HAZARD POTENTIAL CLASSIFICATION ASSESSMENT
BIG BROWN STEAM ELECTRIC STATION
NORTH AND SOUTH BOTTOM ASH PONDS
FREESTONE COUNTY, TEXAS

October 2016

Prepared for:

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PBW Project No. 5196C

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC 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 hazard potential classification assessment was conducted in accordance with the requirements of Section 257.73(a)(2) of the CCR Rule.

10/05/16

Patrick J. Behling, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC

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1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) operates the Big Brown Steam Electric Station (BBSES) located approximately 10 miles northeast of Fairfield, Freestone County, Texas (see Figure 1). The BBSES consists of two coal/lignite-fired units with a combined operating capacity of approximately 1,150 megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash and boiler slag are generated as part of BBSES unit operation. The CCRs are transported off-site for beneficial reuse by third-parties or are managed/disposed of by Luminant at the BBSES.

The CCR Rule (40 CFR 257 Subpart D - *Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments*) has been promulgated by US Environmental Protection Agency (USEPA) to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national operating criteria for existing CCR surface impoundments and landfills, including periodic hazard potential classification assessment requirements for all CCR impoundments. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to perform the initial hazard potential classification assessment for the CCR impoundments at the BBSES. This report presents the findings of the initial hazard potential classification assessment.

1.1 Hazard Potential Classification Assessment Requirements - CCR Surface Impoundments

Section 257.73(a)(2) of the CCR Rule specifies that periodic hazard potential classification assessments be performed by a qualified professional engineer for each existing CCR surface impoundment. The hazard potential classification assessments must document the hazard potential classification of each CCR impoundment as either:

- A high hazard potential CCR surface impoundment,
- A significant hazard potential CCR surface impoundment, or
- A low hazard potential CCR surface impoundment.

The assessments must document the basis for each hazard potential classification and must be certified by a qualified professional engineer confirming that the hazard potential classifications were conducted in accordance with the requirements of section 257.73(a)(2) of the CCR Rule.

In accordance with 257.73(f) of the CCR Rule, the initial hazard potential classification assessment for an existing CCR surface impoundment must be completed and placed in the facility operating record no later than October 17, 2016. Subsequent periodic hazard potential classification assessments must be completed every five years from the completion date of the initial assessment.

1.2 BBSES Impoundments Subject to Hazard Potential Classification Assessments

The CCR Rule defines coal combustion residuals 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 hazard potential classification assessment requirements of the CCR Rule apply to surface impoundments that dispose or otherwise engage in solid waste management of CCRs.

The following surface impoundments at the BBSES have been identified as CCR Units subject to the hazard potential classification assessment requirements:

- North Bottom Ash Pond (NBAP); and
- South Bottom Ash Pond (SBAP).

The NBAP and SBAP (collectively "Bottom Ash Ponds" or "BAPs") are located approximately 1,500 feet northwest of the BBSES power plant (Figure 2). The NBAP and SBAP are located immediately adjacent to each other and share an interior earthen embankment. Due to their proximity to each other, the NBAP and SBAP will be considered one CCR surface impoundment (identified as the "BAPs) for the purposes of this hazard potential classification assessment.

1.3 Description of Bottom Ash Ponds

A simplified process flow diagram for the BAPs is shown on Figure 3. The BAPs receive recovered overflow from bottom ash dewatering bins and other BBSES process wastewater sources. The ponds also act as a surge basin for storm water runoff from the BBSES ash-water system and infrequently receive non-hazardous liquid metal cleaning wastes delivered by truck from other Luminant facilities under a Texas Commission on Environmental Quality (TCEQ) industrial waste permit. Recovered sluice water, process waters and storm water runoff from the BBSES ash-water system are pumped to each pond through a series of above grade pipes on the east end. The BAPs are located partially above and partially below grade and all material that enters the ponds is pumped into the impoundments – there are no gravity discharges to the BAPs.

A 30-inch diameter subsurface water pipe exits the NBAP on the west end and a 42-inch subsurface water pipe exits the SBAP on the west end. These subsurface lines are connected to a below grade valve box immediately west of the SBAP. Piping from the valve box is connected to a low pressure ash water pump station located east of the SBAP. The BAPs do not have an emergency spillway. Ash contact water is returned to the power plant for reuse in the bottom ash system. When sufficient bottom ash has accumulated in the first pond, the bottom ash slurry is diverted to the second pond. Bottom ash in the first pond is then removed and transported via truck to the nearby Luminant mine for placement in Area C or other beneficial use.

The NBAP and the SBAP are each approximately 1,400 feet long by 250 feet wide. The BAPs are constructed partially above and partially below grade and are surrounded by engineered earthen embankments that extend approximately 14 to 21 feet above grade. The exterior slopes of the embankments are vegetated with grasses and similar vegetation.

The BAPs were originally constructed in the late 1960s and were relined with a 3-foot thick clay liner in 1989-1990. As-built engineering drawings indicate that the clay liner has a permeability of $<1 \times 10^{-7}$ cm/sec (TXU, 1991; TUEC, 1998). The bottom of the BAPs is located at approximately 328 feet above mean sea level (MSL) and the crest elevation of the earthen embankments is approximately 350 feet MSL. The design operating fluid/CCR level in the BAPs is approximately 347 feet MSL (approximately 3 feet below the crest of the perimeter embankments). A digital topographic site plan of the BAPs was created from the as-built engineering drawings for the ponds (PBW, 2016). Based on this site plan and using a design operating elevation of 347 feet MSL, the design operating capacity of the NBAP is approximately 40,000,000 gallons (123 acre-ft) and the design operating capacity of the SBAP is approximately 39,700,000 gallons (122 acre-ft). The total design operating capacity of the BAPs is approximately 79,700,000 gallons or approximately 245 acre-ft.

1.4 USACE Size Classification for BAPs

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 (USACE, 1979). As shown in the table below, based on the embankment height (14 to 21 feet above grade) and total operating capacity (245 acre-ft) of the BAPs, the BAPs would be categorized as small impoundments using the USACE dam size classification criteria:

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

2.0 CCR HAZARD CLASSIFICATION ASSESSMENT METHODOLOGY

As defined in Section 257.53 of the CCR Rule, hazard potential classification means the possible adverse incremental consequences that result from the release of water or stored contents due to failure of a diked CCR surface impoundment or misoperation of the diked CCR surface impoundment or its appurtenances. Hazardous potential classifications for CCR surface impoundments include high hazard potential CCR surface impoundment, significant hazard potential CCR surface impoundment, and low hazard potential CCR surface impoundment, which are defined in the CCR Rule as follows:

- High Hazard Potential CCR Surface Impoundment. A diked surface impoundment where failure or misoperation will probably cause loss of human life.

- Significant Hazard Potential CCR Surface Impoundment. A diked surface impoundment where failure or misoperation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. FEMA considers lifeline facilities to include transportation facilities (highways, airports, ports, trains), electric power, water and sewer, communications (telephone, TV, radio, electronic) and gas and liquid fuel pipelines (FEMA, 1995).

- Low Hazard Potential CCR Surface Impoundment. A diked surface impoundment where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the surface impoundment owner's property.

The hazard classification assessment for the BAPs was performed using the methodology presented in *Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams* developed by the Federal Emergency Management Agency (FEMA, 2004). The FEMA guidelines classify dams into similar hazard potential categories to those defined in the CCR Rule (low hazard potential, significant hazard potential and high hazard potential) and the FEMA guidelines are listed in the Preamble to the CCR Rule as one of the technical resources considered by EPA during development of the CCR Rule.

The FEMA hazard potential evaluation is based on assessing the probable loss of human life and the potential for economic losses, environmental damage, and/or disruption to lifelines caused by failure or misoperation of a dam or its appurtenances. The location/size of the dam and impoundment area is evaluated against development, occupancy and land use conditions in areas downstream of the dam/impoundment that would be affected by a failure of the dam and release of the impounded water. The FEMA evaluation recognizes that the failure of any dam or water-retaining structure, no matter how small, represents a potential danger to downstream life and property and there is always the possibility of someone being in the path of the resulting discharge. However, the FEMA evaluation recognizes that considering every conceivable circumstance that might remotely place a person in the area potentially inundated as a result of the dam failure should not be the basis for determining the hazard classification

level of the dam/impoundment. The FEMA evaluation considers “probable loss of life” to exist where persons are permanently located in the area potentially inundated as a result of the dam failure.

The hazard classification of the BAPs was assessed by identifying the development, occupancy and land use characteristics of areas downstream of the impoundment based on aerial photographs, USGS topographic maps, interviews with Luminant personnel familiar with the area, and similar resources, assessing the probable loss of human life and the potential for economic losses, environmental damage, and/or disruption to lifelines caused by failure of the embankments surrounding the BAPs, and classifying the BAPs based on the FEMA hazard potential criteria.

3.0 PREVIOUS BAP HAZARD POTENTIAL CLASSIFICATION ASSESSMENTS

In 2012, the USEPA contracted with Dewberry Consultants LLC (Dewberry) of Fairfax, Virginia to assess the stability and functionality of the BAPs at the BBSES. The purpose of the assessment was to evaluate the condition and potential for residue release from the BAPs based on a review of available documentation and a site assessment conducted by Dewberry personnel on September 26, 2012. The assessment included a determination of the hazard potential classification of the BAPs.

The results of the BAP assessment were presented to EPA in a March 2014 report (Dewberry, 2014). Key findings related to the hazard potential classification for the BAPs can be summarized as follows:

- Based on the size of the BAP embankment height and impoundment storage capacity, the impoundment would be classified as Small by USACE criteria.
- Luminant owns most of the property in the vicinity of the plant, including the lake and dam. Land near the south end of the lake operated as a State Park is owned by Luminant and leased to the State of Texas.
- Failure or misoperation of the BAPs was not expected to result in a probable loss of human life, and the economic and environmental losses are expected to be contained on the owner's property. Therefore, a Federal Hazard Classification of Low was identified for the BAPs.

The hazard potential classification checklist developed by Dewberry for the BAPs as part of the assessment is reproduced in Appendix A.

4.0 BAP HAZARD POTENTIAL CLASSIFICATION ASSESSMENT

The hazard potential classification of the BAPs was assessed by identifying the development, occupancy and land use characteristics of areas downstream of the impoundments, assessing the probable loss of human life and/or the potential for economic losses, environmental damage, and/or disruption to lifelines caused by failure of the embankments surrounding the BAPs, and using the results of the assessment to classify the BAPs based on the FEMA hazard potential criteria described in Section 2.0 of this report.

4.1 Areas Downstream of the BAPs

The BBSES is located approximately 10 miles northeast of Fairfield, adjacent to the northeast corner of Fairfield Lake. The BAPs are located west of the BBSES generating units, approximately 1,000 feet from Fairfield Lake. The BBSES and the BAPs are located in the drainage area of Fairfield Lake and a failure of the embankments surrounding the BAPs would release CCR solids/fluids that would flow southward to the lake. Figure 4 shows the location of the BBSES and BAPs relative to Fairfield Lake and adjacent areas.

Fairfield Lake is a manmade reservoir located on Big Brown Creek and is impounded by Fairfield Dam (TWDB, 1999). The lake was constructed in 1969 to provide cooling water for the BBSES. Luminant owns the water rights to lake and operates and maintains Fairfield Dam. Fairfield Lake has a drainage area of approximately 34 square miles. At the conservation pool elevation of 310.0 feet, the lake has approximately 33.7 miles of shoreline, covers an area of approximately 2,159 acres, and contains a total volume of approximately 44,169 acre-ft of water. The emergency spillway for Fairfield Dam is constructed at elevation 314.0 feet.

Luminant owns all property immediately adjacent to Fairfield Lake (FCAD, 2016). The shoreline of Fairfield Lake is mostly undeveloped and there are no permanent residences along the lake shoreline. Fairfield Lake State Park is located on the south side of Fairfield Lake. The park covers an area of approximately 1,460 acres and is located on land leased from Luminant by the State of Texas. Activities available at the park include camping, backpacking, hiking, horseback riding, bird watching, and boating, fishing and related water sports on the lake. Lake access is provided by two boat ramps.

There are few significant lifeline facilities immediately adjacent to Fairfield Lake. The electric transmission lines that serve the BBSES run along the west side of the lake and are overhead lines supported by large towers. Underground crude oil and natural gas pipelines run across the southern part

of the lake, but the pipelines are installed below ground and would not be affected by a release from the BAPs (RRC, 2016). There are several small county roads outside the perimeter of the lake, but no large highways that cross the lake. There are no railroads that cross or run alongside of the lake.

4.2 BAP Hazard Potential Classification Assessment

A failure of the embankments surrounding the BAPs would release CCR solids/fluids that would flow southward to the lake. As described in Section 1.3 of this report, the total combined operating volume of the NBAP and SBAP is approximately 228 acre-ft. In the unlikely event that the entire volume of both impoundments is released through catastrophic failure of the embankments, the total volume of fluids that could enter the lake from the BAPs (228 acre-ft) represents only 0.5 percent of the conservation pool volume of Fairfield Lake (44,169 acre-ft).

Assuming a lake surface area of 2,159 acres at the conservation pool elevation of 310.0 feet, the total volume of the BAPs would raise the lake level by approximately 0.1 feet or slightly more than 1 inch. The resulting water surface elevation (310.1 feet) is well below the emergency spillway elevation at Fairfield Dam (314.0 feet), indicating that the total volume of the BAPs would be retained and equalized in Fairfield Lake.

Using the FEMA hazard potential criteria described in Section 2.0 of this report, the projected effects of catastrophic failure or misoperation of the BAPs results in a hazard potential classification of **Low** for the BAPs. This classification is supported by the following:

- No Probable Loss of Human Life - FEMA considers "probable loss of life" to exist where persons are permanently located in the area potentially inundated as a result of dam failure. The shoreline of Fairfield Lake is mostly undeveloped and there are no permanent residences along the lake shoreline. In addition, the total volume of the BAPs would be retained and equalized in Fairfield Lake in the event of a catastrophic failure of the BAP embankments, since the lake level would be raised by approximately 0.1 feet, which is well below the emergency spillway elevation of Fairfield Dam. As a result, a release from the BAPs would result in no probable loss of human life.

- Low Economic and/or Environmental Losses. FEMA considers low economic and or environmental losses to occur when losses resulting from a dam failure are principally limited to the dam owner's property. Since Luminant owns the water rights to Fairfield Lake and the land surrounding the lake, any losses would be limited to the Luminant property.

- No Significant Disruption of Lifelines. There are no significant lifeline facilities immediately adjacent to Fairfield Lake other than the electric transmission lines that serve the BBSES and underground crude oil and natural gas pipelines that crosses the south side of the lake. These facilities would be unaffected by a release from the BAPs.

5.0 FINDINGS OF HAZARD POTENTIAL CLASSIFICATION ASSESSMENT

Pastor, Behling & Wheeler, LLC was retained by Luminant to perform the initial hazard potential classification assessment for the Bottom Ash Ponds at the BBSES in accordance with the requirements of Section 257.73(a)(2) of the CCR Rule. The hazard classification assessment for the BAPs was performed using the methodology presented in *Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams* developed by the Federal Emergency Management Agency.

Based on the FEMA hazard potential criteria, the BAPs are classified as LOW hazard potential CCR surface impoundments, since a failure or misoperation of the BAPs results in no probable loss of human life, low economic and/or environmental losses, and no significant disruption of lifeline systems.

In accordance with 257.73(f) of the CCR Rule, this initial hazard potential classification assessment must be placed in the operating record for the BBSES no later than October 17, 2016. Subsequent periodic hazard potential classification assessments must be completed every five years from the completion date of this initial assessment.

6.0 REFERENCES

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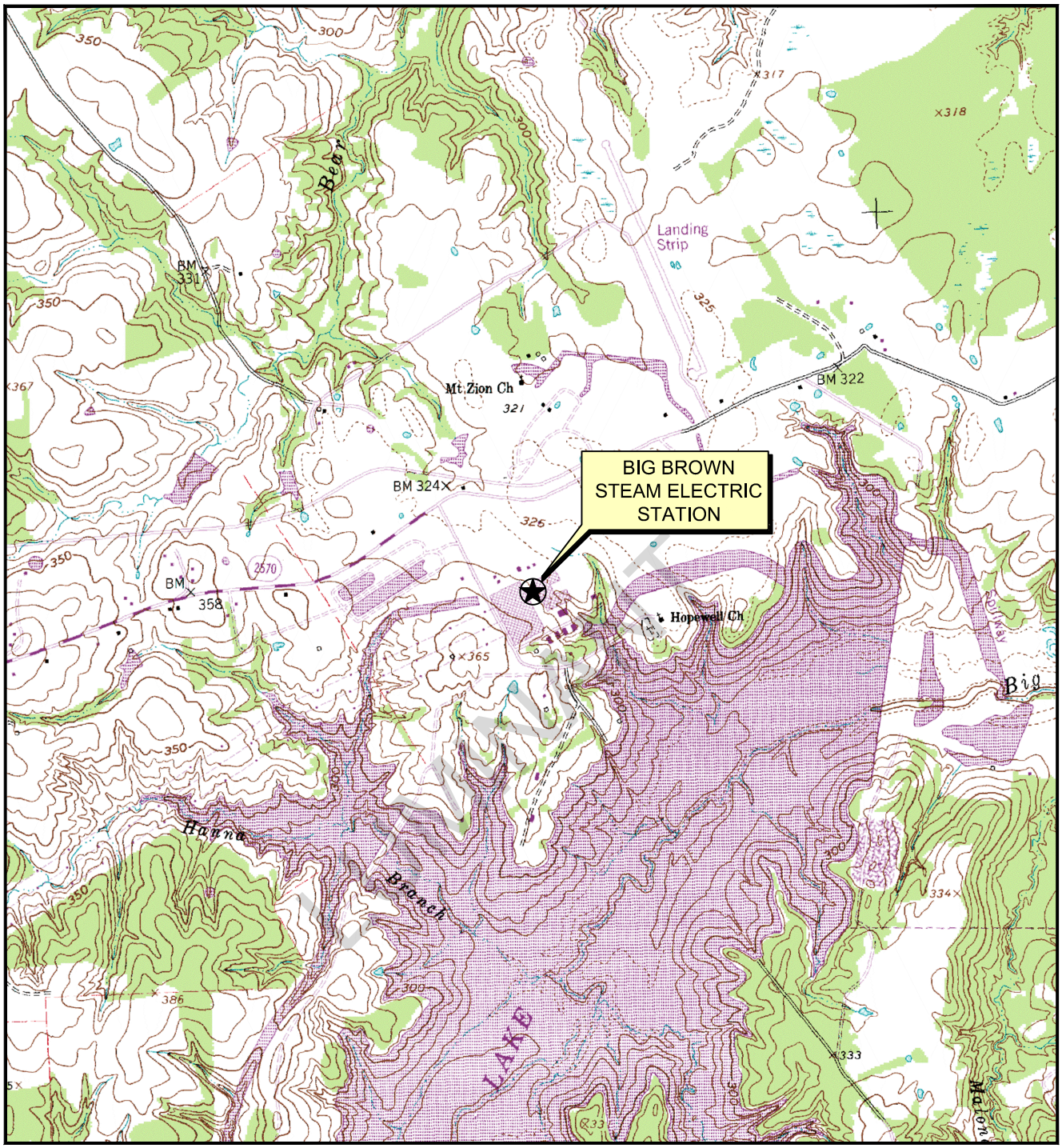
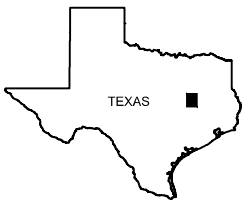
Figures





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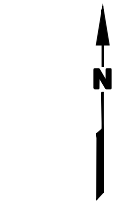

Scale in Feet

0 1000 2000

SOURCE:
Base map from www.tnris.gov, Young, TX 7.5 min. USGS quadrangle dated 1961, revised 1982.

LUMINANT GENERATION COMPANY, LLC
BIG BROWN STEAM ELECTRIC STATION

Figure 1

SITE LOCATION MAP

PROJECT: 5196C	BY: ADJ	REVISIONS
DATE: AUG., 2016	CHECKED: RBL/PJB	

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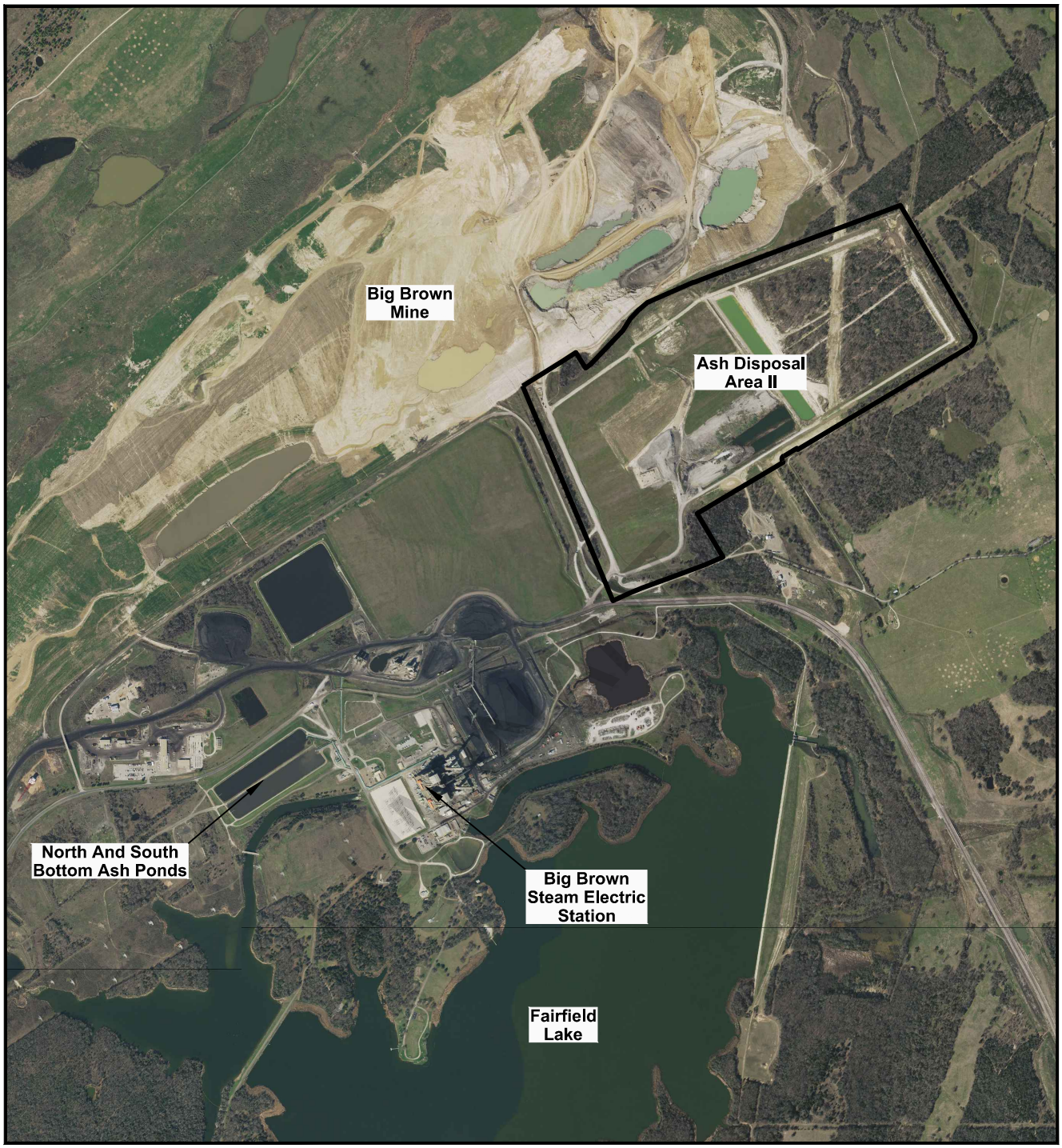
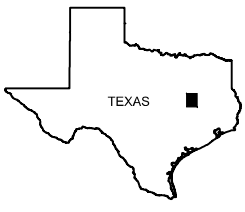
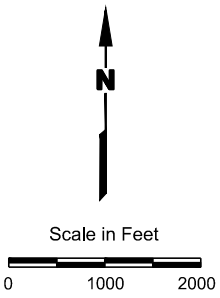
CONSULTING ENGINEERS AND SCIENTISTS





PHOTOGRAPH LOCATION



SOURCE:
Imagery from www.tnris.gov, Young, aerial photographs, 2015.

LUMINANT GENERATION COMPANY, LLC
BIG BROWN STEAM ELECTRIC STATION

Figure 2

SITE VICINITY MAP

PROJECT: 5196C	BY: ADJ	REVISIONS
DATE: OCT., 2016	CHECKED: RBL/PJB	

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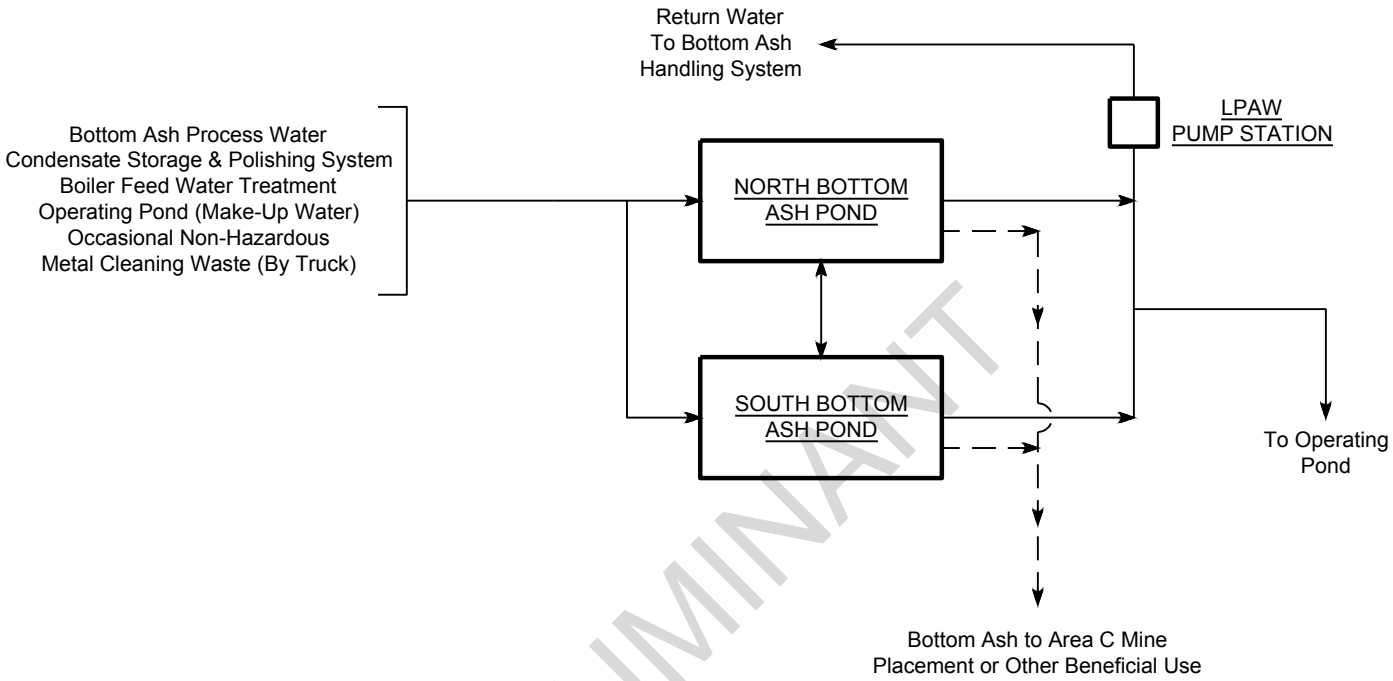

EXPLANATION

Water

Solids

LUMINANT GENERATION COMPANY, LLC

BIG BROWN STEAM ELECTRIC STATION

Figure 3

SIMPLIFIED CCR SURFACE IMPOUNDMENT FLOW DIAGRAM

PROJECT: 5196C	BY: ADJ	REVISIONS
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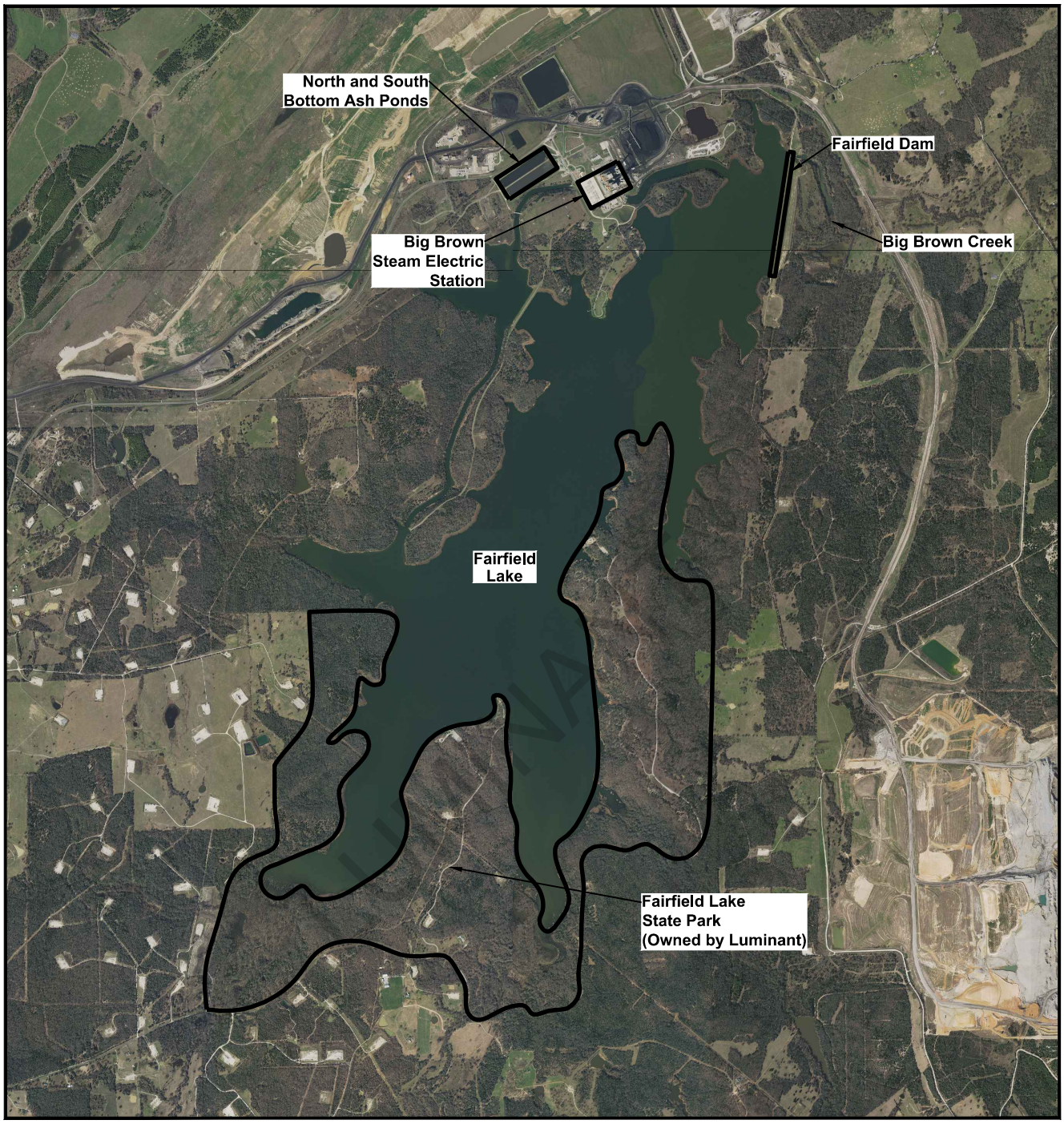

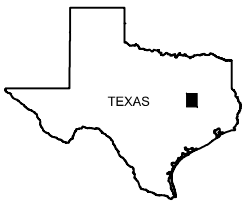

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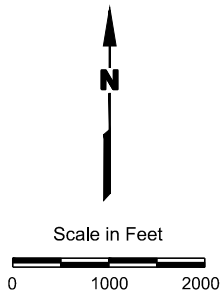

SOURCE:
Imagery from www.tnris.gov, Young, aerial photographs, 2015.

LUMINANT GENERATION COMPANY, LLC
BIG BROWN STEAM ELECTRIC STATION

Figure 4

FAIRFIELD LAKE AND VICINITY

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DATE: OCT., 2016	CHECKED: PJB	

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CONSULTING ENGINEERS AND SCIENTISTS

Appendix A

2012 Dewberry Hazard Potential Classification Checklist

HAZARD POTENTIAL *(In the event the impoundment should fail, the following would occur):*

☐ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

☒ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

☐ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

Based on the size and location of the Big Brown Steam Electric Station Bottom Ash Pond, there is no probable loss of life in the event of failure or misoperation. Economic and environmental losses are expected to be low and limited to the owner's property. The plant owner owns Fairfield Lake and most of the surrounding property. There is a State Park located on the upper end of Fairfield Lake. The park property is owned by Luminant and leased to the State for a nominal annual amount to provide public recreational access to the lake.