximately 2,500 feet northwest of the OGSES power generation units (Figure 2) and are constructed above grade and surrounded by engineered earthen dikes that extend up to approximately 25 feet above surrounding grade.

Figure 3 shows a simplified process flow schematic for the FGD Ponds. The FGD Ponds receive wastewater from the FGD wet scrubber system blowdown, low volume wastewater, bottom ash contact water, and storm water runoff from approximately 41 acres of the power plant. All fluids are pumped into the FGD Ponds and there are no uncontrolled or gravity inflows into the ponds, with the exception of a gravity overflow from FGD-A to FGD-B. Process wastewater can be transferred between the FGD Ponds and is used as makeup water to the FGD scrubber system and related purposes. The are no spillways or other uncontrolled gravity flow releases from the ponds. Solids that accumulate in the FGD ponds are periodically removed and transported to OGSES Ash Landfill 1.

FGD-A covers an area of approximately 9 acres and was constructed in 2008. FGD-A is currently lined with a 3-foot thick compacted clay liner; however, FGD-A ceased receipt of waste by April 11, 2021, and Oak Grove has initiated the retrofit of FGD-A with a composite liner system meeting the requirements of § 257.71(a)(1)(ii). The retrofitted liner system will consist of a minimum 2-foot thick compacted clay liner or geosynthetic clay liner (GCL), overlain be a 60-mil HDPE geomembrane liner. The floor of the pond will be covered by a 1.5-foot thick layer of protective soil and the upper portion of the pond side slopes will be covered with concrete revetment mat.

FGD-B covers an area of approximately 11.2 acres and was constructed in 2011. FGD-B is constructed with a composite liner consisting of a minimum 2-foot thick compacted clay liner, overlain be a 60-mil HDPE geomembrane liner, overlain by a 1-foot thick layer of protective soil. The composite liner system in FGD-B complies with the requirements of § 257.71(a)(1)(ii).

FGD-C covers an area of approximately 15.2 acres and was constructed in 2016. FGD-C is constructed with a composite liner consisting of a minimum 2-foot thick compacted clay liner, overlain by a 60-mil HDPE geomembrane liner, overlain by a 2-foot thick soil/ash protective layer. The composite liner system in FGD-C complies with the requirements of § 257.71(a)(1)(ii).

Based on available construction data, the FGD Ponds were constructed to provide the following estimated storage capacities (with zero freeboard):

- FGD-A: 190 acre-feet,
- FGD-B: 125 acre-feet, and
- FGD-C: 248 acre-feet.

Area-Capacity Curves for the FGD Ponds are reproduced in Appendix B (Golder, 2016b).

1.4 USACE Size Classification for FGD Ponds

The US Army Corps of Engineers (USACE) classifies the relative size of dams based on the height of the dam and the storage capacity of the impounded area behind the dam as follows (USACE, 1979):

USACE Dam Size Classification		
Size Category	**Impoundment Capacity (acre-ft)**	**Impoundment Height (ft)**
Small	50 and < 1,000	25 and < 40
Intermediate	1,000 and < 50,000	40 and < 100
Large	> 50,000	> 100

Based on the dike heights and operating capacities of the FGD Ponds, these ponds are categorized as small impoundments based on the USACE dam size classification criteria.

1.5 Hazard Potential Classification of FGD Ponds

The FGD Ponds are classified as low hazard potential impoundments in accordance with the requirements of § 257.73(a)(2) (Golder, 2021).

1.6 Previous Hydraulic Capacity Evaluations of FGD Ponds

The FGD Ponds were previously subjected to the following Hydraulic Capacity Evaluations:

- **Initial Inflow Design Flood Control System Plan, 2016**. As required under § 257.82(c)(3), the initial Inflow Design Flood Control System Plan for the FGD Ponds was completed and placed in the OGSES operating record in October 2016 (Golder, 2016a). The initial IDFCSP concluded that the FGD Ponds were adequately designed to manage the 100-year, 24-hour inflow design flood in accordance with § 257.82.
- **EPA Hydraulic Capacity Evaluation, 2014**. In 2009, the EPA initiated a program to assess the stability and functionality of coal ash impoundments at coal-fired electric generating plants across the United States. The assessment of the stability and functionality of FGD-A and FGD-B was performed by O'Brien and Gere (OBG) on behalf of EPA (OBG, 2014). As part of the assessment, OBG evaluated the "Hydrologic/Hydraulic Safety" of FGD-A and FGD-B and concluded the following:
  - FGD-A and FGD-B only receive water pumped into the units at a controlled rate, with the exception of a gravity overflow from FGD-A to FGD-B.
  - The normal pool elevation of FGD-A and FGD-B is managed to provide a minimum of 2-foot freeboard.
  - OBG examined the 100-year rainfall event and compared the data with the available freeboard in the ponds. The freeboard should be adequate to contain the one-percent probability, 24- hour precipitation event without overtopping the impoundment embankments.

Based on the information reviewed, FGD-A and FGD-B were given the highest rating of "Satisfactory" for hydrologic and hydraulic safety.

2.0 UPDATED HYDRAULIC CAPACITY EVALUATION OF FGD PONDS

Section 257.73 defines the inflow design flood (IDF) as “the flood hydrograph that is used in the design or modification of the CCR surface impoundment and its appurtenant works.” From an engineering design standpoint, the IDF is the rate of water coming into a surface impoundment over time that the impoundment must be able to safely pass or contain using a combination of outlet works and surcharge storage (freeboard).

The updated IDFCSP for the FGD Ponds must demonstrate that the impoundments are designed to manage flow into and out of the units during and following the peak discharge of the specified inflow design flood. This demonstration will be accomplished through calculation of a water balance for the FGD Ponds. The basic equation for the water balance is as follows:

Inflows = Outflows + Change in Pond Storage

For the water balance to demonstrate compliance with CCR requirements, the rate of inflows into the FGD Ponds (the inflow design flood) must not be greater than the rate of outflows from the FGD Ponds plus the maximum allowable storage in the impoundments.

2.1 Inflows to FGD Ponds

The FGD Ponds are located above grade and inflows that enter the impoundments are pumped into the units under controlled conditions – there are no gravity or uncontrolled discharges to the FG Ponds, other than a gravity overflow from FGD-A to FGD-B. As shown on Figure 3, water coming into the FGD Ponds consists of the following:

- wastewater from the FGD wet scrubber system blowdown,
- low volume wastewater,
- bottom ash contact water,
- storm water runoff from approximately 41 acres of the power plant, and
- direct precipitation on the ponds.

Most of the sources of inflow to the FGD Ponds are process units that generate water at controlled rates which are not significantly affected by variations in precipitation intensity and associated flood conditions. In addition, approximately the same flow rate and volume of water is pumped from the FGD Ponds to the plant FGD wet scrubber system as is returned to the FGD Ponds form the plant. As a result, for the purposes of this IDFCSP, it is assumed that the only net contributions from inflows to the FGD Ponds during the design flood event are:

- storm water runoff from approximately 41 acres of the power plant, and
- direct precipitation on the ponds.

2.2 Outflows From FGD Ponds

The FGD Ponds act as surge basins for various water streams in the plant water system and process wastewater can be transferred to and from FGD-A, FGD-B and/or FGD-C. The rate of outflow from the FGD Ponds is controlled to maintain a minimum 2-foot freeboard in FGD-A and FGD-B and 3-foot freeboard in FGD-C under normal operating conditions.

The are no spillways or other uncontrolled gravity flow releases from the ponds, with the exception of a gravity overflow form FGD-A to FGD-B. It should be noted that water is also removed from the FGD Ponds through natural evaporation; however, evaporation from the FGD Ponds was not considered as part of this evaluation.

2.3 Inflow Design Flood for FGD Ponds

As described in Section 1.5, the FGD Ponds are classified as a low hazard potential CCR Impoundments. In accordance with § 257.82(a)(3), the inflow design flood for a low hazard potential CCR impoundment is the 100-year flood event.

The 100-year, 24-hour storm for the FGD Ponds is estimated to be 10.4 inches based on the Point Precipitation Frequency Estimate Table from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 for Franklin, TX (NOAA, 2021, see Appendix A).

2.4 Hydraulic Capacity Evaluation for FGD Ponds

A hydraulic capacity evaluation was performed on the FGD Ponds for the inflow design flood as part of the development of the IDFCSP. The evaluation was based on the water balance equation described above and the following assumptions:

- The design operating level in the ponds is managed to maintain a minimum 2-foot freeboard in FGD-A and FGD-B and 3-foot freeboard in FGD-C under normal operating conditions.
- Inflows to and outflows from the FGD Ponds considered as part of the evaluation are as described in Sections 2.1 and 2.2 of this report.
- Evaporation from the ponds is assumed to be negligible during the inflow design flood event.

Based on these assumptions, the general water balance equation for the FGD Ponds can be modified as follows:

Process Inflows + Direct Precipitation = Process Outflows + Change in FGD Pond Storage

Since the rate of water decanted from the FGD Ponds (process outflow) is assumed to be equivalent to the process water inflows to the ponds, the FGD Pond water balance equation becomes:

Direct Precipitation + Runoff From Power Plant = Change in FGD Pond Storage

Stormwater runoff volumes were calculated using the Rational Method:

V = CiA, where:

V = Estimated Runoff Volume (cubic feet, cf)

C = Rational Method Runoff Coefficient. Assumed Runoff Coefficients:

- Direct Precipitation on Pond Surface: 1.00
- Runoff From Power Plant: 0.95

i = Rainfall (ft). Assumed to be 10.4 inches (0.87 feet) for the 100-year, 24-hr design flood.

A = Stormwater Drainage Area (sf)

Hydraulic capacity evaluation calculations for the FGD Ponds are presented in Appendix C. Inflows into the ponds during the design flood were estimated to be as follows:

- Direct Precipitation On Ponds. The surface areas of the FGD Ponds at the top of the perimeter dikes are approximately as follows:

  - FGD-A: 9 acres (391,789 sf)
  - FGD-B: 11.2 acres (486,669 sf)
  - FGD-C: 15.2 acres (662, 896 sf)

  A Runoff Coefficient of 1.0 was assumed for direct precipitation on the ponds. Based on these assumptions, the volume of direct precipitation onto the FGD Ponds is estimated to be as follows:

  - FGD-A: 339,768 cf
  - FGD-B: 422,822 cf
  - FGD-C: 573,830 cf

- Runoff From Power Plant. For the purposes of this IDFCSP, it is assumed that all stormwater runoff/drainage from the power plant area is pumped to the FGD Ponds during the design flood. The surface area of the plant area is estimated to be approximately 41 acres (1,785,960 sf) (Golder, 2016a). The plant area is primarily concrete, so a Runoff Coefficient of 0.95 was assumed for this area. Based on these assumptions, the volume of runoff from the Power Plant is estimated to be 1,470,440 cf.

The total inflow into the FGD Ponds during the design flood is estimated to be 2,806,861 cf (64.4 acre-ft).

Based on the Area-Capacity Curves in Appendix B, the available storage capacity provided by the 2-foot freeboard in FGD-A and FGD-B and 3-foot freeboard in FGD-C is estimated to be as follows:

- FGD-A:
  - Capacity at top of dike: 190 acre-ft
  - Capacity at 2 feet below top of dike: 172 acre-ft

    Available Freeboard Storage: 18 acre-ft

- FGD-B:
  - Capacity at top of dike: 125 acre-ft
  - Capacity at 2 feet below top of dike: 104 acre-ft

    Available Freeboard Storage: 21 acre-ft

- FGD-C:
  - Capacity at top of dike: 248 acre-ft
  - Capacity at 3 feet below top of dike: 204 acre-ft

    Available Freeboard Storage: 44 acre-ft

The total available freeboard storage in the FGD Ponds is approximately 83 acre-ft (3,615,480 cf).

The available freeboard storage compares to the total inflow into the FGD Ponds during the design flood as follows:

- Available Freeboard Storage: 3,615,480 cf (83 acre-ft)
- Total Inflow into FGD Ponds: 2,806,861 cf (64.4 acre-ft)

  Remaining Freeboard Storage: 808,619 cf (18.6 acre-ft)

As a result, the FGD Ponds are adequately designed to manage the inflow design flood in accordance with § 257.82.

3.0 UPDATED INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN FOR FGD PONDS

The FGD Ponds are adequately designed to manage the 100-year, 24-hour inflow design flood in accordance with § 257.82. The FGD Ponds should be operated in accordance with the following Inflow Design Flood Control System Plan to maintain adequate freeboard in the impoundment to manage the design flood conditions:

- The operating level in FGD-A and FGD-B should be maintained to provide a minimum of 2 feet of freeboard in the impoundments under normal operating conditions.
- The operating level in FGD-C should be maintained to provide a minimum of 3 feet of freeboard in the impoundment under normal operating conditions.
- Stormwater managed by OGSES sumps should be allowed to accumulate to the extent practicable and the transfer of stormwater collected by the plant sumps should be monitored and regulated to ensure adequate freeboard is maintained in the FGD Ponds during a storm event.

In accordance with § 257.82(c)(4), this updated IDFCSP must be placed in the operating record for the OGSES no later than October 12, 2021. Subsequent periodic IDFCSPs must be completed every five years. In addition, the IDFCSP must be amended whenever there is a change in conditions that would substantially affect the plan.

4.0 REFERENCES

Golder Associates, Inc. (Golder), 2021. Hazard Potential Classification Assessment – 5 Year Update, Oak Grove Steam Electric Station FGD Ponds, Robertson County, Texas. October.

Golder, 2016a. Hydrologic and Hydraulic Capacity Requirements – CCR Surface Impoundments, Oak Grove Steam Electric Station, Robertson County, Texas. October.

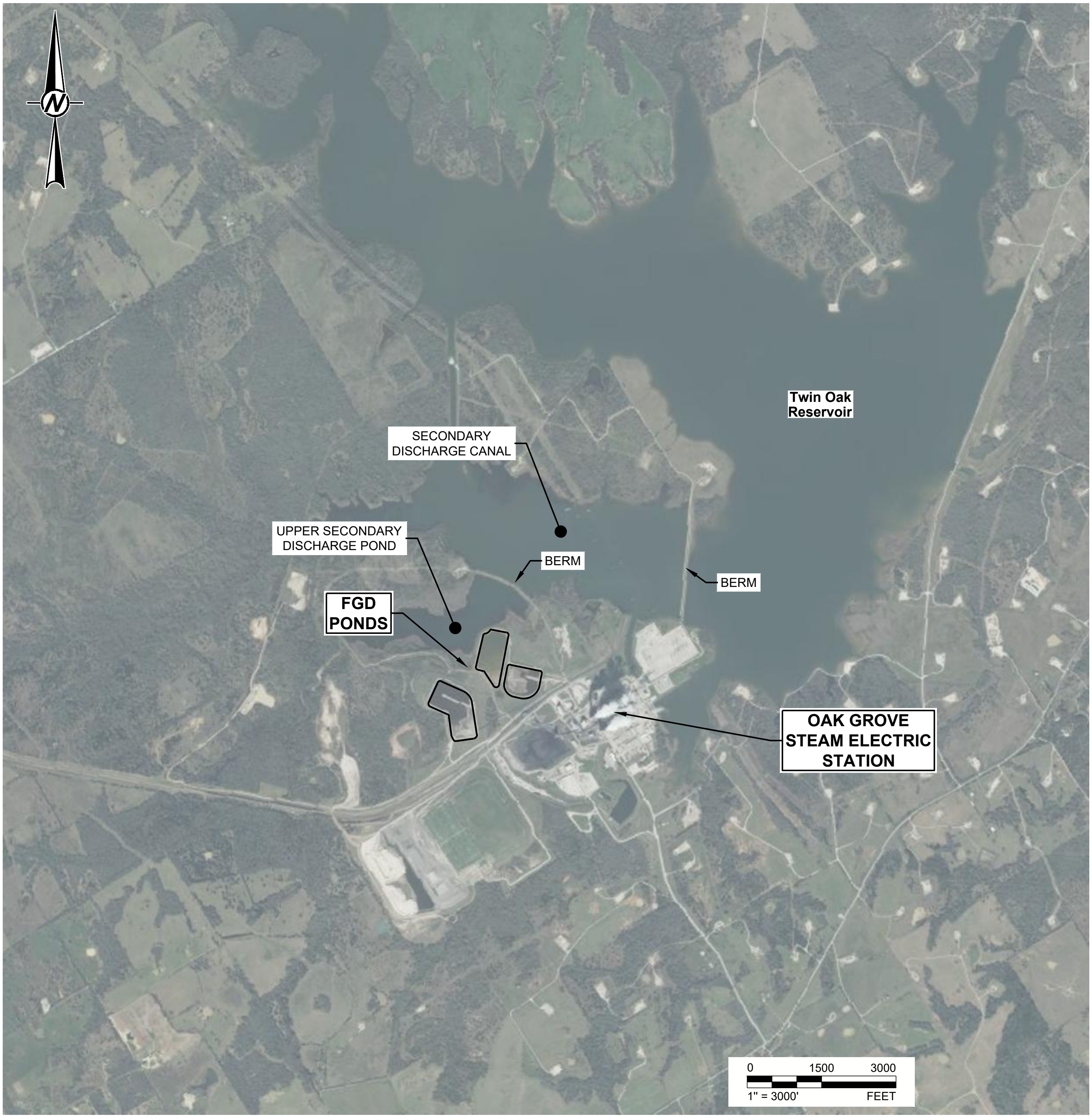
Golder, 2016b. History of Construction - CCR Surface Impoundments, Oak Grove Steam Electric Station, Robertson County, Texas. October.

National Oceanic and Atmospheric Administration (NOAA), 2021. Atlas 14 – Point Precipitation Frequency Estimates Website, Franklin, Texas. September.

O’Brien & Gere (OBG), 2014. Dam Safety Assessment of CCW Impoundments – Luminant Oak Grove Steam Electric Station, June 3.

United States Army Corps of Engineers (USACE), 1979. Recommended Guidelines for Safety Inspections of Dams, ER 1110-2-106, September 26.

FIGURES



CLIENT
OAK GROVE MANAGEMENT COMPANY LLC

PROJECT
OAK GROVE STEAM ELECTRIC STATION
FGD PONDS
INFLOW DESIGN CONTROL SYSTEM PLAN UPDATE

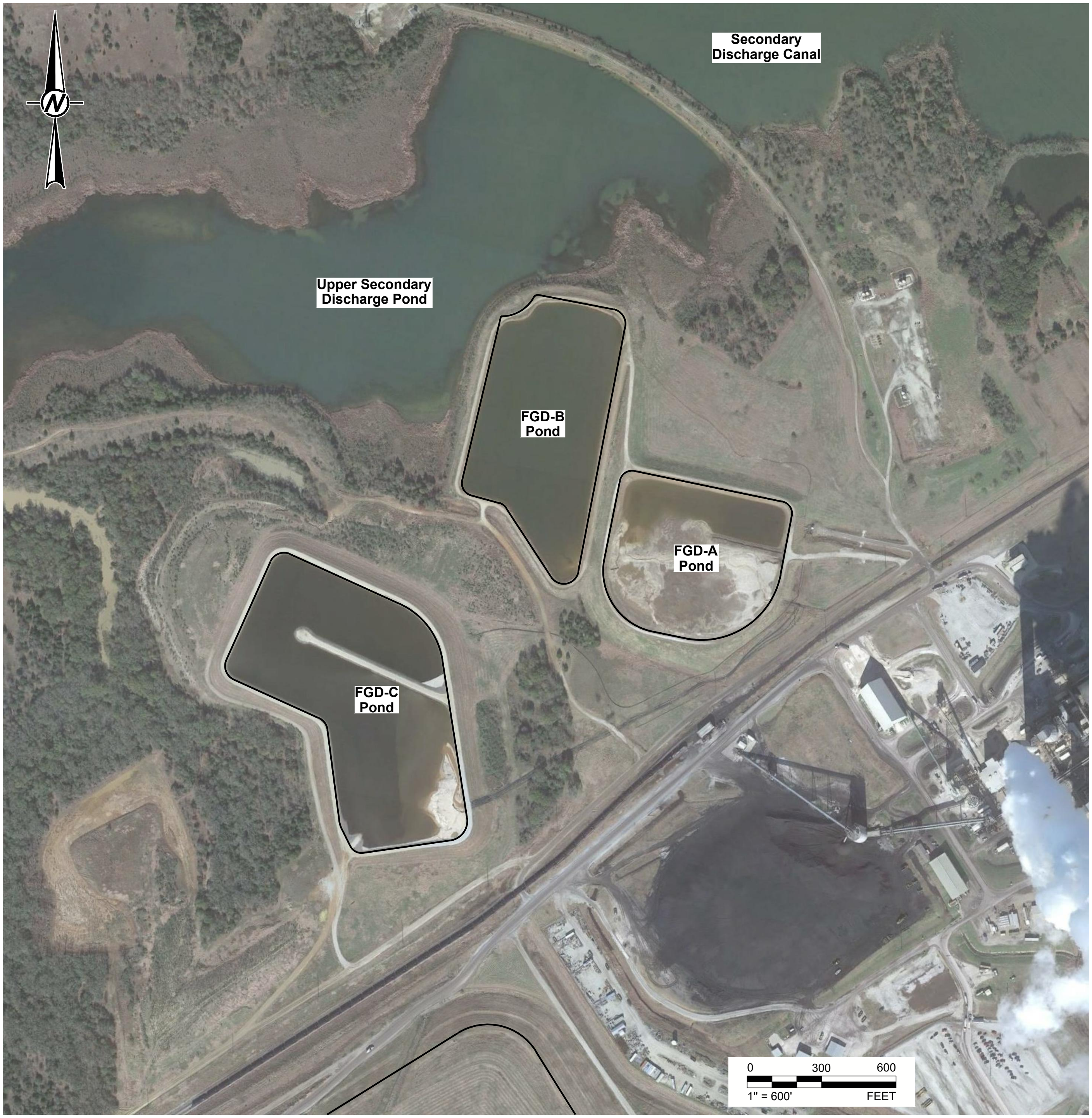
TITLE
SITE LOCATION MAP

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-29
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT NO.	CONTROL	REV.	FIGURE
21465177		0	1

REFERENCE(S)
BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED 12/9/18.



CLIENT
OAK GROVE MANAGEMENT COMPANY LLC

PROJECT
OAK GROVE STEAM ELECTRIC STATION
FGD PONDS
INFLOW DESIGN CONTROL SYSTEM PLAN UPDATE

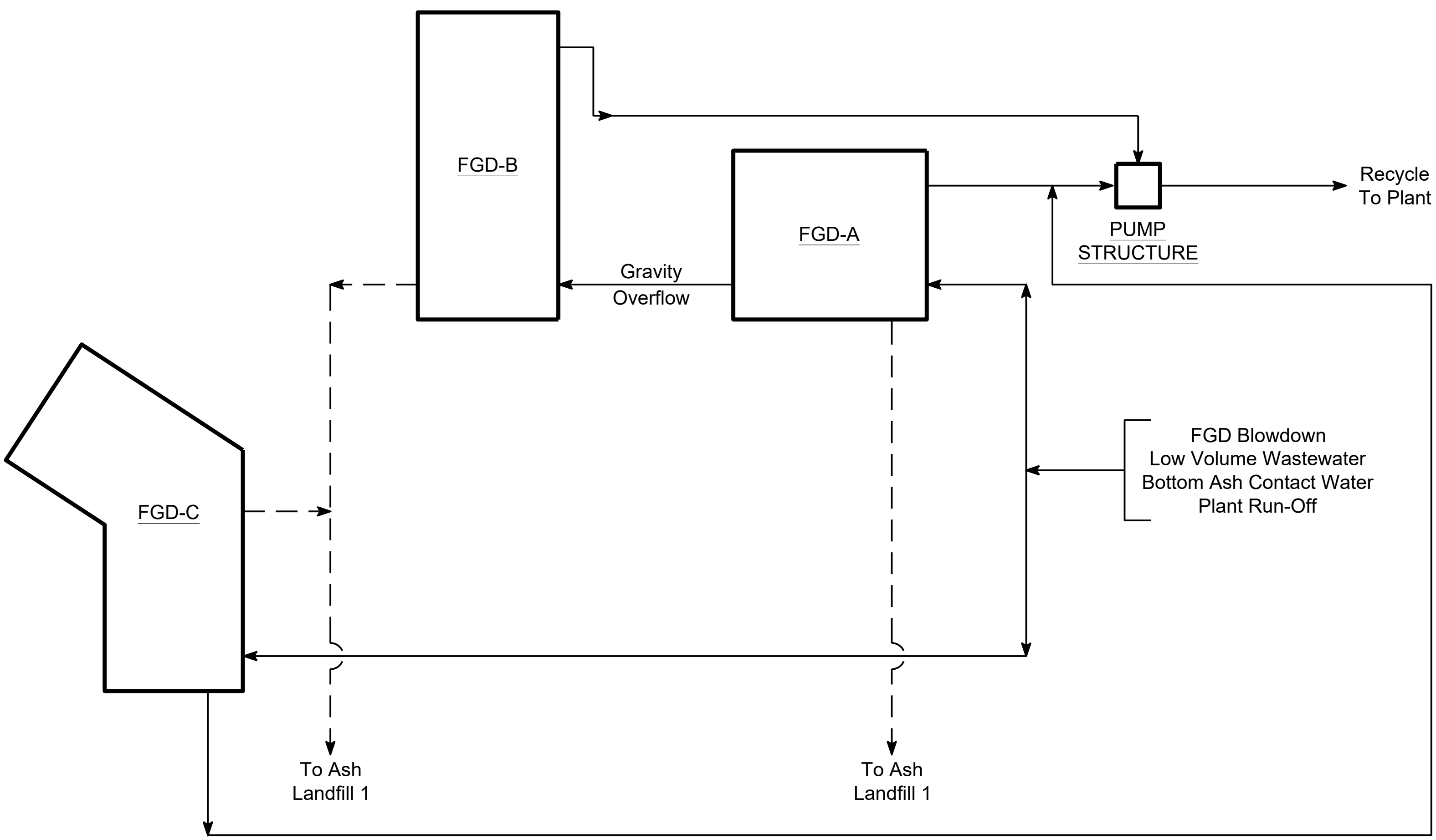
TITLE
SITE PLAN

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-29
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT NO.	CONTROL	REV.	FIGURE
21465177		0	2

REFERENCE(S)
BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED 12/9/18.



LEGEND

WATER

SOLIDS

CLIENT
OAK GROVE MANAGEMENT COMPANY LLC

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-29
DESIGNED	AJD
PREPARED	AJD
REVIEWED	PJB
APPROVED	PJB

PROJECT
OAK GROVE STEAM ELECTRIC STATION
FGD PONDS
INFLOW DESIGN CONTROL SYSTEM PLAN UPDATE

TITLE
SIMPLIFIED CCR SURFACE IMPOUNDMENT FLOW DIAGRAM

PROJECT NO.	CONTROL	REV.	FIGURE
21465177		0	3

APPENDIX A

NOAA Atlas 14 Precipitation Data – Franklin, Texas

NOAA Atlas 14, Volume 11, Version 2
Location name: Franklin, Texas, USA*
Latitude: 31.1819°, Longitude: -96.4882°
Elevation: 436.43 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min	**0.441** (0.334-0.583)	**0.512** (0.390-0.669)	**0.626** (0.476-0.822)	**0.722** (0.542-0.961)	**0.855** (0.622-1.17)	**0.958** (0.678-1.35)	**1.06** (0.734-1.54)	**1.17** (0.789-1.74)	**1.32** (0.859-2.03)	**1.44** (0.911-2.26)
10-min	**0.704** (0.533-0.929)	**0.817** (0.623-1.07)	**1.00** (0.761-1.31)	**1.15** (0.866-1.54)	**1.37** (0.997-1.88)	**1.54** (1.09-2.17)	**1.71** (1.18-2.47)	**1.88** (1.26-2.78)	**2.10** (1.37-3.22)	**2.27** (1.44-3.57)
15-min	**0.882** (0.668-1.17)	**1.02** (0.783-1.34)	**1.26** (0.958-1.65)	**1.45** (1.09-1.93)	**1.71** (1.24-2.35)	**1.91** (1.35-2.69)	**2.11** (1.46-3.06)	**2.33** (1.57-3.46)	**2.62** (1.70-4.02)	**2.85** (1.80-4.48)
30-min	**1.24** (0.941-1.64)	**1.44** (1.10-1.88)	**1.75** (1.34-2.31)	**2.02** (1.51-2.69)	**2.38** (1.73-3.26)	**2.65** (1.87-3.73)	**2.93** (2.02-4.24)	**3.23** (2.17-4.80)	**3.65** (2.37-5.60)	**3.98** (2.52-6.26)
60-min	**1.62** (1.23-2.14)	**1.88** (1.43-2.45)	**2.30** (1.75-3.02)	**2.65** (1.99-3.53)	**3.13** (2.28-4.29)	**3.51** (2.48-4.94)	**3.90** (2.69-5.64)	**4.32** (2.91-6.42)	**4.91** (3.19-7.55)	**5.38** (3.41-8.47)
2-hr	**1.96** (1.50-2.57)	**2.32** (1.77-3.00)	**2.88** (2.21-3.76)	**3.37** (2.54-4.45)	**4.05** (2.96-5.50)	**4.58** (3.26-6.39)	**5.14** (3.56-7.36)	**5.76** (3.89-8.45)	**6.63** (4.32-10.0)	**7.33** (4.65-11.4)
3-hr	**2.16** (1.65-2.82)	**2.58** (1.98-3.31)	**3.24** (2.49-4.20)	**3.82** (2.89-5.02)	**4.63** (3.40-6.27)	**5.28** (3.77-7.33)	**5.98** (4.15-8.50)	**6.74** (4.56-9.81)	**7.81** (5.11-11.8)	**8.69** (5.53-13.4)
6-hr	**2.50** (1.93-3.24)	**3.04** (2.34-3.85)	**3.87** (2.99-4.97)	**4.60** (3.51-6.00)	**5.65** (4.17-7.58)	**6.51** (4.67-8.95)	**7.43** (5.19-10.5)	**8.45** (5.74-12.2)	**9.92** (6.51-14.7)	**11.1** (7.11-16.9)
12-hr	**2.85** (2.21-3.67)	**3.50** (2.69-4.38)	**4.48** (3.47-5.70)	**5.36** (4.11-6.94)	**6.65** (4.94-8.85)	**7.72** (5.58-10.5)	**8.90** (6.25-12.4)	**10.2** (6.98-14.5)	**12.2** (8.01-17.8)	**13.8** (8.83-20.6)
24-hr	**3.25** (2.53-4.14)	**4.00** (3.09-4.96)	**5.13** (4.01-6.49)	**6.16** (4.75-7.92)	**7.68** (5.74-10.1)	**8.95** (6.50-12.1)	**10.4** (7.31-14.2)	**12.0** (8.20-16.8)	**14.3** (9.46-20.7)	**16.3** (10.5-24.0)
2-day	**3.73** (2.93-4.72)	**4.59** (3.58-5.67)	**5.90** (4.64-7.40)	**7.06** (5.48-9.00)	**8.77** (6.58-11.4)	**10.2** (7.40-13.5)	**11.7** (8.28-15.9)	**13.4** (9.26-18.6)	**16.0** (10.6-22.9)	**18.2** (11.7-26.4)
3-day	**4.08** (3.21-5.15)	**5.00** (3.93-6.17)	**6.41** (5.06-8.02)	**7.65** (5.96-9.71)	**9.45** (7.11-12.2)	**10.9** (7.96-14.4)	**12.5** (8.86-16.8)	**14.3** (9.86-19.7)	**16.9** (11.3-24.0)	**19.1** (12.4-27.6)
4-day	**4.37** (3.45-5.49)	**5.32** (4.20-6.56)	**6.80** (5.39-8.48)	**8.09** (6.32-10.2)	**9.94** (7.49-12.8)	**11.4** (8.35-15.0)	**13.0** (9.26-17.5)	**14.8** (10.3-20.3)	**17.5** (11.7-24.6)	**19.7** (12.8-28.3)
7-day	**5.05** (4.01-6.31)	**6.06** (4.83-7.46)	**7.65** (6.10-9.50)	**9.02** (7.08-11.3)	**10.9** (8.27-14.0)	**12.4** (9.13-16.2)	**14.0** (10.0-18.7)	**15.9** (11.0-21.5)	**18.6** (12.4-25.8)	**20.8** (13.5-29.4)
10-day	**5.62** (4.47-6.98)	**6.67** (5.35-8.21)	**8.36** (6.70-10.4)	**9.79** (7.71-12.2)	**11.8** (8.92-15.0)	**13.3** (9.78-17.2)	**14.9** (10.7-19.7)	**16.7** (11.7-22.6)	**19.4** (13.0-26.8)	**21.6** (14.1-30.4)
20-day	**7.35** (5.88-9.06)	**8.54** (6.94-10.5)	**10.5** (8.52-13.0)	**12.2** (9.65-15.1)	**14.4** (10.9-18.1)	**16.0** (11.8-20.5)	**17.6** (12.7-23.0)	**19.4** (13.6-25.8)	**21.9** (14.7-29.8)	**23.9** (15.6-33.0)
30-day	**8.78** (7.06-10.8)	**10.1** (8.25-12.4)	**12.3** (10.0-15.1)	**14.1** (11.2-17.4)	**16.4** (12.6-20.6)	**18.1** (13.5-23.1)	**19.8** (14.3-25.7)	**21.5** (15.1-28.5)	**23.9** (16.1-32.2)	**25.7** (16.8-35.2)
45-day	**10.8** (8.72-13.2)	**12.2** (10.1-15.0)	**14.8** (12.1-18.1)	**16.8** (13.4-20.6)	**19.3** (14.8-24.0)	**21.1** (15.7-26.7)	**22.8** (16.5-29.4)	**24.5** (17.3-32.2)	**26.8** (18.2-35.9)	**28.5** (18.7-38.7)
60-day	**12.6** (10.2-15.3)	**14.2** (11.7-17.4)	**17.0** (13.9-20.7)	**19.1** (15.3-23.4)	**21.8** (16.8-27.0)	**23.7** (17.7-29.8)	**25.4** (18.4-32.6)	**27.2** (19.2-35.4)	**29.4** (20.0-39.1)	**31.1** (20.4-41.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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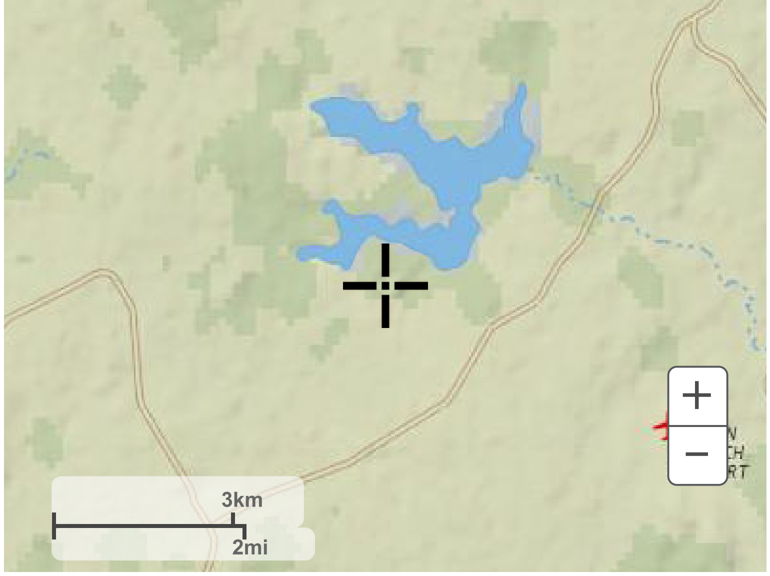
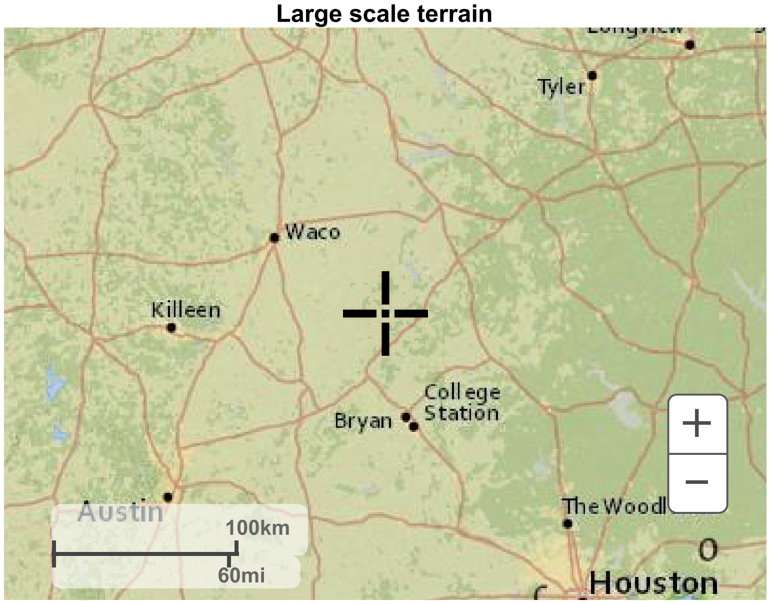
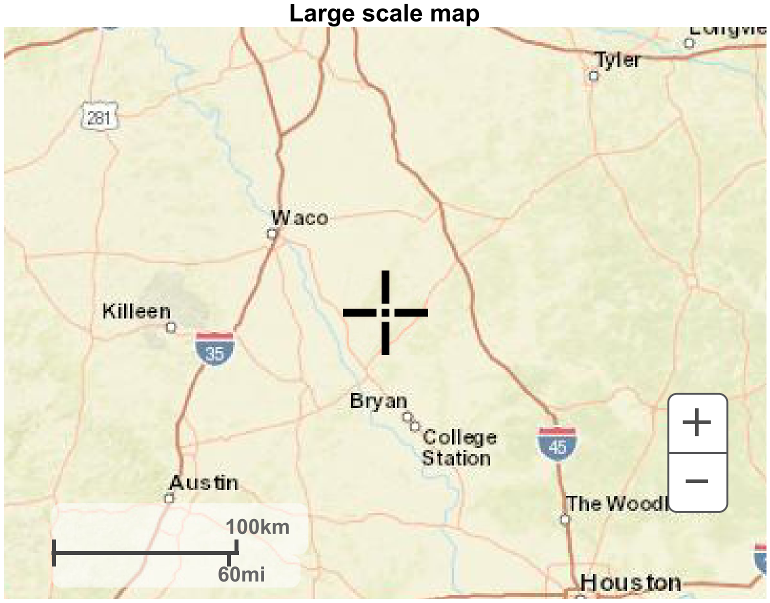
PF graphical



Large scale terrain



Large scale map



Large scale aerial


Tyler
Waco
Killeen
Bryan
College Station
Austin
The Woodl
Houston
100km
60mi

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APPENDIX B

Area Capacity Curves – FGD Ponds

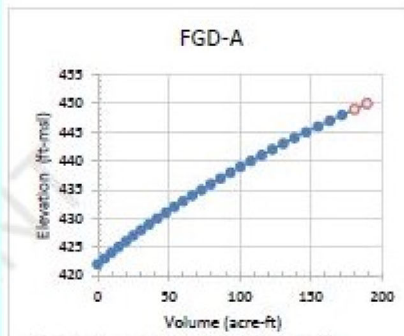
Golder Associates

CALCULATION

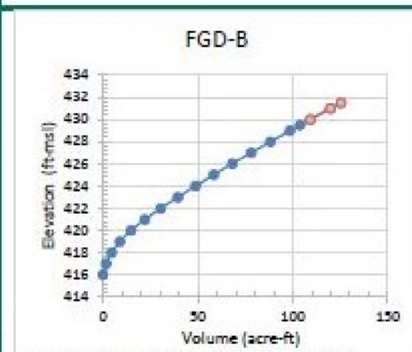
Date:	July 5, 2016	**Made by:**	AGM
Project No.:	1648164	**Checked by:**	VK
Subject:	FGD-A, FGD-B, FGD-C Area Capacity Curves	**Reviewed by:**	JBF
Project Short Title:	Luminant CCR Support		

	Stage (ft)	Elevation (ft-msl)	Area (ft^2)	Incremental Volume (acre-ft)	Cumulative Volume (acre-ft)
FGD-A	1	422	203733	0.0	0
	2	423	209,836	4.7	5
	3	424	215,986	4.9	10
	4	425	222,184	5.0	15
	5	426	228,431	5.2	20
	6	427	234,727	5.3	25
	7	428	241,063	5.5	31
	8	429	247,456	5.6	36
	9	430	253,888	5.8	42
	10	431	260,372	5.9	48
	11	432	266,886	6.1	54
	12	433	273,441	6.2	60
	13	434	280,042	6.4	66
	14	435	286,685	6.5	73
	15	436	293,375	6.7	80
	16	437	300,109	6.8	86
	17	438	306,888	7.0	93
	18	439	313,712	7.1	101
	19	440	320,580	7.3	108
	20	441	327,492	7.4	115
	21	442	334,451	7.6	123
	22	443	341,453	7.8	131
	23	444	348,499	7.9	139
	24	445	355,584	8.1	147
	25	446	362,726	8.2	155
	26	447	369,907	8.4	163
	27	448	377,132	8.6	172
	28	*449*	*384,402*	*8.7*	*181*
	29	*450*	*391,789*	*8.9*	*190*
FGD-B	1	416	39958	0	0
	2	417	98233	2	2
	3	418	158638	3	5
	4	419	220911	4	9
	5	420	285836	6	15
	6	421	347894	7	22
	7	422	383271	8	30
	8	423	403466	9	39
	9	424	411926	9	49
	10	425	420443	10	58
	11	426	429015	10	68
	12	427	437649	10	78
	13	428	446337	10	88
	14	429	455083	10	99
	14.5	429.5	459629	5	104
	15	*430*	*463,885*	*5.3*	*109*
	16	*431*	*472,743*	*10.8*	*120*
	16.5	*431.5*	*486,669*	*5.5*	*125*

Area Capacity Curve



Note: Maximum design operating level is 448 ft.



Note: Maximum design operating level is 429.5 ft.

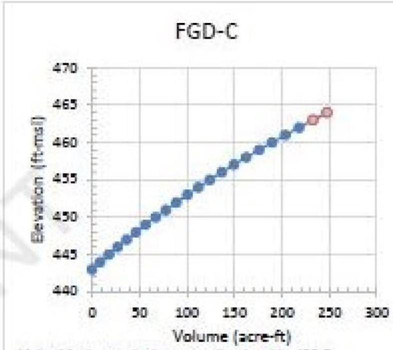
Golder Associates

CALCULATION

Date:	July 5, 2016	**Made by:**	AGM
Project No.:	1648164	**Checked by:**	VK
Subject:	FGD-A, FGD-B, FGD-C Area Capacity Curves	**Reviewed by:**	JBF
Project Short Title:	Luminant CCR Support		

	Stage (ft)	Elevation (ft-msl)	Area (ft^2)	Incremental Volume (acre-ft)	Cumulative Volume (acre-ft)
FGD-C	1	443	369,540	0	0
	2	444	382,825	9	9
	3	445	396,177	9	18
	4	446	409,600	9	27
	5	447	423,093	10	36
	6	448	436,657	10	46
	7	449	450,291	10	56
	8	450	463,995	10	67
	9	451	477,769	11	78
	10	452	491,614	11	89
	11	453	505,529	11	100
	12	454	519,514	12	112
	13	455	533,570	12	124
	14	456	547,696	12	137
	15	457	561,892	13	149
	16	458	576,151	13	162
	17	459	590,467	13	176
	18	460	604,840	14	189
	19	461	619,269	14	204
	20	462	633,755	14	218
	21	*463*	*648297*	*15*	*233*
	22	*464*	*662896*	*15*	*248*

Area Capacity Curve



Note: Maximum design operating level is 462 ft.

10/10/16

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PROFESSIONAL ENGINEER

Professional Engineering Firm
Registration Number F-2578

APPENDIX C

Hydraulic Capacity Evaluation Calculations - FGD Ponds

Appendix C
Oak Grove Steam Electric Station
Inflow Design Flood Control System Plan
Inflow Volume Estimates
FGD Ponds

Assumptions

1) Design Rainfall (in): 10.4 100-Year, 24-Hr Storm

2) Inflows to FGD Ponds Consist of the Following:

- Direct Precipitation on the FGD Ponds
- Runoff Pumped From Power Plant

3) Runoff Volumes Calculated Using the Rational Method:

V = CiA, where:

V = Estimated Runoff Volume (cf)
C = Rational Method Runoff Coefficient
i = Rainfall (ft)
A = Stormwater Drainage Area (sf)

4) Assumed Runoff Coefficients:

- Direct Precipitation on Lined Pond Surface:	1.00
- Power Plant Drainage:	0.95

5) Drainage Areas (acres):

- FGD-A:	9.0
- FGD-B:	11.2
- FGD-C:	15.2
- Power Plant Drainage:	41

6) Assume Total Inflow Volume Generated During 100-Yr, 24-Hr Storm must be Contained in Freeboard of FGD Ponds

Inflow Volume Estimates

1) Precip on FGD-A (cf):	339,768
2) Precip on FGD-B (cf):	422,822
3) Precip on FGD-C (cf):	573,830
4) Power Plant Runoff Pumped to FGD Ponds (cf):	1,470,440
Total Inflow Volume to FGD Ponds (cf):	**2,806,861**

Notes:

1) 100 Yr, 24-Hr Storm from NOAA Atlas 14 for Franklin, TX.

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